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Species identification and selection to develop agroforestry at Lake Toba Catchment Area (LTCA)

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ABSTRACT

Wijayanto N (2011) Species identification and selection to develop agroforestry at Lake Toba Catchment Area (LTCA). Biodiversitas 12: 52-58. In order to improve land productivity surrounding the LTCA, the existing ITTO project tries to establish agroforestry system. The system will be designed to meet consideration of both sides. on one side is to generate the people awareness of the forest and land rehabilitation, and on the other side is to support the poverty reduction. The aims of this research are: species identification and selection to develop agroforestry at LTCA. Data collecting was carried out with: interview, group discussion, field observation, divining manual study, and PRA. The diversity of the available crop kind shows the number of choices to be developed by the farmer. The farmers generally have the economic objective to develop agroforestry, including increase in net income, risk reduction, increase in environmental service, and the wealth and savings accumulation. Various types of agricultural crops, plantations and forest trees were found in LTCA. They can be the basis for building a wide variety of agroforestry systems.

Key words: catchment area, agroforestry system, sequential, integrated.

INTRODUCTION

Forests are cleared mainly into agricultural land as a result of population growth, high dependability of population to agriculture sector, and low awareness of forest functions on the environment. This condition together with slash-and-burn cultivation practices that use inappropriate cultivation system caused negative impact on the environment, especially reducing land productivity. Cash crops are often presented as an alternative to slash-and-burn agriculture, assuming that this practice is in crisis or doomed to fail in short term. These conditions lead into a poverty increase which affects many farmers and damage the natural resources (deforestation, watershed degradation, etc.) (Ducoirtieux et al. 2006). In order to improve land productivity surrounding the LTCA, the existing International Trade Timber Organization (ITTO) project tries to establish agroforestry system which combines the techniques for reforestation and land rehabilitation with agricultural cultivation.

Agroforestry is able to mitigate environmental problems through several mechanisms. In turn, practitioners have seen these ecological benefits turn into economic benefits through the increase of agricultural output (Hildreth 2008). Agroforestry serves multiple functions. It is a source of livelihood and it provides environmental service that consists of watershed functions, biodiversity and climate change (Na'iem 2007). The system will be designed with the aims to generate the people awareness to the forest and land rehabilitation, and to support the poverty reduction. Doing agroforestry means caring and adopting the traditional knowledge, as long as the traditional knowledge is not hampering the purpose of the program, which is to reduce the poverty. Hopefully, through agroforestry, land productivity surrounding the LTCA will be improved and income of community will be increased.

Pattanayak et al. (2003) has reviewed 120 studies on on-farm tree growing (agroforestry adoption). This review revealed limited empirical attempts to study on-farm tree growing related to biophysical factors. The limited number of biophysical variables such as slope, soil quality and irrigation are included in a very few studies. They found that only 27% of the studies contained biophysical variables. Notwithstanding, these variables were important predictors in a majority of studies (64%) where they were included. Thus, they emphasized a need of comprehensive empirical studies on on-farm growing to incorporate biophysical factors. In most developing countries, rural communities practice agriculture. These communities are characterized by high socioeconomic inequalities.

The aims of this research are: species identification and selection to develop agroforestry at LTCA.

MATERIALS AND METHODS

The study was conducted from February until May 2008. Agroforestry field survey was carried out on several studies and production demo plots. The locations were Samosir, Simalungun, and Karo District of North Sumatra Province, Indonesia. Details of demo plots in each district were presented in Table 1.

Table 1. Location of demo plot in each district

District	Sub District	Village
Samosir	Sianjur Mula-mula	Sianjur Mula-mula
Simalungun	Girsang Sipangan Bolon	Sipangan Bolon
Karo	Merek	Sibolangit

The primary data collected were soil type, climate, slope, local, and endemic species. The secondary data were land productivity, land use change history, growth of agricultural sector surrounding the LTCA, agricultural commodities, physical aspects surrounding the LTCA (soil, climate, and water), and prospective species on agroforestry of the LTCA. Data collecting was carried out with: (i) interview (semi structured household interviews), (ii) focus group discussion (farmers and local community members, official research and development institution, non government organizations, farmer organizations, artisans and traders, and private enterprise). (iii) field observation (checking and inventorying plants that grow around the demo plot candidate, surveys such as crops variety inventorying and land condition checking), and (iv) PRA (tools are: transects, seasonal calendars, matrices, participatory diagramming); respondents: farmers and local community members (Sianjur Mula-mula 50 respondents, Sipangan Bolon 13 respondents, and Sibolangit 10 respondents).

