

Agroforestry extension needs for land rehabilitation in East Sumba, East Nusa Tenggara, Indonesia

Endri Martini, James M. Roshetko, Pratiknyo Purnomosidhi,
Gerhard Sebastien



**World
Agroforestry
Centre**

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Abstract

This study was conducted to provide baseline information on agroforestry extension needs to support the successful of agroforestry project goals for land rehabilitation in East Sumba. Results from this baseline study are expected to facilitate the implementation of those approaches in the next 2-3 years, specifically in Haharu subdistrict (the most degraded landscape in East Sumba), and generally in East Sumba district. Survey was conducted via focus group discussions (FGD) with communities in 3 villages in Haharu subdistrict (Wunga, Rambangaru and Kadahang), and with subdistrict extension agents, to collect information on agroforestry extension needs and barriers in land rehabilitation in Haharu subdistrict. Additionally interview with key stakeholders was also conducted with local government agencies (Dinas Pertanian, Dinas Perkebunan and Dinas Kehutanan) and non government agencies (Wahana Visi Indonesia, Yayasan Tananua and Lutheran World Relief), to receive inputs on barriers for land rehabilitation in Haharu subdistrict and potentials type of agroforestry extension activities that can be linked to their current programs. Results showed that barriers in land rehabilitation mostly related to limited water resources, poor soil fertility, cattle disturbance, fire, limited facilitation to ensure the sustainability of tree planting program, and limited quality seedlings. Based on those identified barriers, agroforestry extension needs are identified and discussed in this paper. Agroforestry farmer field school is a key option of extension approach that is requested by farmers to enhance their knowledge and capacity to manage their garden and for land rehabilitation in Haharu subdistrict. Integrated with the agroforestry farmer field school, demonstration trials on agroforestry are expected to be established in each sub village in the next 2-3 years as an interactive media to learn about agroforestry practices that can help to rehabilitate land in Haharu. Type of agroforestry system that can be developed in the demonstration trials can be assessed from combination of priority species that farmers are interested in. Extension agents and farmers need to work collaboratively and intensively to ensure farmer participation and learning during planning, establishment and management of the demonstration trials.

Keywords: Demonstration trials, Wunga, Rambangaru, Kadahang, Haharu

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List of Plant Species

Tree species	Indonesian name	Local Name (Sumbanese)	Botanical Name
Mangrove tree	Bakau	Bakau	<i>Sonneratia spp.</i>
Cassia tree	Johar	Johar	<i>Senna siamea</i>
Indian ash tree	Kedondong pagar	Kehi	<i>Lannea coromandelica</i>
Indonesian bay-leaf	Salam	Lobung	<i>Syzygium polyanthum</i>
Lac tree	Kesambi	Kosambi	<i>Scheilechera oleosa</i>
Borassus	Lontar	Mingggit/Tuak	<i>Borassus flabellifer</i>
Coconut	Kelapa	Kelapa	<i>Cocos nucifera</i>
Gmelina	Jati putih	Jati putih	<i>Gmelina arborea</i>
Teak	Jati	Jati	<i>Tectona grandis</i>
Mahagony	Mahoni	Mahoni	<i>Swietenia mahagony</i>
Betel nut	Pinang	Pinang	<i>Areca catechu</i>
Piper	Sirih	Sirih	<i>Piper betle</i>
Cashew	Mente	Mente	<i>Anacardium occidentale</i>
Hog plum	Kedondong	Kedondong	<i>Spondias dulcis</i>
Sandalwood	Cendana	Cendana	<i>Santalum album</i>
Java olive tree	Kepuh	Kelumpang	<i>Sterculia foetida</i>
Breadfruit	Sukun	Sukun	<i>Artocarpus altilis</i>
Jackfruit	Nangka	Nangka	<i>Artocarpus heterophyllus</i>
		Injuwatu	<i>Pleiogynium timoriense</i>
		Marujawa	

1. INTRODUCTION

East Nusa Tenggara Timur (ENT) is the southeastern most province of the Indonesia archipelago. ENT, along with the neighboring provinces of West Nusa Tenggara (WNT) and Maluku, experience ecological conditions that is not normally associates with Indonesia. These provinces are composted of small islands, have limited human populations, are isolated from other areas of Indonesia, and endure long annual dry seasons. This is a sharp contrast to the humid tropical conditions prevailing on the country's better known, larger islands of Sumatra, Java, Bali Kalimantan, Sulawesi and Papua (Roshetko and Mulawarman, 2002).

Small islands in southeastern Indonesia face many ecological and environmental problems. They are vulnerable to natural disasters: volcanic eruptions, earthquakes, landslides and cyclones. Coastal areas compose a large percentage of the land. Proximity to the ocean directly affected the climate of the island. Watersheds are small and ground water limited. The natural environment is specialized, containing many unique species. The land area is steep and soil erosion high. Landuse systems are often of indigenous origin and specialized for the unique combination of local ecological and socioeconomic conditions. There is an inherent danger of land degradation due to excess utilization pressure on the limited land resource (Stubenvoll, 2000; Monk *et al.*, 1997).

Sumba is one of the main islands in ENT and contains four districts: West Sumba, East Sumba, Central Sumba, and Southwest Sumba. The landscape of East Sumba district is highly degraded, with around 86% of the total areas are categorized as degraded, i.e. 191,454 ha of its state forest land and 411,495 ha of non-forestland (Indonesian Ministry of Forestry, 2002). Forests and farms were fired every year. Grassland is the main land cover in the district, maintained through annual burning as a resource for grazing livestock. People in East Sumba are very poor with annual household incomes for year 2013 of Rp 8,236,127 (US\$ 866; AUS\$1,029), with 29% of total households under poverty line (with monthly income below Rp 260,247) (BPS, 2015). Household food security is not assured. There is interest by communities and the government to rehabilitate the landscape as a means of establishing tree-based farming systems to diversify farming systems, obtain food security, enhance livelihoods, improve soil and water conservation, and provide other ecosystem services. However, the harsh environmental conditions limit the success of land rehabilitation programs in East Sumba.

Generally, there are two approaches in land rehabilitation, i.e. by tree planting and by farmer management of natural regeneration. Tree planting is the common approach conducted by many agencies, while the costs is higher than with natural regeneration, tree establishment and growth can be accelerated. While the natural regeneration has low cost, in most cases it require longer time achieve the same impact. The best approach is to combine those two approaches in land rehabilitation. In the case of East Sumba, both approaches have been implemented, however when each approach is appropriate and how the two can be used synergistically needs to be studied and evaluated. Over the past 30 years, tree planting programs have been implemented by various actors to rehabilitate the degraded areas of East Nusa Tenggara (including East Sumba), however the successful rate have been

low due to the barriers in the implementation of land rehabilitation programs (Hutabarat, 2006). Agroforestry systems is promoted as one of landuse system that is expected to support the successful of rehabilitation program (Njurumana, 2008; Njurumana and Prasetyo, 2010), such as in the IRED (Indonesia Rural Economic Development) Sumba program.

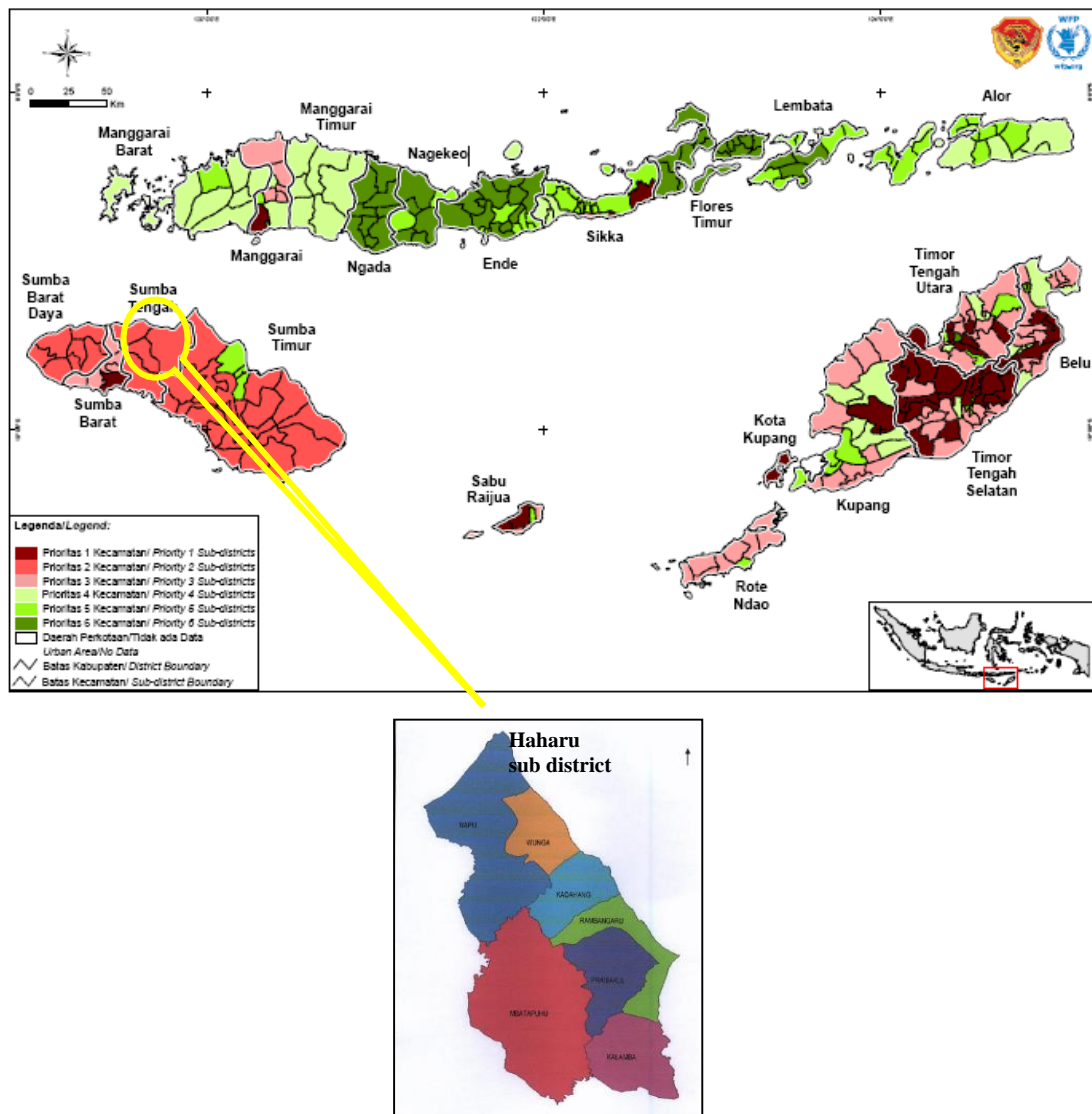
The IRED Sumba program was initiated in 2015 under the leadership of WahanaVisi Indonesia with funding from the Australian Government Department of Foreign Affairs and Trade (DFAT). The World Agroforestry Centre (ICRAF) and Lutheran World Relief (LWR) assist in program implementation. The IRED project targets to directly benefit 3,000 farmers and indirectly benefit more than 10,000 community members in ENT Province. The program use agroforestry to restore grazing lands across 5,000 hectares and drive increased productivity (IRED project description, 2015). In the IRED project, effectiveness of tree planting for food security, livelihoods and environmental services (ESs) enhancement are promoted through community nursery development and demonstration trials. Agroforestry extension activities and approached are conducted to achieve the project targets.

