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Master thesis

Evaluation of forestry and agriculture practices - A case study of Minahasa Regency, Indonesia

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Abstract

A half of the Indonesian population inhabits the rural areas and manages the nature resources which play an important role in local economy in term of agriculture production. Deforestation, frequently occurred natural disasters, food shortages, a high poverty rate and a level of corruption form the specific local conditions. The soil erosion is a crucial problem in the surrounding locality of Tondano lake in Minahasa Regency. Not only the lowlands but also the highlands have a certain potential for agriculture production but the local practices during the last years caused soil deterioration. The average smallholder runs the farm of 0.45 ha employed mainly the family members. Farm production involved cultivation of different plant (*Bamboo spp., Coffea arabica, Zey may, Manihot esculenta, Oriza sativa,* vegetable, flowers) and tree species (*Cordia dichotoma, Durio zibethinus, Lansium domestici, Leucena leucocephala Michelia champaca, Plumeria acuminata, Swietenia mahagoni, Syzigium aromaticum*) in various arrangements mainly for own subsistence. All farmers grow group of trees or own the forest stand. The tree species composition and the unstable market prices have been defined as the main production constraints. The agroforestry proposal has been outlined in respect of local production habits and environmental conditions to meet the needs of the farmers. The agroforestry systems employed the suitable mixture of crops and trees which are considered to be the way how to control soil erosion. This sustainable management of natural resources in Minahasa Regency would contribute to the improvement of the farmer's livelihood in North Sulawesi.

Key words: Indonesia, agriculture, forestry, agroforestry, crops, trees, rural areas, soil erosion

Abstrakt

Polovina indonéské populace žije na venkově a hospodaří s přírodními zdroji, které jsou významné pro místní ekonomiku. Odlesnění, časté přírodní katastrofy, problémy se zajištěním potravin, chudoba i korupce se podílejí na vytváření specifických podmínkách místních oblastí. Půdní eroze se stala díky místnímu způsobu hospodaření významným problémem v oblasti okolo jezera Tondano (Minahasa), kde i přes značený potenciál zemědělské produkce, jak v nížinách tak i ve vyvýšených oblastech, činí potíže. Místní způsob hospodaření v minulých letech problém s půdní erozí stále prohluboval. Běžný farmář hospodaří na farmě o výměře 0,45ha hlavně za pomoci své rodiny. Zaměřuje se jak na pěstování plodin (např. *Bambusa spp., Coffea arabica, Zey may, Manihot esculenta, Oriza sativa*, zelenina, květiny) tak i stromů (např. *Cordia dichotoma, Durio zibethinus, Lansium domestici, Leucena leucocephala Michelia champaca, Plumeria acuminata, Swietenia mahagoni, Syzigium aromaticum)* a to hlavně pro svoji potřebu. Pěstování stromů má v oblasti Minahasa značnou tradici. Součástí každé farmy je les nebo alespoň seskupení stromů pěstovaných výhradně pro různé účely. Farmáři však často vyjadřovali svojí nespokojenost se strukturou pěstovaných druhů, které spolu s nestabilní cenou na trhu byly definovány jako hlavní omezení místní zemědělské produkce. Návrh agrolesnického systému zapojuje různé rozmístění zemědělských plodiny a stromů, tak aby přispěl k řešení problému s půdní erozí dle nároků na zemědělskou produkci definovanou místními farmáři. Udržitelný způsob hospodaření s přírodními zdroji v oblasti Minahasa je způsob jak přispět ke zlepšení živobytí farmářů v Severním Sulawesi.

Klíčová slova: Indonésie, zemědělství, lesnictví, agrolesnictví, plodiny, stromy, venkovské oblasti, půdní eroze

Certification

Me, Eva Pastorková, declare that the thesis, submitted in partial fulfillment of the requirements for degree MSc. at the Institute of Tropics and Subtropics, in the Czech University of Life Sciences Prague, is wholly my own work unless otherwise referred to acknowledged.

Prague,

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Eva Pastorková

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1 Introduction

Indonesia is highly dependent on the local natural resources. The significant contribution of agriculture sector to GDP (IFAD – 2, 2009; FAO, 2005) and also the direct dependence in term of employment and food security (IFAD – 2, 2009) are considered to be the crucial factors powered enough to alter the future of local inhabitants. IFAD (International Fund for Agriculture Development) pointed to the needs of rural Indonesian areas calling for development programs adapted to their specific conditions (IFAD, 2009) which are affected by the rapid deforestation, frequently occurred natural disasters, food shortages, a high rate of poverty and a level of corruption.

All these factors influence each other. It is not possible to stop the natural disaster that deeper the poverty and food security problems but the sustainable management of natural resources provide an opportunity to cope with these difficulties through the suitable practices in agriculture and forestry sector. Therefore the rural areas are considered to be the large opportunities for aid implementation (IFAD, 2008).

The thesis give an overview of the agriculture and forestry systems in Minahasa Regency, located in the northern tip of Indonesian island Sulawesi where was implemented the developing project by the extension and engineering enterprise Mott MacDonald with cooperation of forestry and agriculture experts from Czech University of Life Sciences Prague to encourage the local progress in forestry and agriculture production.

According IFAD (2008) was outlined the importance to boost the farm productivity and to increase the access of rural people to productive assets. The rural areas seems to be a reasonable initiation point for various kind of aid that would drive the development forward and learn the local people how to use and safe their natural resources also for the next coming generation. The rural inhabitants represent a group managing a significant part of the natural resources of their country (IFAD-3, 2009).

The target locality in Minahasa Regency is mostly situated in upland land which has been evaluated by FAO (2005) as the site with a high potential for agricultural development

required a sustainable way of management. The alternation of local agriculture systems have been incorporated in the agroforestry proposals according the results of the field study to promote the farm production in targeted areas. The proposal of changes and innovations try to respect the nature conditions, needs and culture habits of local inhabitants and include the recorded farmer’s request for the future husbandry.

2 Background to the case study region

2.1 Indonesia

The Indonesian archipelago consists of 17 435 islands with a total land area of 192 million ha (FAO, 2005), of which only 6 000 ha are inhabited (IFAD, 2009). Java, Madura, Bali and Lombok are the densely inhabited islands (Figure 1 in Appendix) which account all together for 8 % of total area and became a home for 59 % of the total population thank to the fertile soils and intensive food cropping systems. On the other hand, 88 million (45%) of inhabitants occupy outer islands cope with deterioration soils which are cultivated less intensively mainly with perennial crops (Figure 1). The size of land owned by each household in inner islands is much smaller that in the outer islands (FAO, 2005).