Secondary data such as commodity products were collected from Indonesian Statistic Center of North Sumatra. The object of this research is the Sub District that entered study territory, and the candidate of agroforestry demo plot. The information about those locations was gathered from data of Central Bureau of Statistics (CBS) Simalungun District (2007a, 2007b), CBS Samosir District (2007a, 2007b), and CBS Karo District (2007a, 2007b).

Information and data analysis that was carried out were: (i) managing data: collecting data, completing and classifying it in accordance to concept or category, (ii) displaying data: organizing the result of data reduction that organized and displaying completely, and (iii) verifying data.

RESULTS AND DISCUSSION

Species diversity

The species of crop data divided into agriculture, plantation and forestry commodity are shown in Table 2. Agricultural sector plays a strategic role in Simalungun District, where the contribution from this sector amounts to 54.77%, followed by industrial sector amounted to 18.86%, services 10.4%, commerce 8.44%, as well as other sectors. From these figures and in accordance with the potential and characteristics of the region, the agricultural sector becomes the main priority scale development in this area (CBS Simalungun District 2007a). Agriculture sector is one of Samosir District leading sectors which contribute about 48.16% of Gross District Income (CBS Samosir District 2007a). Karo District is known as an agricultural center in the North Sumatran Province. Agriculture sector gives the biggest contribution for Gross District Income, which is about 59.58% (CBS Karo District 2007a).

The field observation results of demo plot site candidates villages are reported in Table 3. Based on the observation (at Sianjur Mula-mula Village), the results of the agriculture (crop) made by community are *Allium cepa*, *Capsicum annuum*, *Zea mays*, *Oryza sativa*, *Coffea arabica*, *Persea americana*, *Gliricidia sepium* (Jacq.) Walp., and *Erythrina subumbrans* (Hassk.) Merr.. The wanted plantation are combined with second crops, such as *C. arabica*, MPTs (*D. zibethinus, P speciosa*, *Archidendron pauciflorum* (Benth.) Nielsen., *A. heterophyllus, and P. americana*. The forestry trees planted are *Toona sureni* (Bl.) Merr. and *Tectona grandis* L.f.

Table 2. Agriculture, plantation and forestry commodity

District	Commodity	
	Agriculture (crops)	Plantation and Forestry (trees)
Simalungun	*Oryza sativa* L., *Zea mays* L., *Manihot esculenta* Crantz., *Ipomoea batatas* (L.) L., *Arachis hypogaea* L., *Glycine max* (L.) Merr., *Capsicum annuum* L., *Pisonia grandis* R.Br., *Allium cepa* L. forma *ascalonicum, Allium sativum* L., *Solanum aculeatissimum* Jacq., *Solanum melongena* L., *Lycopersicon esculentum* Mill., *Daucus carota* L., *Brassica rugosa* Prain., *Vigna unguiculata* (L.) Walp., *Cucumis sativus* L., *Ipomoea aquatica* Forsk., *Phaseolus vulgaris* L., *Musa paradisiaca* L., *Carica papaya* L., and *Ananas comosus* (L.) Merr.	*Coffea arabica* L., *Cocos nucifera* L., *Eugenia aromatica* O.K., *Cinnamomum burmanii* (C.G. & Th. Nees) Bl., *Aleurites moluccana* (L.) Wild., *Arenga pinnata* (Wurmb.) Merr., *Areca catechu* L., *Vanilla mexicana* Mill., *Durio zibethinus* Murr., *Mangifera indica* L., *Artocarpus heterophyllus* Lam., *Persea americana* Mill., and *Citrus aurantium* L.
Samosir	*O. sativa, Z. mays, M. esculenta, I. batatas, A. hypogaea, G. max,* and *Curcuma longa* L.	*C. arabica, C. nucifera, E. aromatica, A. moluccana, Vanilla mexicana* Mill., *A. pinnata, A. catechu, Theobroma cacao* L., *Myristica fragrans* Houtt., and *Anacardium occidentale* L.
Karo	*L. esculentum, P. grandis, S. aculeatissimum, A. cepa, A. sativum, C. annuum, P. vulgaris,* and *D. carota*	*C. arabica, C. nucifera, E. aromatica, A. moluccana, C. burmanii,* and *Parkia speciosa* Hask.