In East Sumba, farmers have limited accesses to farm management and technology and markets. District agricultural extension agents are also have limited knowledge on tree-based production systems and environmental services (ESs). Thus, this study is conducted to provide baseline information on agroforestry extension needs to support the successful of agroforestry project goals for land rehabilitation in East Sumba. Result from this baseline is expected to help in the implementation of those identified needs in the next 2-3 years, specifically in Haharu subdistrict, and generally in East Sumba district.

2. STUDY SITES AND DATA COLLECTION

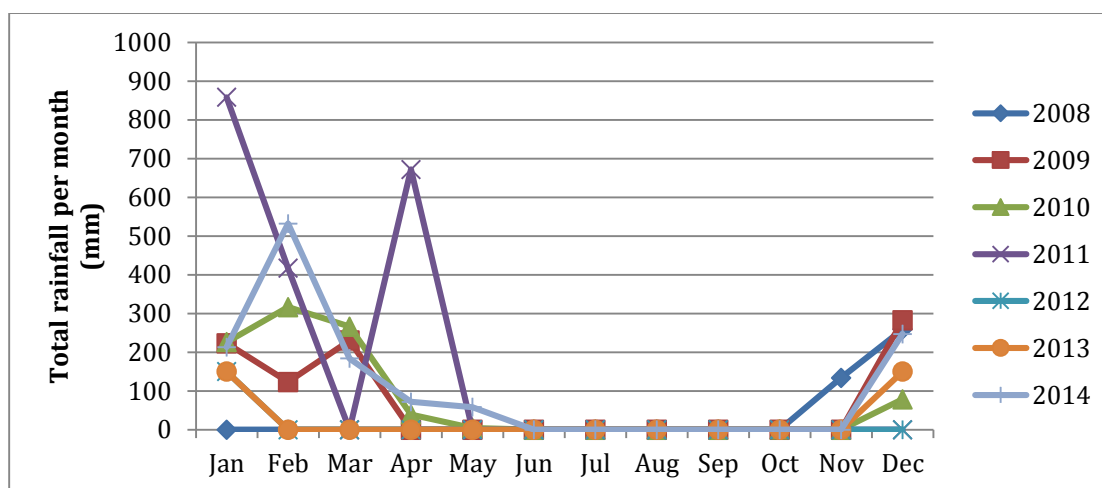
2.1. Study sites

Survey was conducted in Haharu subdistrict that is located in the northern part of East Sumba district, East Nusa Tenggara province (Figure 1). Total area of Haharu subdistrict is 88 090 ha consists of 7 villages, with total population in 2015 is 6 166 persons (10 persons/km²) or 2.5% of total population in East Sumba district. Haharu is known as more critically degraded if compare to the other subdistricts. Based on Schmidt-Ferguson climate type, Haharu is classified as type E or semi arid with savana land cover.



Source: Food security and vulnerability Atlas of Nusa Tenggara Timur (2010) and Haharu in Figures (2014).
 Figure 1. Map of study location in East Sumba, East Nusa Tenggara.

Total rainfall in Haharu subdistrict is considered low, i.e. around 1000 mm per year with only 4 wet months (Dec-Mar) (Figure 2.). The soil characteristics are dominated by limestone, and undulating terrain with altitude from zero to around 320 m above sea levels. Water is not uniformly available in all villages. Water is scarce particularly in villages that are located near the sea, i.e. Wunga, Kadahang, Praibakul and Kalamba villages. While Rambangaru, Napu, and Mbatapuhu are the villages with relatively have sufficient water.



Source: Haharu subdistrict in Figure from year 2008 to 2014.

Figure 2. Annual rainfalls in Haharu subdistrict from year 2008 to year 2014

The main source of livelihood for the people in Haharu district is agriculture (83%), followed by livestock (9%) and fishing (8%), see Table 1. Sumbanese is the dominant ethnicity in the area, with Sumbanese used as the main language followed by Indonesian. The average level of education in Haharu subdistrict is elementary school. Forests in the subdistrict are mainly located in Napu village with 3,375 ha production forest and 14,231 ha protected forest.

Table 1. Characteristics of villages in Haharu subdistrict, East Sumba district.

Village	Area (Ha)	Altitude (m asl)	Total springs	Total HH	Percentage of total HH (%)		
					Farmers	Fishermens	Cattle ranchers
Rembangaru	6 140	18	4	350	67.9	11.1	15.3
PraiBakul	10 500	79	3	216	91.7	1.6	4.0
Mbatapuhu	21 240	375	4	270	90.3	0.0	8.1
Kadahang	2 350	234	2	173	75.2	13.8	9.9
Wunga	2 240	207	1	219	85.5	2.9	9.4
Napu	14 260	20	4	209	78.4	11.4	8.1
Kalamba	3 420	227	3	88	89.6	0.0	9.0

Sources: Haharu subdistrict in Figure, 2014

Based on Haharu subdistrict in Figure 2014 data, peanuts, cassava, sweet potato, maize, rice and mung beans are the short term food crops that contributes to local people livelihood in Haharu (Figure 3.). Total production of food crops from 2009 to 2014 is still considered low due to the low total areas planted, although its productivity is considered to be at the same rate or even higher than the average productivity at district level, particularly for peanuts, cassava and sweet potatoes. Total area for food

crops in Haharu subdistrict is lower than other district in East Sumba subdistrict. Free range chicken, goats, pigs, cows, horses and buffalos are all common livestock that contribute to local livelihood, with free range chicken composing the greatest livestock population in Haharu subdistrict (Figure 4.).

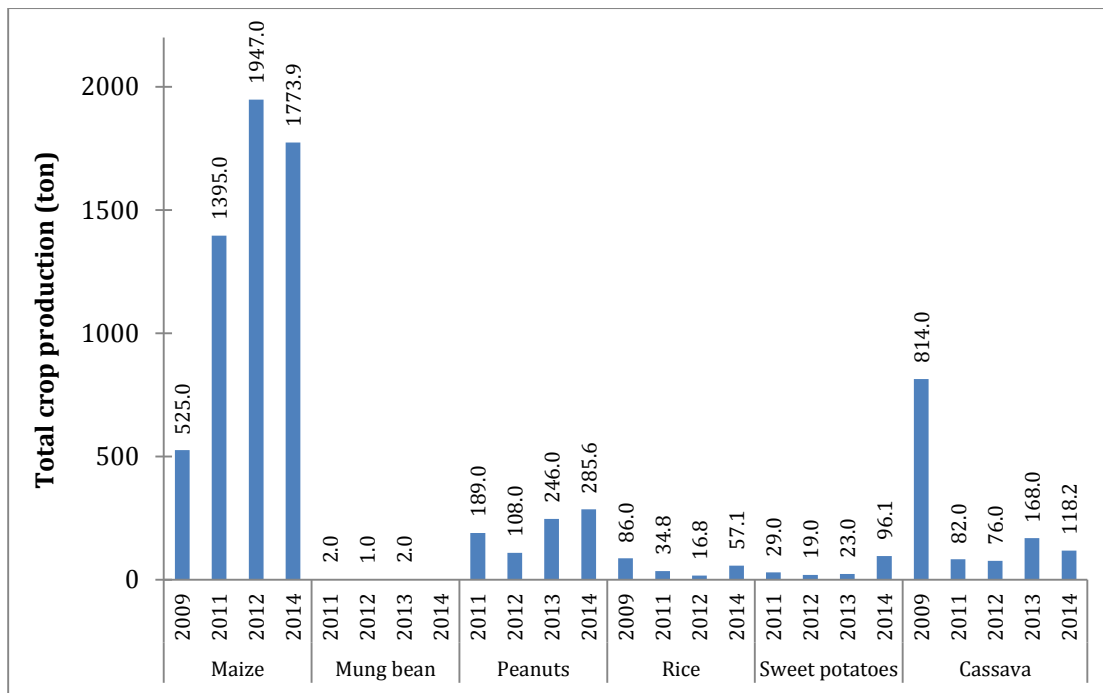


Figure 3. Total agricultural crop production in Haharu subdistrict from year 2009 to 2014 from Haharu in Figure.