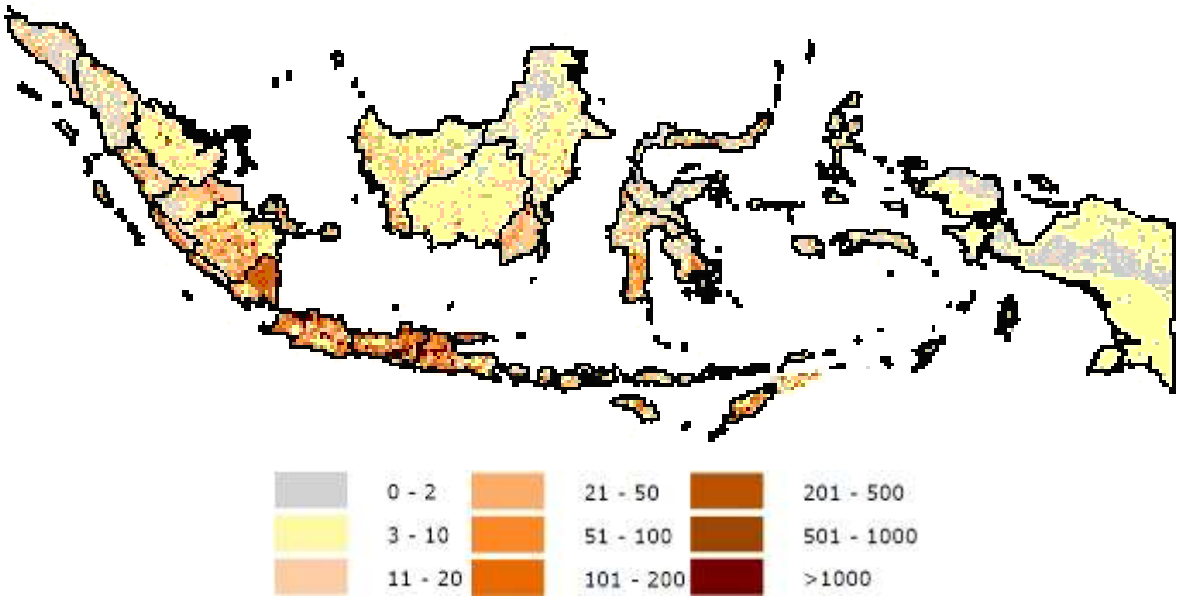


Figure 1 Population density (FAO, 2010)

Indonesia is highly vulnerable to the impact of climate changes resulted in different natural disasters (droughts, flooding and rising sea levels) (Figure 2) (IFAD, 2009).

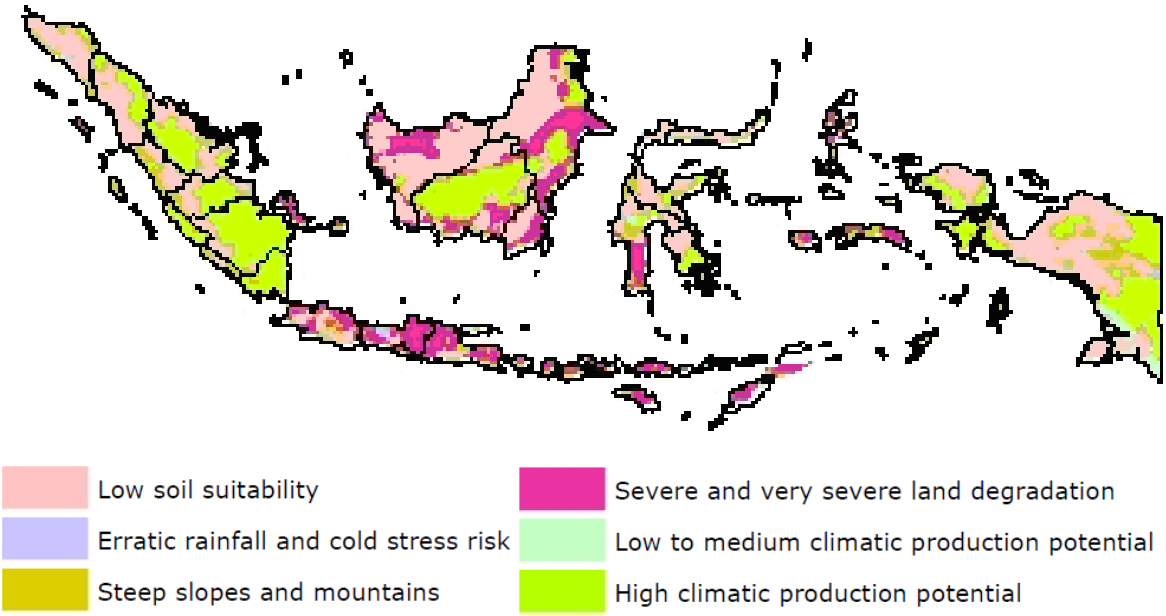


Figure 2 Environmental constrains (FAO, 2010)

2.2 Population

Indonesia is the fourth most populous country in the world. The population is about 282.2 million and is growing at a rate of 1.3 % per year (IFAD – 2, 2009). 60% of people live in the coastal zone (Elliot *et al.*, 2001). 48.5 % of the total population lives in rural areas (IFAD – 2, 2009). There are over 7000 coastal villages, many of which are dependent on inshore fisheries (Resosudarmo *et al.*, 2000). The rural inhabitants manage crucial amount of land and forest area. They are the important mediators in protecting of natural resources and provide significant environmental services (IFAD-3, 2009). According the prediction of UN, the numbers of rural inhabitants will significantly decrease to 32% in 2030 (Effendi, 2006).

In 2008, 35 % of the rural inhabitants (that is equal to 17% of the total population) have been classified as a poor (IFAD – 2, 2009). Further larger numbers refer to the group of the people living just above the defined poverty line and are vulnerable to get the status of poverty. Poverty reduction strategies should to focus on increasing of the incomes of poor and people living just above the poverty line (IFAD, 2009) and reduce their tendency to migrate which considered as an alternative how to escape from the poverty (Effendi, 2006).

Majority of farmers are smallholders (FAO, 2005) farming on very small plots of less than 0.5ha. They are commonly not the land owners. There are a large proportion of women that take care about the households and agriculture task at the same time. Women are often excluded from the decision making process about the farm. 95 % of people residing the rural localities of remote eastern islands are poor. They are vulnerable to external shocks (IFAD, 2009).

Over 300 of ethnic groups speak 680 native languages. The national language Bahasa Indonesia is spoken by most of the literates (Ministry of Education of Indonesia, 2010). Indonesia has the largest Muslim population in the world (IFAD, 2009). There has been a significant decrease in illiteracy rate from 12.88 million in 2006 to 8.7 million illiterates in 2009. In 2008, 95% of the children were enrolled in primary school and 96% in secondary school (Ministry of Education of Indonesia, 2010). Indonesia is also a home of 19 300 of refugees (UNDP, 2010).

2.3 Economic situation

Indonesia is a heterogeneous country. The disparity of regional development between Java and outside Java, between Western Indonesia and Eastern Indonesia, and between urban and rural areas has been detected (Figure 3) (Effendi, 2006).

Figure 3 Development disparities (Effendi, 2006)

GDP per capita reached USD 4.394 US (PPP) in 2008. According the value of GINI coefficient (37.6), the income distribution does not display large inequalities. Other factor characterized one third of the population (29.4%), is an everyday fight for surviving below USD 1.25 /day (PPP) (UNDP, 2010). The development in agricultural sectors has followed the population grow and population geographical distribution influenced by natural conditions (FAO, 2005). A significant part of the people suffering from poverty is concentrated among rural households (IFAD, 2009). Farmers generating their livelihood in remote upland areas are extremely vulnerable and easily end up living in poverty (IFAD, 2009).

8.4% of the national population is unemployed (UNDP, 2010). The infrastructure is in poor condition (IFAD, 2009). All negative factors contribute to the slowdown in economic growth and natural resources overexploitation have been defined as the crucial challenges (Effendi, 2006).

2.4 North Sulawesi

The study focused on the part of one largest Indonesian island Sulawesi particularly on the North Sulawesi (Figure 4). North Sulawesi is characteristics by lower population pressure but also by lower soil fertility. Perennial crops are typical for the local agriculture (FAO, 2005).