Source: CBS Simalungun District (2007b); CBS Samosir District (2007b); CBS Karo District (2007b)

Table 3. The field observation result of demo plot site candidates villages

Demo plot site candidates villages and geographic position	Altitude, annual rainfall, and average temperature	Current vegetation, and soil types	Problem
Sianjur Mula-mula Village 98,47°-98,67° LE and 2,54°-2,55°PN	▪ 900-2,100 m asl. with declivity between 0->40 % or the average gradient. ▪ 1,400-6.000 mm/year ▪ 12˚-33˚C.	▪ Current vegetation: *A. cepa, C. annuum, Z. mays, O. sativa, C. arabica, P. americana, G. sepium, Pinus merkusii* Jungh. & De Vr., and *E. subumbrans* ▪ hapludults, dystropepts, humitropepts, troporthents (Ultisol, Inceptisol, and Entisol)	▪ There are many bare lands with hill and undulate topography that are easy to burn.
Sipangan Bolon Village 2.60˚-2.67˚ PN and 98.96˚-99,04˚ LE	▪ 900-1.800 m asl. with 8-25% of slope or with slightly and steeply area. ▪ 1.500-4.000 mm/year ▪ 18˚-32˚C.	▪ Current vegetation: *C. Arabica, E. aromatica,* Bambusoideae spp., *D. zibethinus, A. moluccana, P. Americana, Psidium guajava* L., *P. merkusii, P. speciosa, A. heterophyllus, Sandoricum koetjape* (Burm.f.) Merr., ▪ kecapi, *M. indica, Macadamia hildebrandii* Steenis, *A. pinnata, C. Annum, Zingiber officinale* Rosc., *P. grandis, L. esculentum, Z. mays,* and *A. hypogaea* ▪ troporthents, dystropepts, humitropepts, hapludults, haplohumults, tropopsamments, and hapludox (Inceptisol, Entisol, Ultisol, and Oxisol)	▪ The rate of land degradation was quite high which was seen from domination of tall grass
Sibolangit Village 2.87˚-2.88˚ PN and 98.54˚-98.56˚ LE	▪ 900-1,200 m asl. with the slope between 8-25% that was slight until medium slope. ▪ The rainfall in this territory revolved between 1,500-5.700 mm/the year ▪ 17˚-32˚C.	▪ Current vegetation: *M. indica, P. americana, A. moluccana, G. sepium, E. deglupta, T. sureni, Melia azedarach* L., *Cassia siamea* Lamk., *Gmelina arborea* Roxb., *A. muricata, A. heterophyllus, Syzygium aqueum* (Burm.f.) Alston, *A. pinnata, Z. mays, C. arabica, A. cepa, T. cacao, A. catechu, D. zibethinus, Solanum torvum* Sw., *P. speciosa, A. Pauciflorum.* ▪ tropudult (Ultisol)	▪ The large number of critical land which was dominated by sedge-grass on that area ▪ Marketing of agriculture yield that is still difficult, fire disaster, and the mango trees that only have a few fruits.

Table 4. The Commodities that were really liked by the farmer

Demo plot site candidates villages and located	Commodity		
	Agriculture (crops)	Plantation	Forestry (trees)
Sianjur Mula-mula Village	*C. annum, Z. mays, O. sativa, A. cepa*	*C. arabica, P. americana, D. zibethinus, P. speciosa, A. pauciflorum, A. Heterophyllus*	*G. sepium, P. merkusii, E. lithosperma, T. sureni* and *T. grandis*
Sipangan Bolon Village	*C. annum, Z. mays, L. esculentum, Z. officinale*	*C. arabica, T. cacao, P. americana, D. Zibethinus*	*T. sureni, S. macrophylla,* and *Podocarpus imbricata* Bl.
Sibolangit Village	*C. annum, Z. mays, M. esculenta, O. sativa, A. cepa, A. hypogaea*	*C. arabica, T. cacao, E. aromatic, M. Indica*	*E. deglupta, T. sureni, C. calothyrsus, A. mangium*