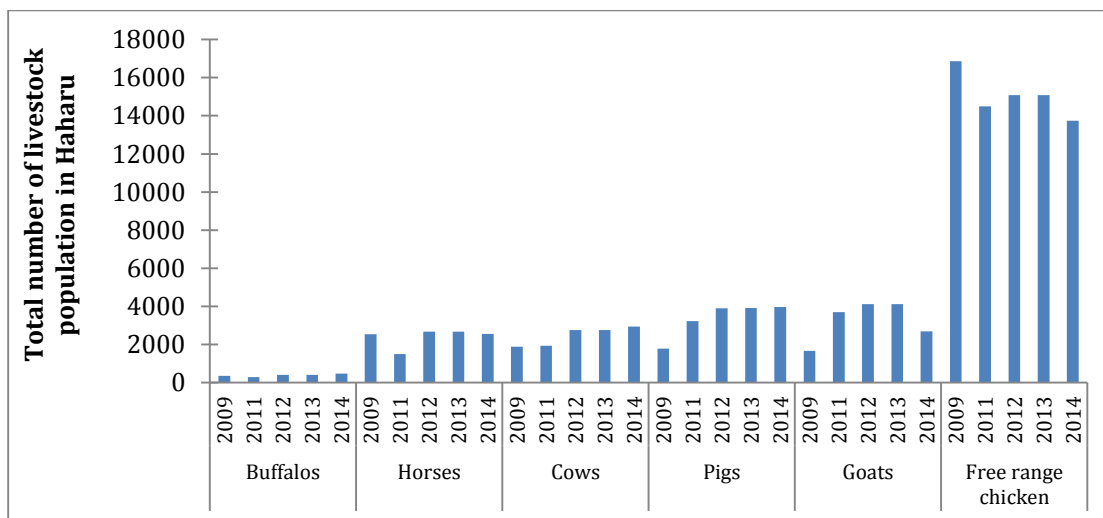


Figure 4. Total number of livestock in Haharu subdistrict from year 2009 to 2014 from Haharu in Figure.

2.2. Data collection and analysis

The survey was conducted from 6 to 14 April 2016, focusing on Haharu subdistrict where the IRED project operates. Information on previous and expected agricultural extension activities related to tree

planting program at subdistrict level were collected, as well as information on tree planting programs and its barriers in East Sumba district. The information was analyzed qualitatively and quantitatively via descriptive statistics.

The information was collected through:

(i) Focus Group Discussions with 3 FGD communities at village level and 1 FGD with government extension agents at subdistrict level. FGDs at the community level were conducted by involving 8-12 participants (mixed female and male) in 3 of the 7 IRED project villages. Village selection was based on the different level of community access to water (Figure 5), which influences the successful of tree planting program, i.e.:

- Wunga village, classified as having limited access to water resources, i.e. only 1 spring.
- Kadahang village, classified as having intermediate access to water resources, i.e. having 2 springs
- Rambangaru village, classified as having good access to water resources, i.e. having 4 springs

FGD with extension agent at subdistrict level was conducted by inviting all extension agents who are working in Haharu subdistrict (10 persons).

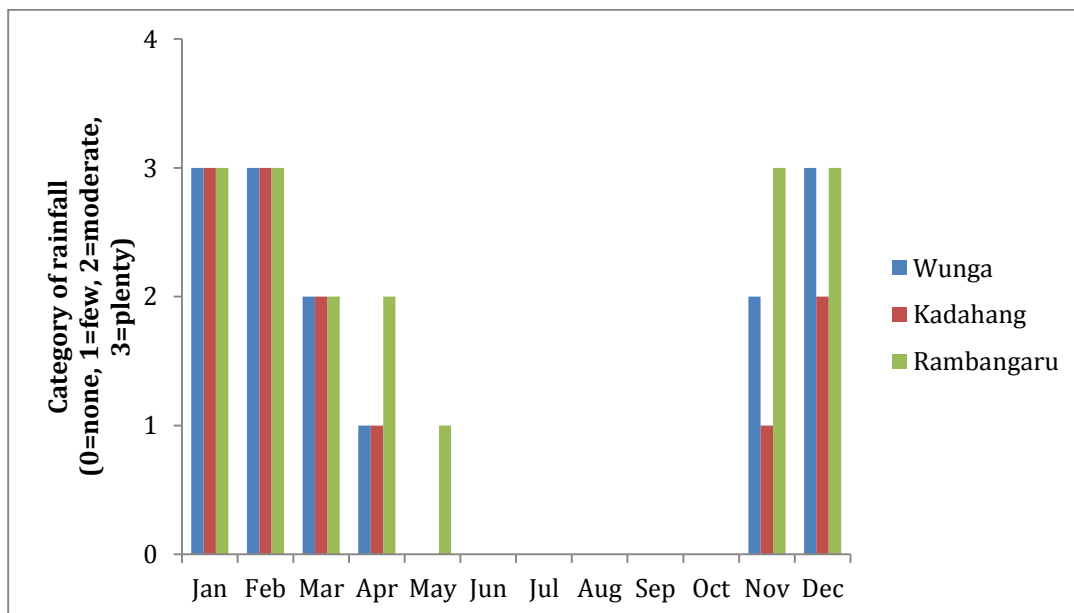


Figure 5. Average annual rainfall pattern in each village based on discussion with the villagers in Wunga, Kadahang and Rambangaru, Haharu subdistrict.

(ii) Interview with key stakeholders via snowball method was conducted with the objective to understand the tree planting and Farmer Managed Natural Regeneration (FMNR) challenges and opportunities in East Sumba. Those key stakeholders were:

- Agricultural Department of East Sumba district (collect information related to Dinas program that link to Tree Planting (fruit trees)).
- Forestry and Estate Crops Department of East Sumba district (collect information related to Forestry Department program that link to Tree Planting).
- District Extension Agency, East Sumba district (collect information on number of extension officers, the programs, capacity building needs related to Tree Planting).
- Wahana Visi Indonesia (WVI), Lutheran World Relief (LWR), and Yayasan Tananua (collect information on Tree Planting and FMNR implementation, progress, challenges, and potential activities that related with capacity building).

(iii) Statistics information on demographics, agricultural production, and forest resources in East Sumba district was obtained from the district statistic office (Badan Pusat Statistik, BPS).

(iv) Secondary data on species prioritization in the Haharu subdistrict was obtained from survey conducted by ICRAF in January 2016. While for agricultural extension needs at household level was obtained from household survey conducted by WVI team in 2016.

3. FINDINGS

3.1. Existing tree planting and farmer-managed natural regeneration programs in Haharu subdistrict

3.1.1. Tree Planting Program

3.1.1.1. Government tree planting programs

In Haharu subdistrict there are 4 government agencies (from district level) that are involved in the implementation of tree planting programs, i.e. agricultural, forestry, estate crop and the extension agencies. Each agency has its specific roles and programs on tree planting (Table 2.). Based on discussion with key stakeholders in each agency, barriers to implement their tree planting programs varied by agency, the key barriers are limited water availability, cattle; fire; limited availability of good quality seedlings; land tenure; and limited facilitation to ensure the sustainability of tree planting program.

Agricultural agency at district level is developing home garden agriculture as part of land rehabilitation program because this landuse system is considered more appropriate in areas with limited water resources and cattle grazing problems. If compares to the other departments, agricultural department recognizes limited seedling quality as one of the barriers to a successful tree planting

program. Currently quality fruit species seedlings are often imported from other island such as from Soe (in Timor Island) for citrus. The main challenges for developing centre of quality seedlings in East Sumba is the limited water resource, limited sources for quality mother trees, and less prioritization from the local government.

The forest agency's tree planting programs promote the establishment of individual forests (*hutan rakyat*) on private land. The objective of the hutan rakyat program is greening or afforestation of private land. The forestry department supplied seeds, polybags, water pipeline, and small size water reservoir. Farmers need to organize group to be eligible to participate in the program. Sandalwood, eucalyptus, paraserianthes are the main species promoted through this program. *Hutan rakyat* program is also has objective to protect springs and wells.

Tree planting programs of the estate crop agency focused to the southern part of East Sumba district (i.e. Pinupaharu, Tabundung, Ponggaludu sub districts) that have more appropriate biophysical conditions for development of cashew, coconut, beetle nut (*pinang*), and piper (*sirih*). Cashew is considered to have high economic value compared to the other species, thus every year there are programs for cashew plantation expansion and post-harvest handling training in collaboration with Industrial and Trade Department at district level.