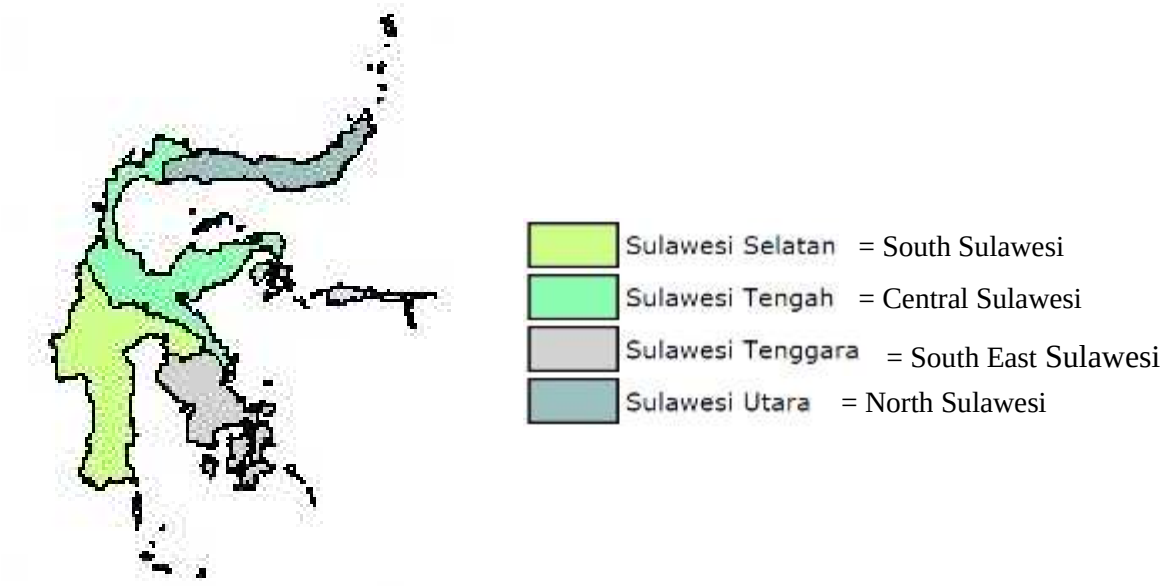


Figure 4 Map of the administration on island Sulawesi (FAO, 2010)

North Sulawesi is inhabited by four ethic groups (Bolaang Mongondow, Gorontalo, Sangihe Talaud and Minahasa) of which names correspond with the names of the province-district. The official language is “Bahasa Indonesia” but local people recognize other 20 languages (The Minahasa, 2004).

The study area has been chosen according the site implementation of the developing project (Rehabilitation of the Tondano Lake Area, North Sulawesi) which focused on the locality situated in Minahasa Regency (North Sulawesi) close to the Makalonsouw village in the vicinity of Tondano lake (Figure 5).

Figure 5 Administrative map of North Sulawesi (Minahasa, 2011)

2.4.1 Social economic description

The population trend develops in the same way like the national population growth and migration (Effendi, 2006). The increasing tendency is demonstrated by the numbers from population census summarized in Table 1 which include also non permanent resident (homeless people, sailor, boat people and remote area communities) (Badan Pusat Statistik, 2010).

Table 1 Population in numbers during 1971-2010

	1971	1980	1990	1995	2000	2010*
Indonesia	119 208 229	147 490 298	179 378 946	194 754 808	206 264 595	237 641 326
North Sulawesi	1 718 543	2 115 384	2 478 119	2 649 093	2 012 098	2 270 596

*) Preliminary figures

(Badan Pusat Statistik, 2009)

The net migrants quotes the figures concerning the decreasing change of total inhabitants sum in North Sulawesi but the numbers of immigrants and also emigrants are still rising (Table 2).

Table 2 In-migration and out-migration in North Sulawesi

	1971	1980	1985	1990	1995	2000	2005
Immigrants	50 356	91 460	74 819	89 096	76 084	147 091	165 689
Emmigrats	60 837	121 231	150 142	153 466	218 240	151 326	166 157
Net Migrants	-10 481	-29 771	-75 323	-64 370	-142 156	-4 235	-468

(Badan Pusat Statistik-e, 2009)

The increasing population trend in urban areas has been detected. The numbers of these people have increasing during the time 2000-2005 by 80%. Mainly among the young people, it was observed the pattern of employment interest which turns to the industrial sectors. In 2004, the unemployment was higher in cities by 4.86% (and reached 13.97%) than in rural areas (Effendi, 2006).

The progress of the Indonesian population situation has been proved by statistics records. The development of Human Development Index (HDI) is illustrated by Table 3. HDI classifies Indonesia in a group of medium human development. During 1980-2010, Indonesia's HDI noted the rise by 1.4% annually from 0.39 to 0.60 today, which gives the country a rank of 108 out of 169 countries (UNDP, 2010). HDI referring to the situation in North Sulawesi never drops under the national average during the time 1996 - 2009 and usually exceeded this number at least by 4% (Badan Pusat Statistik - b, 2010).

For all that, this progress does not satisfy a significant part of the population living under the poverty line or those that just escape from the statistics to be classified as the poor but still living just above the defined poverty line. These people are very vulnerable and can very

easily get in the group which the statistics already includes among the poor (Human Development Report, 2004).

Table 3 Trend of Human Development Index

	1996	1999	2002	2004	2005	2006	2007	2008	2009
North Sulawesi	71.8	67.1	71.3	73.4	74.2	74.4	74.7	75.2	75.7
Indonesia	67.7	64.3	65.8	68.7	69.6	70.1	70.6	71.2	71.8

(Badan Pusat Statistik-b, 2010)

2.4.2 Climate

Most parts of the country have a wet humid tropics climate with a rainy season (the west monsoon) between October and March and a dry season (the southeast monsoon) between April and September (FAO, 2005). Manado received in 2010 an average precipitation of 2840 mm. Along the year, the rainfall ranged from 110 mm/month in August up to 420 mm/month in January (Weatherbase, 2011).

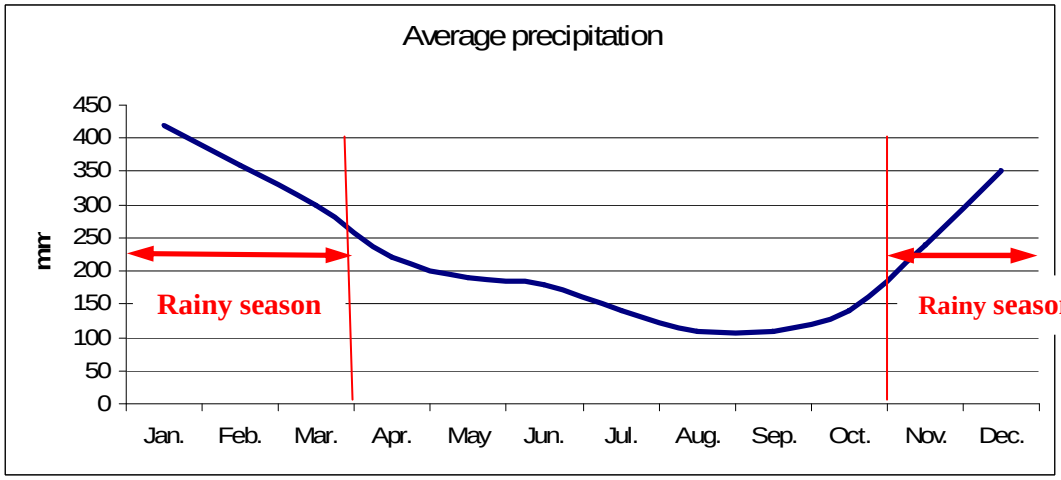


Figure 6 Average precipitation (mm) – Manado, 2010 (Weatherbase, 2011).

The average temperature varies only slightly around the year (Figure). The year average reached 26°C. The extremes temperature drop down to 15°C and rise up to 40°C according to the season (Weatherbase, 2011).