The available crops in the community's land consist of *A. cepa*, *C. annum*, *A. hypogaea*, *Z. mays*, *M. esculenta*, and *O. sativa* as the agricultural crop. The available plantation crops in Sibolangit Village are *C. arabica*, *T. cacao*, and *E. aromatica* clove. The forestry crop planted by the Sibolangit Village community are *M. indica*, *A. moluccana*, *P. Americana*, *T. sureni*, *D. zibethinus*, *Gmelina arborea* Roxb., *P. guajava*, *A. Pinnata*, *A. muricata*, *A. catechu*, *S. torvum*, *P. speciosa*, *A. Pauciflorum*, *E. deglupta*, *A. heterophyllus*, *M. azedarach*, *G. sepium*, and *Cassia siamea* Lamk.

The commodities really liked by farmer are reported in Table 4. Based on results of the interview with participants (Sipangan Bolon Village) in the meeting and results of stocktaking, it is known that available crops variety in demo plot land (the Sagala-resin Village), which serve as an agricultural crops, were *C. annum*, *Z. officinale*, *P. grandis*, *L. esculentum*, and *Z. mays*. The available plantation crops in the community's land are *C. arabica* and *E. Aromaticum,* whereas for the forestry crops were *Bambusoideae* spp., *D. zibethinus*, *A. moluccana*, *P. americana*, *P. guajava*, *P. merkusii*, *P. speciosa*, *A. heterophyllus*, *S. koetjape*, *M. indica*, *M. hildebrandii*, and *A. pinnata*.

The community often does not know about the species of crops that can be planted, nor do they know how the production technique of seedling cultivation of the forestry crops (the tree) is. However, the most wanted second crop species are the legumes, which are *Z. mays*, *L. esculentum*, *Z. officinale*, and *C. annum*. The most wanted species of the plantation crop are *C. arabica*, and *T. cacao*. *P. americana* is the most wanted species of MPTs followed by *Solanum aculeatissimum* Jacq. and *D. zibethinus*, whereas for the community's trees, the most wanted species is *T. sureni* in addition to *Swietenia macrophylla* King., and *Podocarpus imbricata* Bl.. Most of the group's members do not like *P. merkusii* because of consideration that it will drain the land.

Then, the plantation crops really liked by the farmer (at Sibolangit Village) are *C. arabica*, *P. americana*, and *T. cacao*. The forestry crops that they want are *Eucalyptus deglupta* Blume, *T. sureni*, *Calliandra calothyrsus* Meissn., *D. zibethinus*, *A. mangium* Willd., and *M. indica*. Actually *A. mangium* kind was not yet known by them, but they are interested of planting the acacia after having been given the explanation that *A. mangium* could be planted as the pioneer of fast growing crop before the bare land is planted by *C. arabica* and *T. cacao*.

In the determination of species, there are some interesting information: (i) participants in the meeting want not only *T. sureni*, but also the combination of various kinds of trees/crops, (ii) *P. merkusii* was not liked by the most because of belief in by the community that it will absorb water quite a lot, (iii) *C. calothyrsus* is known by the community as the fire barrier that grows faster than *M. hildebrandii*.

Considering the condition of the villages as mentioned above, plant varieties which were appropriate to be planted in the demo plot are: (i) For Sianjur Mula-mula Village: *C. arabica*, *P. americana*, *P. merkusii*, and *T. sureni*; (ii) For Sipangan Bolon Village: *S. macrophylla*, *M. tinctoria* Roxb, *T. sureni*, *C. calothyrsus*, *Jatropha curcas* L., *P. americana*, *C. arabica*, *T. cacao*, and *S. aculeatissimum*; (iii) For Sibolangit Village: *T. sureni*, *C. calothyrsus*, *E. deglupta*, *C. arabica*, *T. cacao*, *M. indica*, *Caesalpinia sappan* L. and *P. americana*.

Trees play a crucial part in almost all terrestrial ecosystems and provide a range of products and services to rural and urban people. As natural vegetation is cleared for agriculture and other types of development, the benefits provided by trees are the best sustained by integrating trees into agriculturally productive landscapes (Kuswanto 2007).