Tabel 2. Government tree planting programs in Haharu subdistrict

Government agency	Role in tree planting programs	Existing tree planting programs in 2016	Barriers in tree planting programs
Agricultural agency at district level	Developing and delivering fruit tree planting for food security issues	Home garden program for intercropping peanuts and maize under mango, citrus and rambutan trees.	1. Limited water availability 2. Cattles disturbance 3. Limited quality seedlings from good quality mother trees for fruits species
Forestry agency at district level	Developing and delivering tree planting for land rehabilitation and conservation programs	a. In State Forest area: Sandalwood Plantation with the objective to increase sandalwood population in the state forest; b. Outside State Forest area: Sandalwood Plantation with Hutan Rakyat scheme; Village Tree Nursery (<i>Kebun Bibit Desa/KBD</i> and <i>Kebun Bibit Rakyat/KBR</i>) of sandalwood, mahagony, gmelina, and injuwatu.	1. Cattles disturbance 2. Fire 3. Limited water availability 4. Social issues (land tenure issues)
Estate Crop agency at district level	Developing and delivering tree-based industrial crops planting programs	a. Enhancement of cashew production. b. Enhancement of coconut production (to be implemented in 2017)	1. Limited facilitation to ensure the sustainability of tree planting program.
Extension agency at district and subdistrict level	Facilitating tree planting programs deliver by Agricultural department, Forestry department, and Estate Crop department	a. Agriculture: food security program from national program and home garden development from district program; b. Forestry: KBR from national program and KBD from district program. c. Estate crop: Enhancement of cashew and coconut production from district program and from provincial programs.	1. Cattles disturbance 2. Limited water availability

Source: Interview with key stakeholders in each government agency.

Extension agency performs the key role of ensuring the sustainability of tree planting activities through intensive facilitation and monitoring. There are a number of challenges faced by the extension agency, such as limited number of extension agents and limited technical capacity of those extension agents. The agency acknowledges further training is required.

3.1.1.2. Tree planting programs initiated and implemented by Non Governmental Organization (NGOs)

In East Sumba, there are numbers of NGO working in community development on food security, poverty alleviation and environmental issues. Yayasan Tananua is the longest established. Yayasan Tananua partners with numerous other organizations in East Sumba and other areas, i.e. Pelita, Koppesda, World Neighbours, Kemitraan Indonesia, Yakersum, Yasalti, FALP (Forum Anda Lindu Pala on marketing issues), YSS (Yayasan Sumba Sejahtera), WVI (Wahana Visi Indonesia), Bumi Lestari, Stimulant, Pahadang Majoru and Local Government Agencies. Collaboration with government agencies is conducted by Yayasan Tananua particularly to obtain seedlings for tree planting programs. Other important NGOs that currently work in Haharu district are Wahana Visi Indonesia (WVI) with 10 years experience in the area, and Lutheran World Relief (LWR).

Table 3. Tree planting programs initiated by NGO in 2016 in Haharu subdistrict

NGO	Role in tree planting programs	Existing tree planting programs in 2016	Barriers in tree planting programs
Yayasan Tananua	Community development, and conduct training for farmer groups.	a) In collaboration with LWR on climate smart agriculture in Wunga village (Haharu). b) In collaboration with The Nature Conservancy (TNC) Indonesia for community development in Napu village on Community Forestry program. c. In collaboration with Pelita and Koppesda on SPARC (Strategic Planning and Action to Strengthen Climate Resilience of Rural Communities) with objective to strengthen community resilience on food security, water resource and livelihood security in a changing climate.	1. Limited water availability 2. Cattles disturbances
Wahana Visi Indonesia (WVI)	Community development, and conduct training for farmer groups.	Indonesia Rural Economic Development (IRED) with the objective to help farmers regenerate degraded farmlands and forests, increase yields, improve quality, enhance market access and boost income.	1. Cattles disturbances 2. Fire
Lutheran World Relief (LWR)	Provide aids for building water reservoir and	a) Indonesia Rural Economic Development (IRED) b) Climate Smart Agriculture	1. Limited water availability

Source: Interview with key stakeholders at each NGO.

3.1.1.2. Tree planting programs received by farmers and its barriers

At village level, many tree planting programs have been implemented in the past 10 years, however the tree survival rates were low. Based on the discussion with the farmers, seedling survival varied from 0% up to 50% (Table 4.). However there is no systematic document on the seedlings survival rates. The numbers given by the farmers were estimation based on their perceptions.

Table 4. Tree planting programs received by villagers in Wunga, Kadahang and Rambangaru village, Haharu subdistrict

Village	Agency	Tree planting programs	Year	Tree survival	Note
Wunga	CRS-AUSAID	Social delegation program to distribute candlenut, mango, and breadfruit seedlings.	2003	50%	Some of the surviving candlenut trees are fruiting.
	Provincial Forestry Agency	Seedlings distribution (1HH = 5-10 seedlings).	2006	50%	The trees have grown well
	Pidra	Seedlings distribution of mahogany and gmelina, through farmer group.	2007	50%	
	WVI	Demonstration plots and FMNR, planting sandalwood, breadfruit, mango.	2010	50%	
	District Estate Crop Agency	Coconut and Cotton plantation	2008, 2010	0%	Coconut and cotton were not priorities in Wunga. No facilitation.
Kadahang	Village Development Fund	Land rehabilitation with mahogany and gmelina	2007	25%	
	District Forestry Agency	KBD (Kebun Bibit Desa) program with mahogany and gmelina species, 50000 seedlings were given to farmers.	2014	30%	Seedlings were distributed and planted.
		Distribution of 11000 seedlings for springs conservation and protection.	2014	4%	There are around 400 trees survived.
	Yayasan Sumba Sejahtera (YSS)	Seedlings distribution of sandalwood, mahogany and gmelina.	2011-2014	25%	Sandalwood trees are still occurred on a 1 ha area.
	WVI	Demonstration plot and seedlings distribution.	2008-2016	25%	
Rambangaru	Pelita Sumba	Seedlings distribution of mahogany.	2016	N.A.	The program was started in early 2016.
	WVI	Seedling distribution, of mahogany, gmelina and teak.	2013	40%	
	District Forestry Agency	KBR that distributed 50,000 seedlings, with mahogany, gmelina and breadfruit.	2014	45%	

Source: FGD with villagers in each village

From field observation and discussion with the villagers, the locations of the successful trees plantings were near springs, rivers, beaches and in flat fertile land. Tree species which survived near rivers and on flat fertile land were those with economic value (coconut and other estate crops), while those that survived near springs are species with less economic value but have high potential to protect the springs.

Low numbers of survival rate of the planted trees were basically due to some barriers occurred during and after tree planting programs. Based on discussion with villagers, fire is the most common barrier particularly in Kadahang and Rambangaru, cattle disturbances is the second most important barrier, limited water resources as the third, plant pests and diseases as the fourth and soil fertility as the fifth. In Rambangaru limited availability of quality seedlings is also an important tree planting barrier. In Kadahang, human resource is a key barrier, specifically the limited knowledge on livestock management and fire control. There is opportunity to implement trainings to improve farmers' knowledge on livestock management and fire controls.

Fires occur mainly during the dry season. The main cause of fire is human carelessness when burning trash and discarding cigarettes; another cause is the local habit of burning dry grasslands to stimulate a flush of new grass growth for cattle feed. Currently there are no village regulations that govern the way to burn the field for rejuvenating the grasses. However, in the last few years has been quite a lot of education and socialization of fire controls, and it is quite effective in reducing the number of field fire incidences.

Cattle disturbance usually occurs because cattle are set free to graze and owners do not control where the cattle go, main gardens are not fenced, and there are no village regulations regarding land use for grazing and gardens. In Haharu subdistrict, Kalamba village has started developing village regulations to recognize separate areas for grazing and gardens. This cattle disturbance happens in all villages in Haharu subdistrict.

Limited water resource is also the main factor causes the low survival rate of the planted trees. In some locations such as in Wunga, water shortages have always occurred, but in other areas such as in Kadahang and Rambangaru, limited water resource has become an issue only in the past 10 years. Farmers feel drought is more frequent in Haharu nowadays due to deforestation from illegal logging and the frequent annual burning of grasslands.

Between the villages in Haharu subdistrict, sources of water varied, between rain water, springs, rivers and wells. Currently in Wunga, the community receives aids from government and other organizations such as LWR and Tananua to build small size water reservoir with size varies from 2 x 2 meter to 4 x 4 meter.

Dry season in Haharu usually occurs during the months of May to October. In dry season, households typically use springs, wells, or obtaining water from other villages. They may even buy water. As for gardening, in Rambangaru and Kadahang, which are located near the river, farmers plant their crops along the riverbanks. While in Wunga, farmers stop agricultural activities in dry season. During the dry

season cattles are usually drinking in other villages or in the river. Sometimes, many cattles die in the dry season due to a shortage of water and food.

In the past 5 years, the incidence of pests and diseases in crops and livestock were increasing. According to farmers, it happens because of the drought that has caused crop and livestock stressed and thus susceptible to pests and diseases. However, some farmers like those in Kadahang do not know the cause of the increase in pests and diseases problems. Currently the species most commonly attacked by pests are gmelina, coconuts, mangroves (*Sonneratia* spp.) and kosambi (*Scheilechera oleosa*). The trunk and leaves of kosambi are attacked by white insect mostly happens in May; this pest has only occurs in the past 5 years. While the common diseases in livestock are swine fever, bloating goats, lame cows, and flu in chickens.

Soils types in Haharu varied between villages depending on location. Villages near the coast tend to have limestone based soils, which applies to Wunga, Napu, part of Kadahang, and part of Rambangaru. Inland villages, such as Kalamba and Mbatapuhu, tend to have deeper, darker, more fertile soil. Farmers do not know how to improve fertility of thinner limestone soils, thus agricultural activities in those areas are prone to failure during drier years.