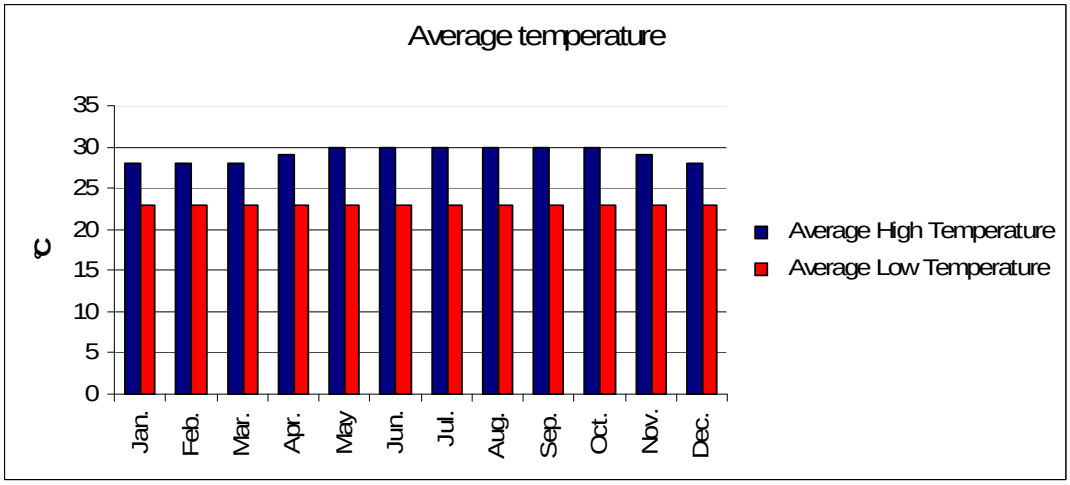


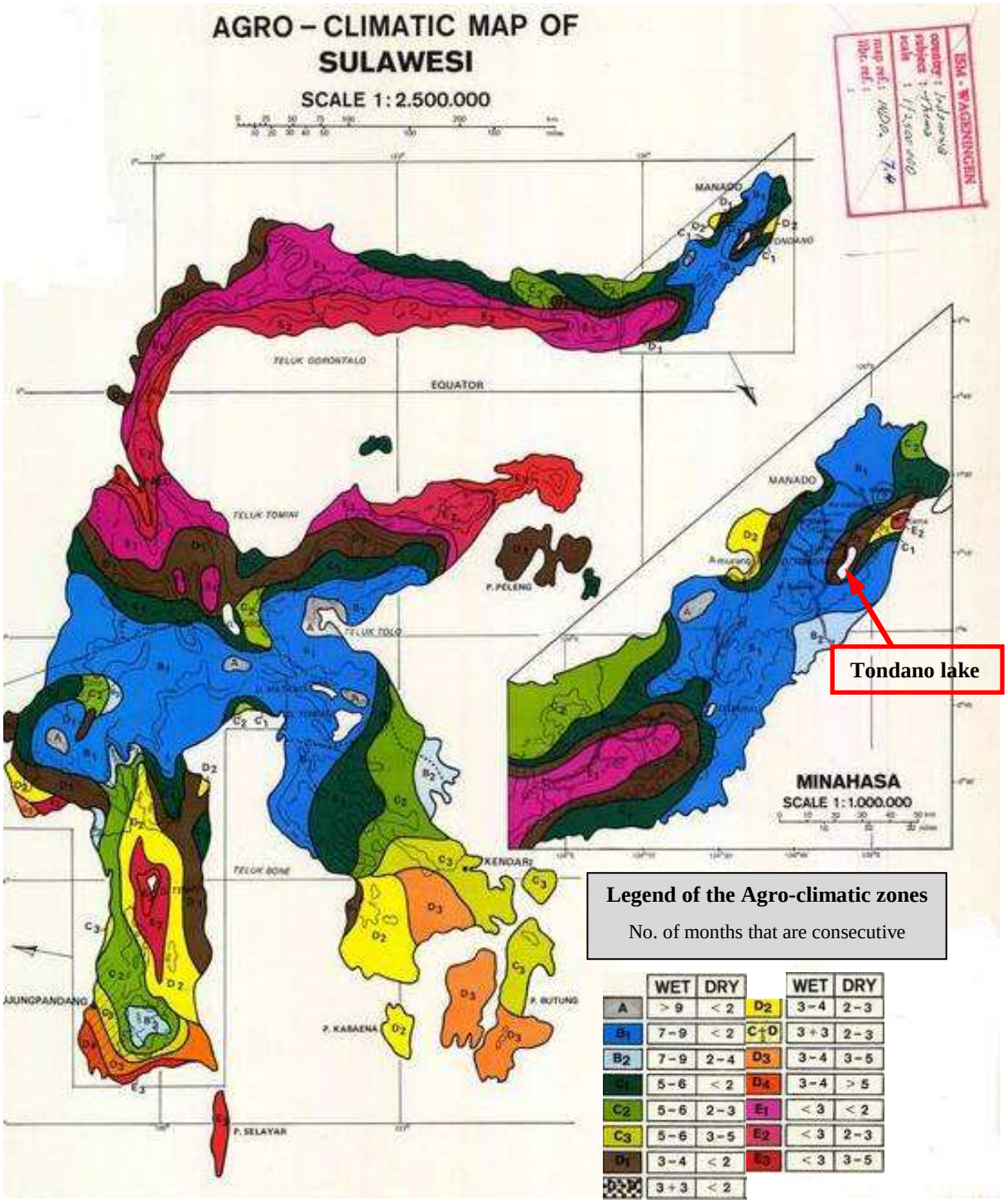
Figure 7 Average temperature (°C) – Manado, 2010 (Weatherbase, 2011)

The mentioned data came from the weather observation in Manado, which is the capital city of North Sulawesi. Manado is located 79 m above the sea level at the latitude of 1°32' North and longitude of 124°55'Eeast (Weatherbase, 2011).

2.4.3 Agro-climatic zones

The agro-climatic zones separate areas with similar sets of potentials and constraints for development. Based on these features, these zones represent a crucial tool for rural land-use planning (FAO, 1996).

The year is divided in Indonesia in two distinctive seasons that differ in amount of receiving precipitation (Weatherbase, 2011). According the Figure 8 referring to the agro-ecological zones, most of the area of Minahasa Regency is characterized by the 7 up to 9 wet months and only 2 (or less) dry months. The adjacent locality of Tondano lake slightly differ from the surroundings. This climatic zone does not display a significant difference along the year as it is shown by a Figure 8. Just 3 – 4 wet month and 2 dry moths has been recognized. The wet months have been determinate as the periods within is received more than 200 mm/month and dry months as periods within them the precipitation does not exceed the 100 mm/month. Another important characteristic of the agro-ecological zone is soil features which has been described in followed chapter.



Two or more consecutive months with more than 500 mm month rainfall.

WET: > 200 mm/month

DRY: < 100 mm/month

(Based on Long Term Averages)

Figure 8 Agro-climatic zones of Sulawesi (Oldeman, Darmiyati, 1977)

2.4.4 Soil types and terrain characteristics

Sulawesi is covered by various types of soils, of which development have been affecting by a lot of incidences of volcanic activity during the centuries. On Indonesian islands are located tens of volcanoes (Figure 2 in Appendix), which 8 of them are located on the inland of North Sulawesi. The most common soils are Lithosol, Rendzina, Latosol, Red – yellow podzolic soil as is displaying by the Figure 9. In the adjacent locality to Tondano lake are presented Andosols and Latosoils.