The selection of agriculture plant species

The choice of crop species was very important, because the mistakes that might be happened will have a long impact and will be very damaging. The species being selected should not only suitable with the specific site, but also have capacity to grow and develop ideally together with other crop species being planted on the same land.

Factors which determine the success of agroforestry

A key to successful mixed cropping is selection of species with complementary root system behavior patterns as well as complementary shoot growth habits (Huck 1983). Multispecies agro-ecosystems, with their potential for synergy in terms of below-ground interactions, can offer improved farmer livelihoods and sustainability and basic ecosystem functions, at levels of complexity far below those of natural ecosystems (Van Noordwijk et al. 2004).

Factors which should be considered for achieving success in agroforestry are among other things (Perum Perhutani 1993): (i) Environmental factors: species of plants, topography, soil fertility, climate, pest and diseases; (ii) Supporting factors: road condition, accessibility (distance), supporting facilities, capital support, and market prospect; (iii) socio-cultural factors: planting techniques, skill level, and types of needs. Patterns of agroforestry are determined by several factors, which are among other things: (i) interaction between components within the agroforestry system, (ii) determination of planting distance (spacing) of main crops, (iii) management treatment, and (iv) efforts to seek multifunction of land and sustainability of yield. Regulation of plant components (Nair 1993) can be conducted by among other things: (i) spatial regulation (dense mixture, sparse mixture, strip and *boundary*); (ii) temporal regulation (coinciding, in a row, *overlapping*, in sequence, *interpolated*). Imo (2009) showed that tree survival, growth and nutrient uptake, and maize growth and yield were higher in the deep soil site than the shallow site.

The planting technology which is needed to make the existing land use systems be functional in increasing land productivity and supporting soil and water conservation functions, are among other things: development of terrace and the use of compost or organic fertilizer. Therefore, development of forage crops in a land unit, for terrace reinforcement, becomes a requirement which should be prioritized. In the study area, there is a great potential for development of compost or organic fertilizer. Development of this kind of fertilizer should be emphasized, due to consideration that at present, as indicated by interview results, the dependence of farmers on chemical fertilizer is very high. In long term, chemical fertilizer will have negative impact toward Lake Toba ecosystem.

Calliandra plants are appropriate to be developed. The main objectives of calliandra plant developments are for terrace reinforcement and for honey bee culture. However, there is also other purpose of the bee culture, namely assisting the process of pollination of fruit crops (mango). According to information from the farmers, the *mangga udang* (a kind of mango) plants, at present become rare in producing fruit or sparse in the fruit production.

Sequential system and succession system which are managed properly could become the main alternative in developing forest with the agroforestry system in Toba Lake area, because the system have the following potency: (i) efficient in light utilization, (ii) maintaining the nutrient availability, (iii) increasing soil organic matter, (iv) increasing productivity, (v) having *more self-maintenance* features, (vi) having relatively less pest and diseases, (vii) having relatively less competition from weeds.

Requirements of plant species for agroforestry

In conventional intercropping in agricultural tree crop plantations, certain criteria have been suggested for choosing suitable ‘subsidiary’ crops. Thus, Allen (1955) stated that the second or subsidiary crop grown under or between a tree crops should be tolerant of partial shade, and should not: (i) grow as tall as the main crop; its root system should exploit different soil horizons; (ii) be more susceptible than main crops to diseases they have in common; (iii) demand harvesting or other operations that would damage the main crop or induce soil erosion or damage soil structure; and (iv) have an economic life longer than that of the main crop. In addition to these, Hartley (1977) adds that: (i) the soil shall be suitable for both crops; (ii) the combine yield of the two crops shall be greater in monetary terms than that of the main crop when grown without the subsidiary crops; and (iii) if and when the subsidiary crops comes to the end of its bearing life, the yield of the main crop shall continue at an economic level unaffected by previous presence of subsidiary crop. Agroforestry can help prevent land degradation while allowing continuing use of land to produced crops and livestock on sustainable basis (Cacho 2005).