Based on their experience and learning during the last 10-20 years, most farmers feel the subsequent 10-20 years will be better in regards to food security, control of fire and tree cover (Table 5.). However, they feel problems with water resource and cattle grazing issues will not be better in the next 10-20 years, particularly if there is no assistance to explore ways of addressing those problems. Thus, any assistances or extension services on water resources and cattle management becomes important to increase the success of tree planting programs in Haharu.

Tabel 5. Trends of barriers in tree planting based on farmers perspective from 10-20 years ago to the next 10-20 years.

Issues	Village	Trend		Note
		10-20 years ago	Now	
Water resources	Rembangaru	>	>	Rembangaru and Kadahang have similar water resource conditions, i.e. water resources are decreasing and without further actions such as tree planting, the water resources will continue to decrease. In Wunga water resources are better than 10 years ago because many trees were planted and access to water however if assistance is not developed will become more difficult in the future.
	Kadahang	>	>	
	Wunga	<	=	
Tree-based land cover	Rembangaru	>	<	The trend for tree based landcover in 10-20 years ago is inline with the trend in water resources. While the future trend is different, all villagers agree that tree-based land cover will be increase in the next 10-20 years.
	Kadahang	>	<	
	Wunga	<	<	
Cattles disturbance	Rembangaru	<	<	In Rembangaru, farmers are pessimistic that the condition is getting better, particularly because there is no regulation for livestock management in the village. While Wunga and Kadahang feel that in the future the condition will be better with less damage from cattle due to improved awareness regarding effective cattles.
	Wunga	<	>	
	Kadahang	<	>	
Fire issues	Rembangaru	<	>	In Wunga and Kadahang, people are optimistic that the future condition will be better, but not for Rembangaru.
	Wunga	=	>	
	Kadahang	>	>	
Food security	Rembangaru	>	<	All villages agree that the future conditions will be better, due to increased awareness regarding food security from the government and other agencies.
	Wunga	<	<	
	Kadahang	<	<	

Source: FGD at village level

According to farmers, they have not yet received direct economic benefits from tree planting, because the trees are still young. However, they expect to benefit in the next 20-30 years from past tree planting activities, through: (i) increased family income; (ii) existence of on-farm timber resources for their own use; and (iii) sale of timber. Besides economical benefit, they also expect to gain environmental benefits such as cooler air temperature, comfortable atmosphere, and decreasing problems of drought.

3.1.2. Farmer-managed natural regeneration program

Farmer-managed natural regeneration (FMNR) is a land-restoration technique that increasing food and timber production, and involves the systematic regeneration and management of trees and shrubs from tree stumps, roots and seeds (Rinaudo, 2012). In Haharu subdistrict, WVI introduced the FMNR via the INFOCUS (Increase Food Security within the Community through Sustainable Livelihood and Natural

Resource Management System) project with main objective to motivate farmers to plant and maintain trees in their landscape. Cattle grazing and fire are the barriers to successful FMNR implementation in Haharu. FMNR is also known as “palotang” in Sumbanese.

Under palotang program farmers are trained to develop healthy trees through pruning and thinning. Farmers were required to prune trees monthly, with every HH required to maintain 600 trees. Farmers located their palotang sites in areas with less fire and cattle issues. The maintained trees were marked with string and monitored every month.

Currently farmers have few palotang sites that were pruned and thinned, and they are still monitoring tree growth of the previous palotang sites. Based on discussion with the farmers, the growth of the trees are good, however most of the pruned trees are trees with low economic value, thus they have not yet received direct monetary benefit from the palotang program. They have received knowledge benefits regarding tree maintenance. In the future, the farmers will implement the knowledge they received through palotang in their own garden.

3.2. Extension needs for land rehabilitation in Haharu subdistrict

3.2.1. Based on villagers perspective

Based on discussion with the villagers, many extension activities are conducted by numerous organizations in the subdistrict covering forestry, agricultural, fisheries and livestock management (Table 6.). Training on agroforestry has been conducted by WVI in all villages. The presence of government extension services was only identified in Kadahang and Rambangaru, while extension by private extension agents occurred in all villages. This shows the important of the role of private extension agents in Haharu subdistrict.

Based on study conducted at household level by WVI in 2016, general topics on agroforestry become the third most requested by the farmers in Haharu subdistrict, with agriculture as the first and livestock management on the second. Farmers participation in agricultural extension still limited due to no information given to farmers, no invitation for farmers and location of the training is far from their home. Type of extension media that farmers received the most were leaflet, booklet and movie, respectively.

Table 6. Existing extension services from government and non government agencies in Haharu subdistrict.

Villages	Extension institutions	Extension topics	Annualvisit Frequency	Extension method	Extension media
Government extension agents (BP3K)					
Kadahang	Livestock extension officer	Livestock management (goats, cow and pig)	1	Discussion	None
Rambangaru, Kadahang	Forestry extension officer	Meeting with forestry farmer groups; Forestry regulation	Occasionally	Discussion	Film shows
Rambangaru, Kadahang	Fisheries extension officer	Marine and coastal conservation; Enviromentally friendly fish catching; Coral reefs conservation; Mangrove planting.	1	Discussion (Socialization)	Leaflet
Rambangaru	Agricultural extension officers	Pests and diseases handling in maize and peanuts.	1	Discussion	Leaflet.
Private extension agents (NGOs)					
Rambangaru	Bethesda	Tree planting.	4	Discussion	None
Rambangaru	Curches	Land rehabilitation.	4	Discussion (Socialization)	None
Rambangaru	ICRAF-IRED	Tree nursery.	24	Training and discussion	Booklet
Wunga	Tananua	Nursery; Production and application of organic fertilizers.	12	Training	Booklet
Wunga	LWR and Tananua	Developing rainfall water reservoir.	12	Discussion	None
Kadahang	Pelita Sumba	Tree planting; Soil and water conservation.	48	Discussion and training	Poster
Rambangaru, Wunga, Kadahang	WVI	Tree planting; FMNR; Demonstration trials; Agroforestry.	12	Discussion and training	Booklet

Source: FGD with villagers

Most of the farmers think that extension services have some limitation particularly on conveying new technologies that are needed by the farmers. Based on the discussion with farmers, we identified the needs through 2 different approaches (Table 7.). First by asking directly the topics they want to learn, and the second by evaluating their needs based on review of their dry season livelihood strategies. Farmers' dry-season livelihood strategies are of the utmost importance as that is when drought, food insecurity and limited income generation opportunities occur.

Table 7. Extension services needs based on farmer perspectives in Haharu subdistrict

Subjects	Villages	Topics
Dryland agriculture	Wunga	Land preparation
		Use of superior seedlings for dryland restoration
		Pest and diseases management for dryland systems
Fisheries	Rambangaru	Regulations and socialization on fishing technologies
	Kadahang	Tools and technology to improve fish production
		Fish marketing (selling fish, bargaining skills, access to price information)
	All villages	Post harvest processing and marketing of fish
		Fishing technologies and skills.
Agroforestry	Wunga	Agroforestry products marketing
		Tree planting preparation
		Tree spacing and planting
		Cultivation of cashew, mango, breadfruit and candlenut
	Wunga, Rambangaru	Pests and diseases handling, particularly for coconut and other estate crops
	Rambangaru	Tree management
		Identification of mother trees for producing quality seed
	Kadahang	Fallow management
		Drip irrigation
		Vegetative propagation
	All villages	Identification tree species with high economic value and match biophysical conditions in Haharu.
		Nursery management (including fertilizing, germinating seeds, and preparing seedlings to be planted in the field).
		Socialization of forest use regulation to stop illegal logging and field burning.
Agriculture	Wunga	Facilitating linkages between farmer groups and local government, particularly to foster farmer group involvement in government programs
	Kadahang	Drip irrigation
		Use and management of chemical and organic fertilizers
	Kadahang, Rambangaru	Maize seeds production, pests and diseases handling
		Dry season irrigation of vegetable and maize crops
Livestock management	Kadahang	Livestock management of fowl and cattles
		Livestock marketing
	Kadahang, Wunga, Rambangaru	Livestock pests and diseases management (this particularly due to the increase incidences of bloating goats, swine fever, lame cow, flu in chicken).
	Kadahang, Rambangaru	Livestock nutrition; Livestock sanitation

Source: FGD with villagers

3.2.2. Based on government extension officers perspective

In Haharu subdistrict extension office (BP3K Haharu), there are 10 extension officers, i.e. 1 forestry extension officer, 1 fisheries extension officer, 1 estate crops extension officer, 3 agriculture extension officers and 3 livestock extension officers. The average length of duty in Haharu for extension officer is 5 years, varying one to 15 years. The highest education level of the extension officers are Bachelor degree (S1).

Discussion with farmers is the most common extension method used by BP3K extension officers in Haharu; other method such as field visit, demonstration plots, or training seldom used due to budget limitations. Other obstacle faced by extension officers is their own limited training, experience and lack of access to capacity building opportunities. Most common extension media distributed by extension officers to farmers is leaflet. Sometimes they also distribute poster produced by other government agencies.

Major role of extension officers in tree planting program is as facilitator of programs that are initiated by other agencies such as from Forestry Department at district level, and the Estate Crop Department. Extension officers have responsibility to monitor and assist the implementation of those tree planting programs from the other government agencies. Based on the extension officer's experience, the programs that have high success story are programs that are requested by farmers and involving species that have high economic values, such as cashew and coconut plantation program from Estate Crops Department.