Andosols are the light highly porous black soils of volcanic landscape (Andosols of Europe, 2005). They have been developed on the parental material of volcanic origin (ash, tuff, pumice, cinders or other silicate-rich material) (Agrostats, 2009; UISS, 2007) or on silicate-rich materials under acid weathering in humid and perhumid climates. Rapid weathering of porous volcanic materials results in accumulation of stable organo-mineral complexes or short-range-order minerals such as allophane, imogolite and ferrihydrite. Acid weathering of other silicate-rich material in humid and perhumid climates also leads to the formation of stable organo-mineral complexes (UISS, 2007).

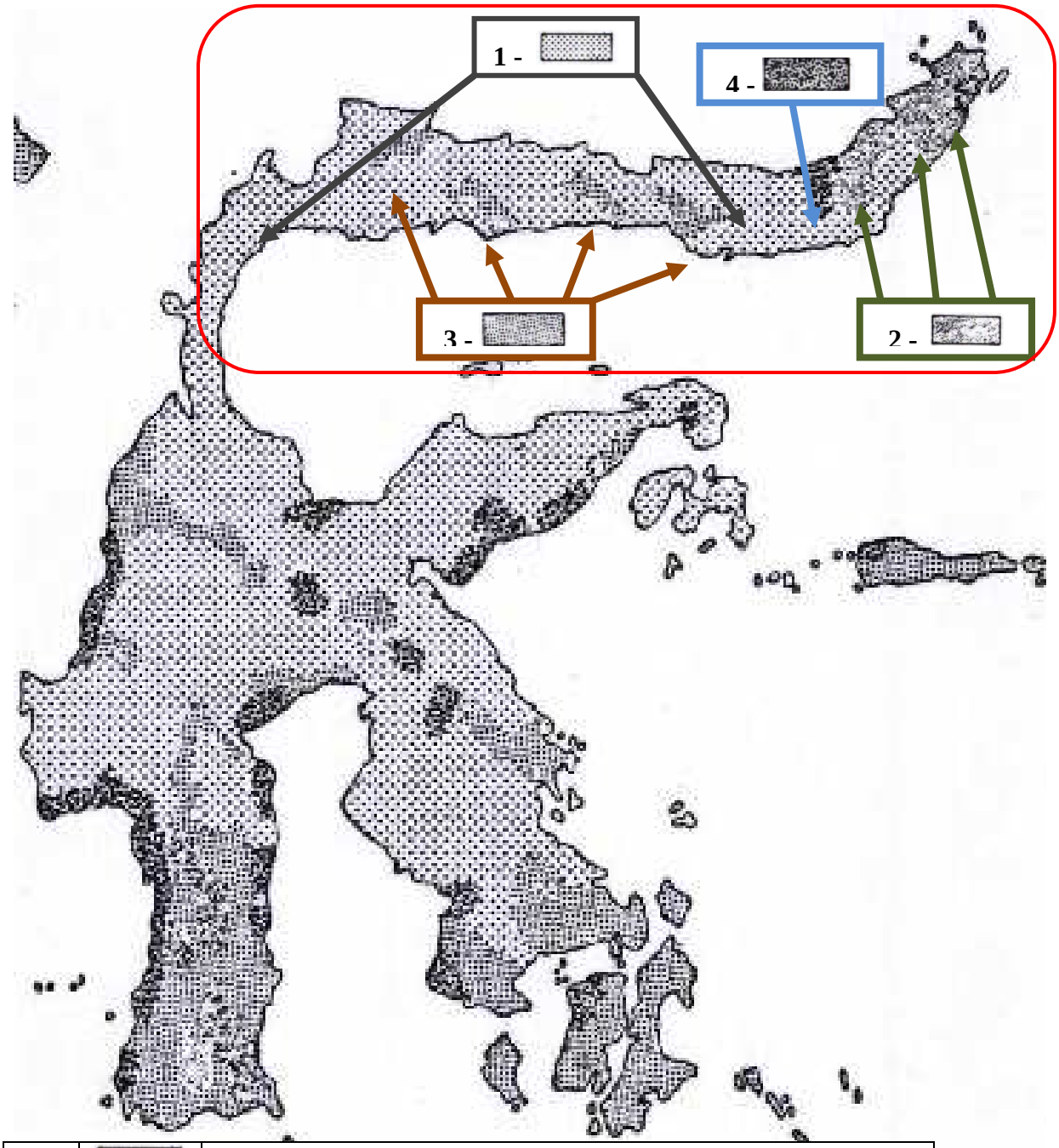
Andosols are usually very fertile soils (Andosols of Europe, 2005) which are easily cultivated (UISS, 2007) and also posses the outstanding water-holding and nutrient capacity and also a good root ability (Agrostats, 2009). All this features predetermine these soils for a high agriculture production potential (UISS, 2007). There are also some difficulties that have to be considered and overcome with a proper management. These soils are characterized by the high aluminum content that causes the obstacles in term of phosphor unavailability for the plants. Thank to this fact, a strong reaction with phosphate makes agriculture without fertilizing problematic (Agrostats, 2009). These soils often lack of cohesion. If they contain excessive water, become prone to landslides and erosion by wind and water (Andosols of Europe, 2005).

Latosols (Oxisols) are highly weathered soil formed under the tropical rainforests (University of Idaho, 2011; Bowen, Pallister, 2006). These soils are red or yellowish in color and very deep (often up to 20-30m). Humus formers narrow upper layer (Bowen, Pallister, 2006). A higher clay content in the subsoil than in the topsoil is a result of pedogenetic processes

(especially clay migration). These soils have a high base saturation and a low-activity clays at certain depths (UISS, 2007). The soils are often rich in the iron and aluminum oxides but other minerals have been washed out by leaching (University of Idaho, 2011; Bowen, Pallister, 2006). These soils usually do not demonstrate the high fertility without the adequate inputs of lime and fertilizers. Phosphorus deficiency is usually a major constraint for crop production (FAO, 2005).