Research Institutes of IPB (1986) reported plant species which are used for each form of agroforestry should fulfill the following requirements: (i) *Ecological requirement:* The plant species should (a) be suitable with the local condition where the agroforestry will be developed; (b) not create competition with food/forage or feed crops, either in the form of root competition or crown competition (for this purpose, species being selected are trees with light crown, and deep rooting; or there should be proper regulation of spacing of planting); (c) be able to increase and maintain soil fertility/soil productivity; (d) have slow regeneration and narrow radius of seed dispersal to prevent expansion toward food crops which are combined with the tree crops; (ii) *Economic requirements:* The plant species should (a) produce yield rapidly (in this case, fast growing species with high increment could be chosen) (b) have multiple benefits (such as in the form of carpentry wood, raw materials for pulp and paper, firewood, and others); (c) be easily marketed (the developed plant species should be integrated with other sectors); (d) be as far as possible produce intermediate yields (the obtained yield in the form of wood is obtained not only in the end of the rotation, but also during the whole period of the rotation, and for this purpose there could be efforts in the form of establishing multistoried tree stands which are combined with plantation of estate crops, feed/forage crops or food crops).

Any choice of species (Huxley 1999) is conditioned by a combination of the farmer's objectives and constrains, the biology of the species concerned, and the nature of the system in which it is be grown – we have to get all of these right. Sometimes ascertaining the farmer needs thorough a consideration of the technical alternatives as it should. Assumptions about the benefits of agroforestry may, unwisely, be taken for granted. Keeping an open mind about the whole spectrum of possibilities is crucial. Also, of course, in optimizing land use it is essential that, after the social issues have been exposed and explored, all the technical alternatives are evaluated in economic terms.

Agroforestry is one possible option to enhance the stability and productivity of agro-ecosystems (Kindt et al. 2006) and alleviate environmental stresses (Leakey and Jaenicke 1995). Especially, fruit-based agroforestry has a real promise in alleviating poverty by contributing both products and important ecological services. For the many crop components and combinations possible, this system is highly adaptable and applicable to a wide area and range of physical and social conditions (Withrow-Robinson et al. 1999; Withrow-Robinson and Hibbs 2005). Fruit-based agroforestry can potentially be developed from indigenous fruits that are now mostly found in the wild as much as from exotic fruit sources. The contribution of indigenous fruits to poverty reduction and their vital role in the livelihoods of many communities is getting good recognition (Garrity 2004; Schreckenberg et al. 2006). In addition, as they are adapted to the local environment, indigenous fruits can grow easily with few requirements for external input and be integrated into sustainable farming systems.

An evaluation of farmers' experiences planting native trees in rural Panama: implications for reforestation with native species in agricultural landscapes (Garen et al. 2009) reported all participants in the program considered their experience to be positive, few had problems with their plantations, and most were interested in planting more native trees. The program's frequent and ongoing technical support was an important factor for farmers. These results indicate widespread interest in, and success with, planting native species and underscore the need to systematically examine farmers' interests and perceptions when planning, implementing, and evaluating reforestation initiatives.

Ecological and socio-economic sustainability is not just related to species diversity per se, but rather to more specific features such as presence of keystone species and diversity in functional species groups. Socio-economic sustainability in terms of adjustment to socio-economic change implies dynamics in species diversity (Abebe et al. 2010).

How the plants utilize sun light?

If light it is the main limiting environmental resource, then leaves become organs of aggression, and the dominant crop will be that which is tallest. One of the most potent ways of resource sharing is to plant crops so that they each become tallest in turn. Five ways of doing this spring to mind (Cannel 1983): (i) by planting crops together which attain similar heights but with different life cycles, (ii) by planting crops together which attain different heights such that the sorter ones mature before the taller ones, (iii) by planting crops at different time, (iv) by planting crops which can climb up the stalks of crops that mature before them, and (v) by minimizing the shade by the tall crops, by using erect-leaved crops (for example, maize), by pruning trees or by planting deciduous trees. .

The findings of spatial arrangement, interview results and literature review, revealed the following things. . The villages around lake Toba has the following characteristics (i) The farmer made efforts to maintain diversity of the crops (ii) the farmer generally knows well the species of annual crops, estate crops, and forestry crops which they cultivated (iii) the farmer generally practices the land use system of agroforestry (iv) the women had important role in the land use system, (v) there were high dependence on chemical fertilizer, (vi) the farmer generally knows crop species which have high economic value (vii) generally, the farmer did not really practice the proper conservation technique for soil and water (viii) Farm land in the villages seldom received the attention of agricultural extension workers (ix) organic fertilizers were still rarely used.