Based on the discussion with extension officers, in facilitating the tree planting programs in Haharu subdistrict, most barriers are biophysical such as soil conditions, climate and water resource, topography and fire. Social barriers were also encountered, particularly those related with grazing management and fire control. Of those barriers, soil conditions are considered the easier and faster to solve by using organic fertilizer and soil supplements (biomass transfer) for improving fertility. Grazing and fire can also be addressed by developing and applying village and district level regulations. Barriers that related with climate and water resource are the one that more difficult and need longer time to be solve. Thus, the short-term extension needs for farmers is to support how to enhance farmers' knowledge in manipulating soil fertility by applying organic fertilizers and for communities is the development and application of appropriate grazing and fire managemtn regulations.

Extension officers feel that their knowledge and capacity need to be enhanced in order to provide better extension services to communities. Lists of training and extension needs for extension officers in Haharu subdistrict as identified in this survey are provided in Table 8. Tree nursery and production of organic fertilizer are the topics directly related to agroforestry for land restoration.

Table 8. Training and extension needs for extension officers in Haharu subdistrict.

Subjects	Topics for training or extension
Forestry	a) Forest tree nursery
	b) Concept and application of agroforestry
	c) Individual forest (Hutanrakyat), particularly on its implementation due to the weak coordination between Forestry Department with Extension Agent at district and subdistrict level.
	d) Socialization on new forestry regulation related to conditions in Haharu subdistrict.
Livestock management	a) Cattle reproduction
	b) Livestock pests and diseases handling
	c) Livestock nutrition
	d) Post-harvest handling
	e) Artificial insemination
	f) Livestock vaccination
	g) Producing organic fertilizer from cattle dungs
Agriculture	a) Pests and diseases management for food crops and vegetables
	b) Demonstration plots for organic agriculture
	c) Estimation on agricultural productivity
Estate crops	a) Estate crops nursery
	b) Agroforestry and its potential economic benefits
	c) Post harvest handling of cashew
Fisheries	a) Aquaculture nursery
	b) Pests and diseases management in aquaculture
	c) New technologies on aquaculture

Source: FGD with extension officers in BP3K Haharu subdistrict.

3.3. Potential agroforestry programs for land rehabilitation in Haharu subdistrict

On average the level of education of most farmers in Sumba is elementary school. The survey found that the most appropriate extension approach for those farmers is introducing more practical technologies via establishing demonstration trials and also via field visit to successful farmers. Those two approaches can be implemented via agroforestry farmer field school, as have been implemented by Martini *et al.* (2016) in South and Southeast Sulawesi where general farmers are from elementary school and below. For the case of East Sumba, the main topic for the agroforestry farmer field school should be focused on land rehabilitation – tree planting and enhanced management of agroforestry systems.

The first step in planning an agroforestry farmer field school, is to identify the priority species in each village – both the tree species and short term crop species that can be intercropped under agroforestry systems. Farmers' capacity and knowledge on tree and system management need to be enhanced via agroforestry farmer field school. After farmers' capacity is enhanced, the next step is to establish agroforestry demonstration trials. Demonstration trials need to be established via participatory and voluntary approach which is including farmers from designing the plot up to maintaining the plot.

3.3.1. Priority plants species

In a land rehabilitation program, priority plants species can be selected by observing type of plants that are abundant and grow well in the landscape, and plants that are prioritized by farmers. Selecting plants prioritized by farmers will enhance farmers' participation and motivation in managing those species. Farmers are more willing to invest their efforts and time if they have been involved in the selection process and see the potential benefits of those species for improving their livelihood and increasing their income.

Based on the discussion with farmers, many of the tree species currently abundant in Haharu subdistrict have low economic value, such as mangrove species (*Sonneratia* spp.), johar, kehi, lobung (see Table 9). Yet, farmers recognize that many of the tree species with low economic values have high environmental value.

Table 9. Tree species that are abundant and grow well in Haharu subdistrict

No.	Tree species	Newly introduced	Economic value	Uses
1	Bakau/Mangrove tree (<i>Sonneratia</i> sp.)	No	LOW	Coastal conservation
2	Johar (<i>Senna siamea</i>)	No	LOW	House construction
3	Kehi/Kayu Cina (<i>Lansea coromandelica</i>)	No	LOW	Living fence, fuelwood, house construction
4	Lobung/Salam (<i>Syzygium polyanthum</i>)	No	LOW	Springs conservation, house construction, condiment, and medicine.
5	Injuwatu (<i>Pleiogynium timoriense</i>)	No	Medium	Timber for house construction
6	Kosambi (<i>Scheilechera oleosa</i>)	No	Medium	Fuelwood, fruits for food, shellac (sells with the price USD1.5 to USD5/kg)
7	Mingggit/Tuak (<i>Borassus flabellifer</i>)	No	Medium	Handicraft, the flower sap for traditional alcoholic beverage, the fruits for fodder.
8	Coconut (<i>Cocos nucifera</i>)	No	Medium	The fruits for homeuse and market sale as nuts and copra; timber for house construction, leaves for roof, fibre for ropes, coconut oil, broom.
9	Jati putih (<i>Gmelina arborea</i>)	Yes	High	House construction; and the leaves are fodder.
10	Teak (<i>Tectona grandis</i>)	Yes	High	Timber for house construction
11	Mahagony (<i>Swietenia mahagony</i>)	Yes	High	Timber for house construction

Source: FGD with farmers in Haharu sub district

Injuwatu and kosambi are two interesting species that occur naturally in the landscape and grow well under the harsh climatic conditions in Haharu subdistrict. Both species have economic values; however, the growth of those species is quite slow and required time to reach size of economic value. While

minggit and coconuts have faster growth compared to kosambi and injuwatu, the economic value of their products are low. Thus, currently farmers are more interested to new introduced species that can grow fast and well under Haharu conditions and have better economic value, such as timber trees, cashew, and breadfruit. Timber trees are for long term income, while cashew, betel nut and breadfruit are expected to provide annual income starting 5-10 years after establishment (Table 10). While for monthly income farmers are expected to gain benefits from planting short term plants such as mung beans, peanuts, shallot, garlic, tomato, and maize.

Table 10. Plant species prioritized to be planted by farmers in Haharu sub district

Village	Priority				
	1	2	3	4	5
Short termincome plant class					
Kadahang	Mung beans	Peanuts	Arab beans	Water melon	Tomato
Kalamba	Peanuts	Arab beans	Shallot	Cassava	Eggplant
Mbatapuhu	Shallot	Eggplant	Bitter melon	Arab beans	Mung beans
Napu	Tomato	Chili	Eggplant	Peanuts	Mung beans
Praibakul	Garlic	Shallot	Brassica	Tomato	Maize
Rambangaru	Maize	Peanuts	Mung beans	Tomato	Chili
Wunga	Maize	Peanuts	Bitter melon	Rice	Eggplant
Annual income plant class					
Kadahang	Breadfruit	Jackfruit	Neem	Mango	Citrus
Kalamba	Betel nut	Cashew	Coffee	Breadfruit	Coconut
Mbatapuhu	Breadfruit	Cashew	Mango	Citrus	Coconut
Napu	Breadfruit	Jackfruit	Cassia	Hog plum	Mango
Praibakul	Breadfruit	Banana	Citrus	Coconut	Cashew
Rambangaru	Breadfruit	Papaya	Banana	Citrus	Cassia
Wunga	Breadfruit	Citrus	Hog plum	Banana	Mango
Long term income plant class					
Kadahang	Teak	Gmelina	Sandalwood	Mahagony	Injuwatu
Kalamba	Sandalwood	Teak	Mahagony	Injuwatu	N.A.
Mbatapuhu	Mahagony	Teak	Sandalwood	Injuwatu	Paraserianthes
Napu	Teak	<i>Sterculia foetida</i>	Mahagony	Marujawa	Injuwatu
Praibakul	Sandalwood	Mahagony	Teak	Injuwatu	Gmelina
Rambangaru	Teak	Injuwatu	Sandalwood	Mahagony	N.A.
Wunga	Sandalwood	Teak	Mahagony	Eucalyptus	Injuwatu

Source: Secondary data from FGD with farmers in 7 villages in Haharu subdistrict

3.3.2. Agroforestry Farmer Field School for land rehabilitation

Based on the household survey to farmers in Haharu subdistrict, 90% of the surveyed farmers selected farmer field school as one of the training method applied in Haharu. The survey showed that most of the respondents preferred extension methods that contained practical sessions and face-to-face

discussions. The concept of farmer field schools, which uses participatory training techniques to achieve learning objectives, fits well with farmers' needs for innovative extension approaches. Agroforestry farmer field schools can be an effective extension approach to enhance farmers' capacity in managing their gardens for higher and sustainable productivity (Martini *et al.*, 2016).

Based on the experience with agroforestry farmer field school (AFFS) implementation in South and Southeast Sulawesi Martini *et al.* (2016) showed that 97% of the respondents gained benefit from attending AFFS. New and reliable knowledge or information was perceived as the most important aspect motivating farmers to attend AFFS. After one year of AFFS implementation, 14% of respondents had generated cash benefits from testing new knowledge learned from AFFS. The amount of money generated depended on the type of knowledge tested. Fertilizing and pruning were important techniques that yielded cash benefits for farmers in the short term (within one year). The evaluation concluded that following AFFS activities implementation, a minimum of one year of facilitation would be required to assist participants to effectively test and adapt the new knowledge learned.