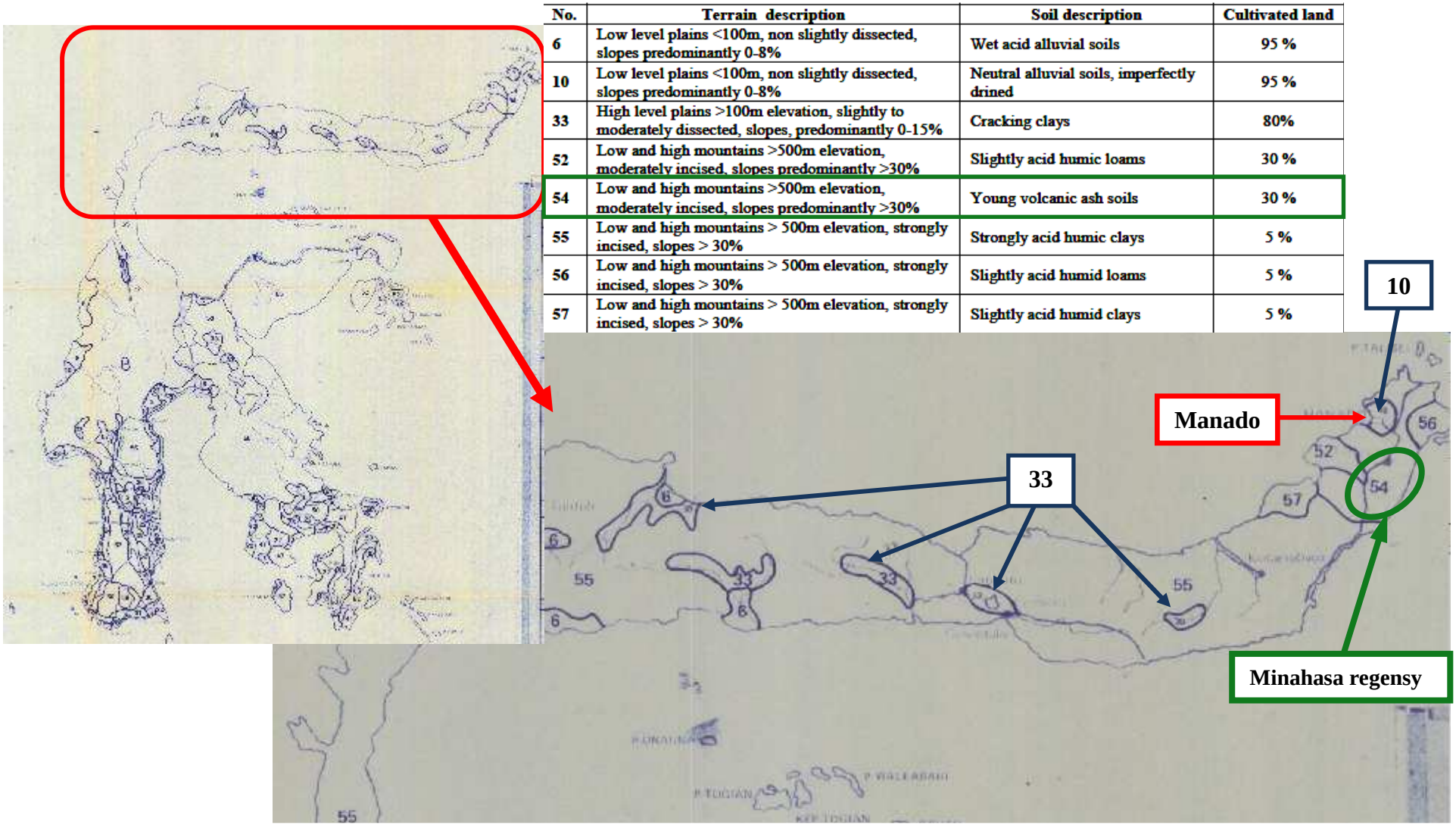
The Figure 9 demonstrates the presence of young volcanic soil and therefore it is estimated that andosols are more typical for the locality of the research interest and also fit to the characteristics given by projects coworkers participating on the field research.

The terrain covering the surroundings of Tondano lake is moderately undulating (Figure 10). The average slope does not exceed 30% but occasionally reached up to 100%. The locality is formed by the low mountains at the average altitude 700m above the sea level that rising also in the higher altitude, which was the case of the target area of the project “Rehabilitation of the Tondano lake area” (Republic of Indonesia, Ministry of Agriculture, 1973).



1		Lithosol, Rendzina, Latosol, Red – yellow podzolic soil
2		Andosol, Latosol
3		Reddish-brown mediteraanean soils, Lithosol red yellow podsolic soils, Yellowish Red Latosol, Tropicalic soils, Dark red latosol
4		Aluvial soils, Low humic gley soils, Saline soil and Acid sulphete soils

Figure 9 Soil types – Sulawesi (red frame is highlighting the study area of North Sulawesi), (National Coordination Agency for Surveys and Mapping, 1976)



No.	Terrain description	Soil description	Cultivated land
6	Low level plains <100m, non slightly dissected, slopes predominantly 0-8%	Wet acid alluvial soils	95 %
10	Low level plains <100m, non slightly dissected, slopes predominantly 0-8%	Neutral alluvial soils, imperfectly drined	95 %
33	High level plains >100m elevation, slightly to moderately dissected, slopes, predominantly 0-15%	Cracking clays	80%
52	Low and high mountains >500m elevation, moderately incised, slopes predominantly >30%	Slightly acid humic loams	30 %
54	Low and high mountains >500m elevation, moderately incised, slopes predominantly >30%	Young volcanic ash soils	30 %
55	Low and high mountains > 500m elevation, strongly incised, slopes > 30%	Strongly acid humic clays	5 %
56	Low and high mountains > 500m elevation, strongly incised, slopes > 30%	Slightly acid humid loams	5 %
57	Low and high mountains > 500m elevation, strongly incised, slopes > 30%	Slightly acid humid clays	5 %

Figure 10 Soil description – North Sulawesi, original map scale 1:2 500 000 (Republic of Indonesia, Ministry of Agriculture, 1973)

2.4.5 Soil development in the locality of Tondano lake

On the end of the 19th century, surrounding of Tondano lake was covered by the rainforest. Small part of the flatten bank was under extensive cultivation. The number of inhabitants living on the bank was rapidly reduced due to the popular uprising against Dutch colonists (Research team - Mott MacDonald; CULS, 2010).

In the 1960s has been introduced the new tree species which star to play a key role in this area. The ornamental purpose of clove (*Syzigium aromaticum*) has been shifted to the large scale production in the locality. A new marketable product has been rose up. During this time 501 ha have been affected by soil erosion (Research team - Mott MacDonald; CULS, 2010).

The problem with the soil erosion has been accelerated as the consequences of increasing clove cultivation combined with the wood logging and intensive agriculture production at all on the slope in the lake vicinity. During the 1980s, the soil deterioration has already affected 15 times larger area in comparison with the situation in 1960s. The upper soil layers have been washed off ending up on the lake bottom. Since this time, the locality surrounding Tondano lake began to be considered as the area with the serious problem due to the 20% of degraded soil. Farmers utilized the slope larger than 8% which was insufficiently covered during the dry period. On the end of 1980s, the radical price drop on the market forced local farmers to leave their clove plantation. Some of them were partially cleared other were unexploited (Research team - Mott MacDonald; CULS, 2010).

The economic crises during 1998 – 1999 made worse the situation. The forest logging carried on. The shifting cultivation was a common agriculture practice. Nevertheless, a part of the farmers shifted from crop production to the intensive cage fish keeping in a lake. This fact resulted in serious deterioration of water quality. The soil wash off was still a current problem (Research team - Mott MacDonald; CULS, 2010).

During the last two years (2009-2010) have been achieved slight improvements. The natural vegetation (bushes and trees) have covered the most seriously affected land which has been unexploited. The continuation of soil degradation were controlled but the land is still not economical profitable. This areas are small in their size and cover a non-homogeneous

localities (2 – 10 ha). They have been developed mainly as a consequence of shifting cultivation (Research team - Mott MacDonald; CULS, 2010). Table 4 gives an overview of the size of degraded land in the Tondano lake surrounding.

Table 4 Development of the erosion affected areas in the vicinity of Tondano lake

Time interval	Area (ha)	% of total area
1960-1969	501	3.1
1980-1989	7 525	25.0
1998-1999	10 719	38.0
2003-2004	9 692	33.8

(Research team - Mott MacDonald; CULS, 2010)

3 Literature review

3.1 Agriculture in Indonesia

In 2006, agriculture's share of GDP reached 13 % (IFAD-2, 2009). The involvement of agriculture sector in GDP generation has been declined (FAO, 2005; IFAD-2, 2009) but still defend a title of the largest employer (43% of total population). This number differed only slightly during the period 2000-2008 (Laborstata Internet, 2010). It has been recognized an increasing importance of food crops, fishery and also livestock husbandry (IFAD-2, 2009).