The diversity of the existing crop species showed the number of choices to be developed by the farmer. The farmer generally has the aims of economic gain in developing agroforestry, such as risk reduction increase in net income, increase in environmental service and increase in wealth and savings. The villagers would only receive and developed agroforestry, when they felt that it was beneficial. Therefore, agroforestry was not only an art of mixing woody plants, fruit tree, annual crops, and animal in skill full manner, but agroforestry was also in the long run, an art to make life in rural areas more productive and interesting. "Interesting" in this sense was related with the ability of agroforestry to maintain good cultural values, to control the use of land, and to increase people's income, as well as to reduce risk in farming works and to spread the use of labors in the farm.

The concepts, strategies and policies associated with agroforestry are rapidly evolving towards the creation of sustainable land uses that enhance farmers' livelihoods, provide commodities for global markets and mitigate global concerns about environmental degradation. In parallel, the techniques for the domestication of indigenous trees for the agroforestry production of NTFPs also are evolving rapidly and should produce further benefits in terms of income generation for agricultural inputs and household welfare (Leakey and Tchoundjeu 2001). Moreover, the present study open vistas for using farmers' experience and knowledge of adoption of agroforestry to stimulate on-farm tree growing. The wider implication of the study is that biophysical as well as social variables should be considered together in designing suitable agroforestry systems in various parts of the world (Sood and Mitchell 2009).

Modern agriculture and forestry, without and agro-ecological perspective, has gone a long way toward satisfying the demand for food, fiber, and other products. This has been accomplished in a world with rapidly expanding population and a less stable land area (Wojtkowski 2002). Wijayanto (2001) stated that management system for community based forest could be done through maintaining and implementing dynamic equilibrium condition, with implies that occurring growth in economy and business should be accompanied by ecological sustainability and socio-cultural stability.

Agroforestry is one options directly linked to the double goal of providing a good income to farmers and maintaining the environmental services that all of society expects: no landslides that destroy houses, no flooding beyond what is to the expected when there are is heavy rain, no pollution of the water sources by over use fertilizers and pesticides as we find in vegetable production. Farmers interested planting trees in their farm depending on land ownership, economic value, market access, low labor requirements and availability of good seedlings. Farmer choice on tree species differs among ethnic background and associated resource base (Hairiah 2006).

CONCLUSION

Various types of agricultural crops, plantations and forest trees were found in LTCA. They have the potential to be developed in agroforestry systems. Based on the data and information being collected, as well as the available literature references, the combination of the crops species which were potential to be developed were among other things: (i) The agricultural crop: *Z. mays*, *O. sativa*, *C. annuum*, *B. rugosa*, *L. esculentum*, *S. tuberosum*, *P. grandis*, *Phaseolus* spp., *A. cepa*, *C. papaya*, *M. paradisiaca*, *A. comosus*, *P. vulgaris*, and *M. esculenta*; (ii) The plantation/estate crop: *C. arabica*, *T. cacao*, *E. aromatica*, *C. aurantium*, *S. aculeatissimum*, *P. americana*, *J. curcas*, *M. indica*, *C. burmanii*, *P. speciosa*, *S. aqueum*, *A. occidentale*, *P. guajava*, and *E. lithosperma*; (iii) The forestry tree species: *T. sureni*, *S. macrophylla*, *P. merkusii*, *P. falcataria*, *G. arborea*, *C. calothyrsus*, *E. deglupta*, *M. hildebrandii*, *T. grandis*, *C. siamea*, *G. sepium*, *A. moluccana*, *P. imbricata*, *M. tinctoria* Roxb., *A. heterophyllus*, *C. sappan L.* Development of integrated agriculture in the form of agroforestry system (livestocks, livestock feed, agriculture, plantation, forestry) are better to be prioritized, to create sustainable forest and prosperous community. Sequential system and succession system which are managed properly, should become the basis of plant selection and combination for development of agroforestry system to make the farmers happy and the forest sustainable.

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