For Haharu case, the focus of the AFFS topics can be identified based on the agroforestry extension needs identified at farmers and extension agents level. As explained in the above sections, topics on tree management of species priority can be combined with other important topics that related with technologies to improve agroforestry role to support livestock management, fire control, and increase the number of trees in the landscape.

3.3.3. Agroforestry demonstration plots for land rehabilitation

Agroforestry is a landuse option that can provide multiple economic and environmental benefits to farmers (de Foresta *et al.*, 2000). In small size garden plots, agroforestry can provide benefits from a diverse range of tree and annual species. By combining timber species that provide annual income with annual crop species that provide a short term income, agroforestry systems are expected to improve the livelihood of the owner of the plot. If agroforestry systems are scaled up from the plot to landscape level, it will provide more environmental benefits for the landscape, such as better soil fertility and better microclimate which are essential to support the land rehabilitation programs.

Normally, each farmer develops their own agroforestry systems based on their knowledge, experience and motivation. Radandima (2001) indicated that knowledge and experience of farmers have become the basis for development of Agroforestry program in Sumba. Although, the knowledge and experience of each individual farmer is still limited. Farmers' knowledge could be enhanced particularly on agroforestry concept, crop intercropping and management, selection of priority species, soil fertility management, and propagation of quality seedlings. The establishment of demonstration plot in each sub village would be an appropriate channel to enhance farmers' knowledge via agroforestry extension programs, and this has been applied in ICRAF project sites in Sulawesi, Indonesia (Martini *et al.*, 2014).

In the agroforestry demonstration plots need to be designed according to the existing plot conditions. In the case of Hararu, East Sumba two general conditions and respective approaches are summarized here.

1) If the land is degraded with tree canopies less than 25%, fast growing, sun tolerant tree species that have economic value should be planted, such as coconuts, jackfruit and candlenut. Kehi (*Lannea coromandelica*) can also be planted as living fence for providing shade and barrier to cattle; additionally kehi is resistant to fire. Annual crops such as mung beans, maize, and peanuts can also be planted in between trees to provide short term income for the farmer.

2) If the tree canopies have reached 25% to 50%, shade tolerant crops should be planted, such as pepper, cocoa, coffee and nutmeg can be planted under the existing trees.

Discussion with extension officers in BP3K Haharu resulted in recommendations for developing demonstration trials (Table 11.). These areas are mostly have 25% of tree canopies, thus option two from above can be applied. Planning, assessment of plot conditions, and implementation must be conducted with farmers, who are the ultimate users and adopters of the technologies being tested. Farmer participation during planning, establishment and management is a must to maximize commitment, learning and innovation.

Table 11. Demonstration plots recommended by extension officers

Priority	Location	Demplot topics
1	Kalamba	Intercropping turi-glicridia-leucaena-mahagony-candlenut
2	Rembangaru (Dusun Hambuang)	Intercropping coconuts-paddy rice field; Aquaculture in agroforestry systems
3	Praibakul	Intercropping leucaena-coconut-other trees species; Spacing – species trials; Development of cashew agroforestry systems
4	Mbatapuhu	Intercropping leucaena-coconut-gmelina; Agroforestry techniques to prevent fire
5	Kadahang (RT Ndara)	Intercropping cashew -coconut-leucaena
6	Napu (Dusun Prailangina)	Intercropping mahagony-gmelina-cashew-leucaena
7	Wunga (Dusun Wunga Barat)	Enrichment of existing demonstration plots (established by WVI) through underplanting additional tree species

Source: FGD with Haharu subdistrict extension officers

4. CONCLUSIONS

Results showed that barriers in land rehabilitation are primarily related to limited water resources, poor soil fertility, cattle disturbance, fire, limited facilitation to ensure the sustainability of tree planting program, and limited quality seedlings. Based on those barriers, immediate extension needs for land rehabilitation in Haharu subdistrict are (i) to enhance farmers' knowledge regarding soil fertility improvement through the use of organic fertilizers and (ii) the development and application of

appropriate grazing and fire management regulations. Training and capacity building activities for enhancing extension agents' knowledge on tree nursery development and organic fertilizer production will enable extension agents to assist farmers to rehabilitate land through agroforestry.

Agroforestry farmer field school is a key options of extension approach that is requested by farmers to enhance their knowledge and capacity to manage their garden and for land rehabilitation in Haharu subdistrict. In the agroforestry farmer field school, topics on tree management of species priority can be combined with other important topics that related with technologies that can improve agroforestry roles to support good livestock managements, controls fire, and increase the number of trees in the landscape.

Integrated with the agroforestry farmer field school, demonstration trials on agroforestry are expected to be established in each sub village as an interactive media between farmers, extension agents and researchers to learn about agroforestry practices that can help to rehabilitate land in Haharu subdistrict. Extension agents and farmers need to work collaboratively and intensively to ensure farmer participation and learning during planning, establishment and management of the demonstration trials.

Type of agroforestry system that can be developed in the demonstration trials can be assessed from combination of priority species that farmers are interested in. Currently farmers are more interested with new introduced species that grow fast under Haharu conditions and provide a good economic return, such as timber trees, cashew, and breadfruit. Timber trees are cultivated as long term income, while cashew, betel nut and breadfruit are cultivated to provide annual income starting 5-10 years after establishment. For short-term (weekly to monthly) income farmers plant short rotation crops such as mung beans, peanuts, shallot, garlic, tomato, and maize.

In summary, the following are recommended:

1. Enhance farmers' knowledge regarding soil fertility improvement through the use of organic fertilizers;
2. Development and application of appropriate grazing and fire management regulations;
3. Provide training and other capacity building activities for extension agents regard tree nursery development and organic fertilizer production
4. Continue assiting farmers with the introduction, testing and adoption of tree and annual crop species that provide economic benefits;
5. Use the agroforestry field school approach to enhance farmers' awareness, knowledge and experience; and
6. Develop demonstration trials - that are planned, established and managed with farmers with the assistance of government extension agents– as an integrated part of the agroforestry field school approach.

References

- Badan Pusat Statistik (BPS). 2009. Haharu sub district in Figures year 2009. BPS Kecamatan Haharu.
- Badan Pusat Statistik (BPS). 2010. Haharu sub district in Figures year 2010. BPS Kecamatan Haharu.
- Badan Pusat Statistik (BPS). 2011. Haharu sub district in Figures year 2011. BPS Kecamatan Haharu.
- Badan Pusat Statistik (BPS). 2012. Haharu sub district in Figures year 2012. BPS Kecamatan Haharu.
- Badan Pusat Statistik (BPS). 2013. Haharu sub district in Figures year 2013. BPS Kecamatan Haharu.
- Badan Pusat Statistik (BPS). 2014. Haharu sub district in Figures year 2014. BPS Kecamatan Haharu.
- Badan Pusat Statistik (BPS). 2015. East Sumba district in Figures year 2015. BPS Kecamatan Haharu.
- de Foresta, H., Kusworo A, Michon G, Djatmiko WA. 2000. KetikaKebunBerupaHutan - Agroforest Khas Indonesia. World Agroforestry Centre (ICRAF). Bogor.
- Hutabarat, S. 2006. Model Forest: Alternatif Pengelolaan Hutan di Nusa Tenggara Timur. Prosiding Sosialisasi Hasil-Hasil Penelitian Kehutanan. Pusat Litbang Hutan dan Konservasi Alam. Bogor.
- Martini E, Saad U, Angreiny Y, Roshetko JM. 2014. KebunBelajarAgroforestri: KonsepdanPembelajarandari Sulawesi Selatan dan Tenggara. Paper presented at Seminar Nasional Agroforestri ke-5, 21 Nov 2014, Ambon, Indonesia.
- Martini E, Saad U, Angreiny Y, Roshetko JM, Gunawan H, Maulana HT, Suganda G, Dwipayana G, Erwin LO, Hadedi A. 2016. Agroforestry and Forestry in Sulawesi series: Evaluation of the Agroforestry Farmer Field Schools on agroforestry management in South and Southeast Sulawesi, Indonesia. Working paper 220. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. 16p. DOI: 10.5716/WP16002.PDF.
- Monk, K.A., Y. de Fretes and G. Reksodiharjo-Lilley. 1997. The ecology of Nusa Tenggara and Maluku. The ecology of Indonesia series, volume 5. Dalhousie University, Nova Scotia, Canada.
- Njurumana GND. 2008. RehabilitasiLahanKritisBerbasisAgrosylvopastur di Timor dan Sumba, Nusa Tenggara Timur. Info Hutan Vol V(2): 99-112.
- Njurumana, GND, Prasetyo, BD. 2010. Lende Ura, Sebuah Inisiatif Masyarakat dalam Rehabilitasi Hutan dan Lahan di Sumba Barat Daya. Jurnal Analisis Kebijakan kehutanan Vol 7(2): 97-110.
- Radandima, U. 2001. Pengembangan masyarakat dalam pengelolaan sumber daya alam melalui program wanatani. Pengalaman Yayasan Tananua Sumba. In: JM Roshetko, Mulawarman, WJ Santoso and I.N. Oka. *Wanatani di Nusa Tenggara. Prosiding Lokakarya Wanatani Se-Nusa Tenggara (Agroforestry in Nusa Tenggara, Proceedings of a Workshop)*, 11-14 November 2001. Denpasar, Bali. International Centre for Research in Agroforestry (ICRAF) and Winrock International
- Rinaudo, T. 2012. Natural Resources Advisor, World Vision Australia and pioneer of Farmer Managed Natural Regeneration in Niger in 1983. World Vision Australia.
- Roshetko JM and Mulawarman. 2002. Wanatani di Nusa Tenggara: Ringkasanhasillokakarya (Agroforestry for Nusa Tenggara: A Summary of Workshop Outputs). In: JM Roshetko, Mulawarman, WJ Santoso and I.N. Oka. *Wanatani di Nusa Tenggara. Prosiding Lokakarya*

Wanatani Se-Nusa Tenggara (Agroforestry in Nusa Tenggara, Proceedings of a Workshop), 11-14 November 2001. Denpasar, Bali. International Centre for Research in Agroforestry (ICRAF) and Winrock International.