In 2007, 48.5 million ha of the total area were utilized for agriculture and forestry purposes (FAO, 2010). 7.8 million ha (4.2 %) were planted with lowland rice, 13.2 million ha (7 %) with upland crops, 19.9 million ha (10.5 %) with plantation and industrial crops and 10.1 million ha (5.3 %) were under forest. Rice and maize are the major food crops and rubber and oil-palm are the major plantation crops (FAO, 2005).

Production of seven crops (upland rice, maize, soybean, sweet potato, potato, cabbage and mustard green) has declined due to the reduction in the cropping area. The production of the most fruits and other cash crops (banana, papaya, rambutan, oil-palm, sugar cane and clove) cultivated on plantation has achieved an increase due to the raising yields. The land under rubber cultivation has been decreased in size since the large arable areas have been converted to oil-palm production. Rubber and oil-palm are produced in large governmental or private plantations but also on the smallholder's farms. The oil-palm cultivation has been significantly accelerated by favorable income (FAO, 2005). In 2009, was cultivated on 4 520 600 ha. Java produces about 60 % of total rice production and half of total production of maize, groundnut, soybean, cassava and sweet potatoes (FAO, 2005).

There have been recognized three major farming systems: lowland, upland and perennial crop farming systems (Figure 11). Lowlands represent the livelihood generation for the most of the rural inhabitants due to the rice cultivation which provide stable yields. During the last years, the rice prices have frequently fallen down in the time of peak harvest. This aspects result in lover farmer's incomes (FAO, 2005).

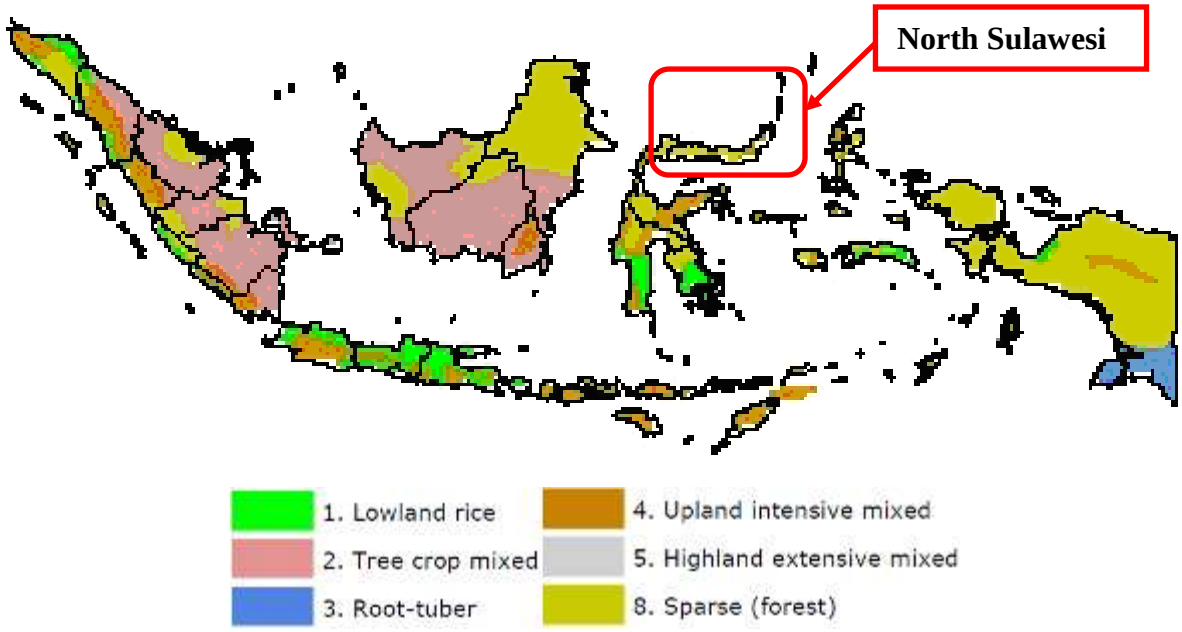


Figure 11 Farming systems (FAO, 2010)

Perennial farming system is the suitable practices for areas of acid soils and low soil fertility of the outer islands (FAO, 2005). Common upland faming with high potential for agricultural development is practiced mostly under rainfed conditions in the outer islands where are found acid soils (Ultisols, Oxisols and Inceptisols) and the phosphorus deficiency is the main constrain. Shifting cultivation is still a common practice in particular remote areas (except from Java). The old rubber trees or secondary forest are mined, followed by burning and then planting of new rubber trees mixed with food crops (rice, maize) for subsistence (FAO, 2005).

3.1.1 Forestry

Forestry plays an important role in the Indonesian agriculture sector due to that fact that more than 60% of the land is covered by the forest of various types (Figure 12) (UN-REDD, 2009; Wood explorers, 2008). The most common forest type counts for more than 60% of total forest area are considering being an evergreen broadleaf rain forest in lowlands. Table 1 in Appendix summarizes the main examples of the species growing in this forest type (Wood explorers, 2008).

The half of the world peat swamp forest is possessed by Indonesia. They are cleared at an alarming speed to make way for oil palm plantation (Schaefer T., 2010). The most vulnerable are the lowland tropical forests, which are the richest in timber resources and biodiversity.

They have been almost entirely cleared in Sulawesi and are predicted to disappear in Sumatra by 2005 and in Kalimantan by 2010, if current trends continue (Global Forest Watch).

Forest stands are mainly under state control. A significant part of the forest types are represented by plantations (Wood explorers, 2008). Industrial timber plantations have been widely promoted and subsidized as a means of supplying Indonesia's booming demand for pulp and taking pressure off the natural forests. Consequently, millions of hectares of the natural forest have been cleared to make way for plantations that in 75 % cases were never actually planted. 9 million ha of natural forest has been cleared with an intention to establish the plantation. Just 2 million ha have actually been planted with fast-growing species (mostly with *Acacia mangium* suitable for pulpwood production). 7 million ha cleared land lied idle was the implication of this practices (Global Forest Watch, 2011). Table 2 in Appendix shows the commonly traded timber species.

Production forests are granted to private or state companies under logging concessions issued for specified periods. Logging concessions are managed on a selective system (TPTI = Indonesian Selective Cutting and Planting System) with a cutting cycle of 35-years including a provision for tree planting (Wood explorers, 2008). The total number of theses production forest according the Indonesian statistics rose by 20% during 2004-2009. It was observed the contrary trend in North Sulawesi. The area of the production forest significantly decreases by 42% (Table 5) (Badan Pusat Statistik-c, 2009).

Table 5 Total area of the Forest Concession Estates, 2004-2009

	2004	**2005**	**2006**	**2007**	**2008**	**2009**
Indonesia	21 412 319	27 715 184	28 424 883	28 271 043	26 169 813	25 770 887
North Sulawesi	105 500	60 800	60 800	60 800	60 800	60 800

(Badan Pusat Statistik-c, 2009)

In spite of the fact, Indonesia hold one third of the world rainforest. A dramatic loss of the forest cover connected with lowering biodiversity due to the deforestation and forest degradation has to considered (Global Forest watch, 2011; UN-REDD, 2009). Forty percent of the forests existing in 1950 were cleared in the following 50 years. Forest cover fell from 162 million ha to 98 million ha. Since 1996, deforestation has demonstrated an increased which average counts for 2 million ha per year (Global Forest Watch 2011).