Stubenvoll, S. 2000. Traditional Agroforestry and Ecological, Social, and Economic Sustainability on Small Tropical Islands: A dynamic land-use system and its potential for community-based development in Tioor and Rhun, Central Maluku, Indonesia. Doctoral Dissertation. School of Architecture – Environment – Society, Technical University of Berlin.

Annex 1. Sketches of Wunga, Kadahang and Rambangaru villages

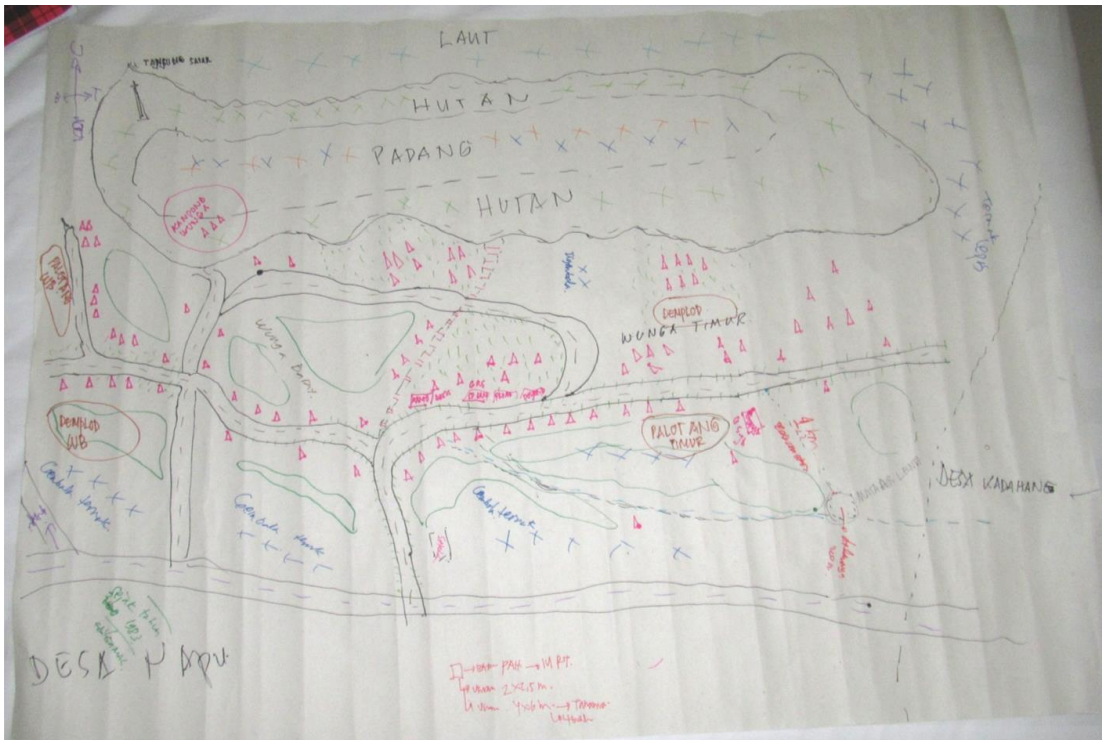


Figure 6. Wunga village, Haharu subdistrict, East Sumba

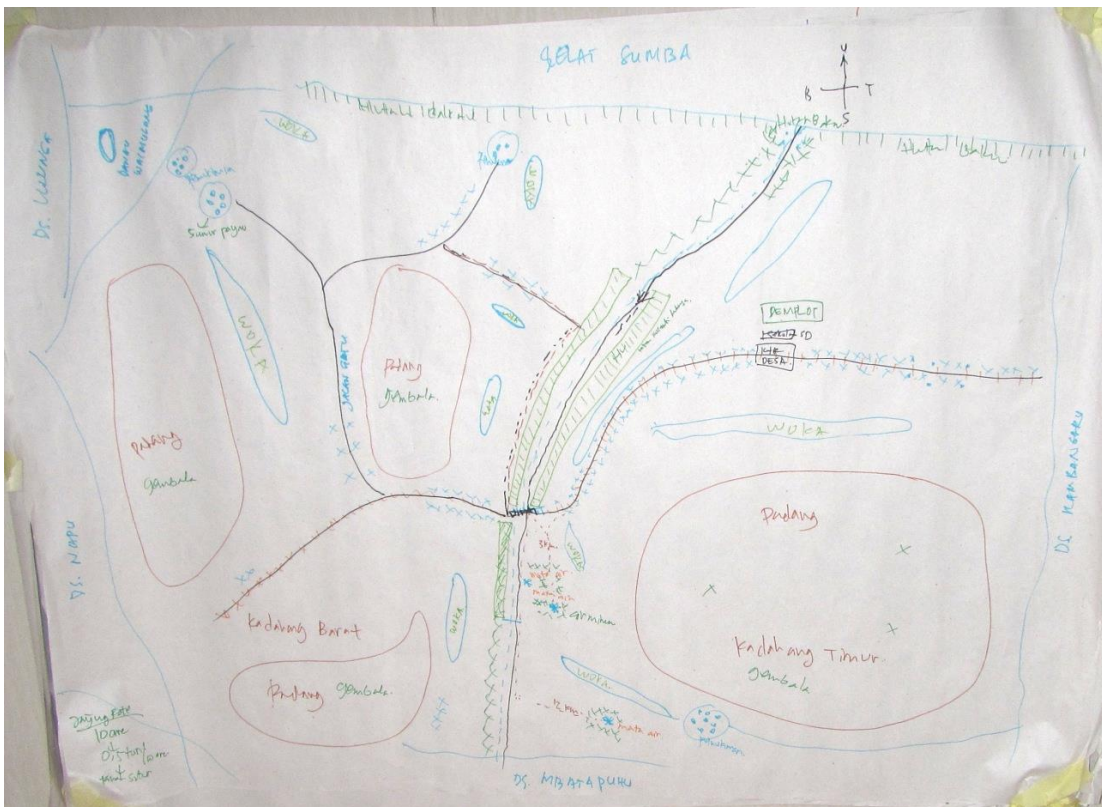


Figure 7. Kadahang village, Haharu subdistrict, East Sumba

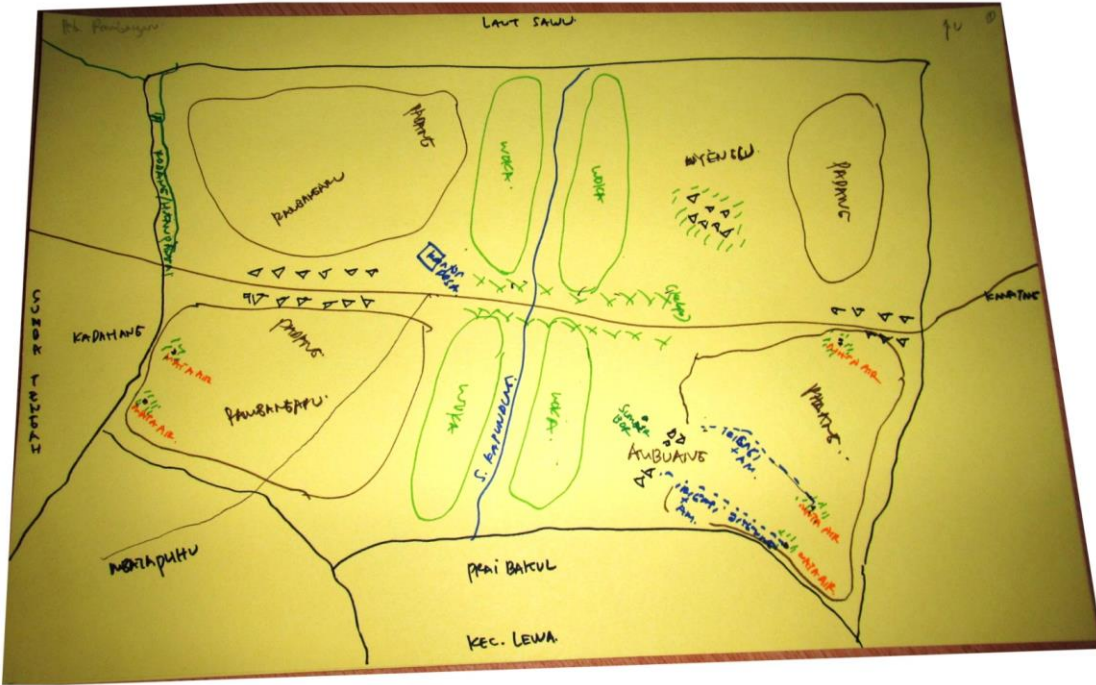


Figure 8. Rambangaru village, Haharu subdistrict, East Sumba

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