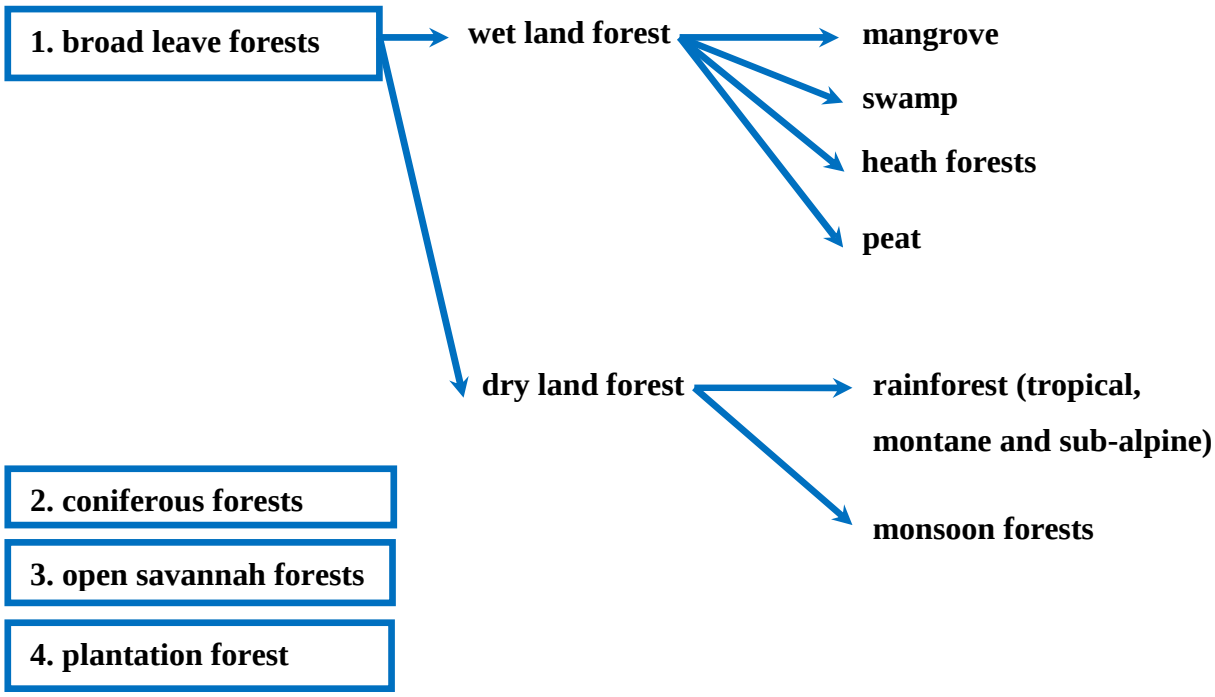


Figure 12 Forest types in Indonesia (Wood explorers, 2008)

Deforestation in Indonesia is significantly encouraged by the corrupt in political and economic system. Ministry of Forestry claimed that theft and illegal logging have destroyed an estimated 10 million ha of Indonesian forests. Wood processing industries openly acknowledge their dependence on illegally cut wood (Global Forest Watch 2011).

Indonesia's official wood supply during the time 2003 - 2006 was approximately 20 million m^3 per year, but Indonesian forest industry process more than 50 million m^3. Obviously, the illegal logging increased the total amount of processed wood by 150 %. The shaded area in Figure 13 represents the minimum amount of the wood that came from illegal logging or smuggled imports (Human Rights Watch, 2009). The methodology used by forestry industry experts to estimate these numbers is outlined by Figure 14.

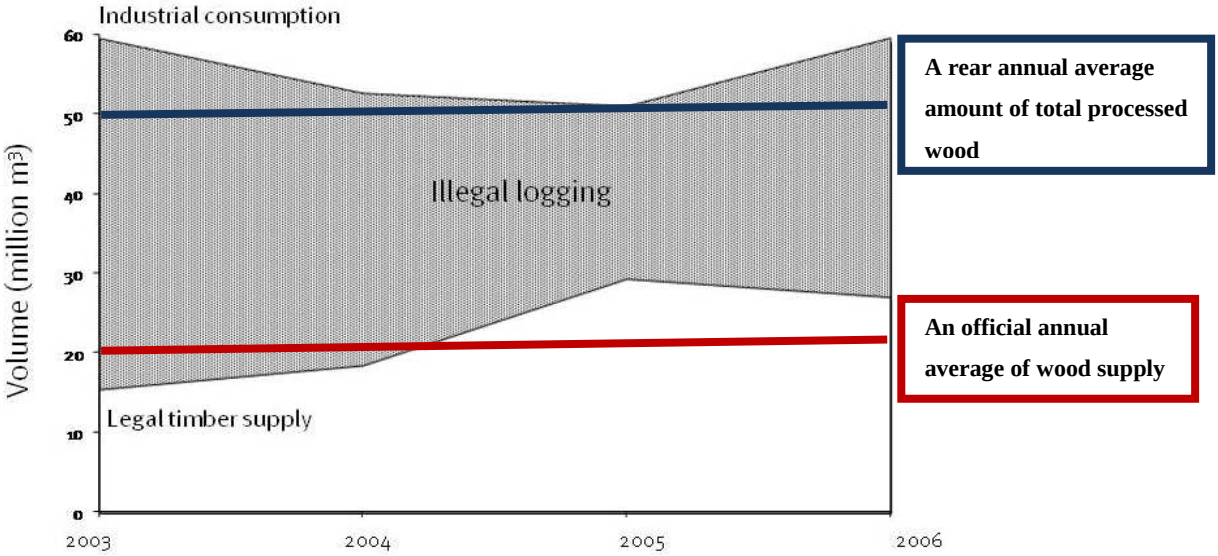


Figure 13 Volume of wood consumed by Indonesia's forestry industry (including wood imports), 2003-2006 (Human Rights Watch, 2009)

Volume of illegal wood = [wood consumption] – [legal wood supply]

Wood consumption = [sum of consumption by all timber industries] x [roundwood equivalent equivalent]

Legal wood supply = [logging concession harvest] + [clearcuts] + [plantation harvest] + + [imports]

Figure 14 Methodology for estimating the volume of illegally harvested wood (Human Rights Watch, 2009)

4 Thesis objectives

- **Identification of local agricultural and forestry practices**

Key characteristics identification within the local agricultural and forestry system in the surrounding area of the Tondano lake (Regency Minahansa, North Sulawesi, Indonesia) is the main aim of this thesis.

- **Gaining the perspective about the typical practices used by the local community**

The general characterization of these systems for Indonesian area outlined in theoretical chapters followed by the particular example of three studied villages (Makalonsouw, Paslaten and Touure) located in Minahasa Regency.

- **Uunderstanding of the attitudes and preferences of the local community towards to the agriculture and forestry systems**

The analysis is based on the households resources that contribute to the comprehensive overview of the principles prevailed among the local farmers practices which are involved in the environment changies.

- **Determination of the agriculture and forestry importance for the local people**

The fulfillment of this objective outlines the possible solution for the target area. The outcomes contributed to the identification of the farmer's situation and agroecosystem development.

- **Definition of the farmers picture about their future in agriculture involvement**

- **Proposal of agroforestry systems for chosen locality**

- **Identification of possible obstacles in the target region regarding to the agriculture sector**

5 Methodology

5.1 Experimental site

The target locality of the research was selected according the area of a implemented project "Rehabilitation of the Tondano Lake Area, North Sulawesi" by project extension and engineering enterprise Mott MacDonald (Prague). The project was granted by the Ministry of Agriculture of the Czech Republic in frame of Developing aid. North Sulawesi is one of the Indonesian province located on the island Sulawesi. The target area lies in Minahasa Regency on the Tondano lake bank were have been chosen three villages (Makalonsouw, Paslaten, Touure) for the research purposes (Figure 14).

The data collection conducted in selected villages provided the key information for proposal of the alternation within the local farming systems. The outcomes of the field research also served for project purposes.

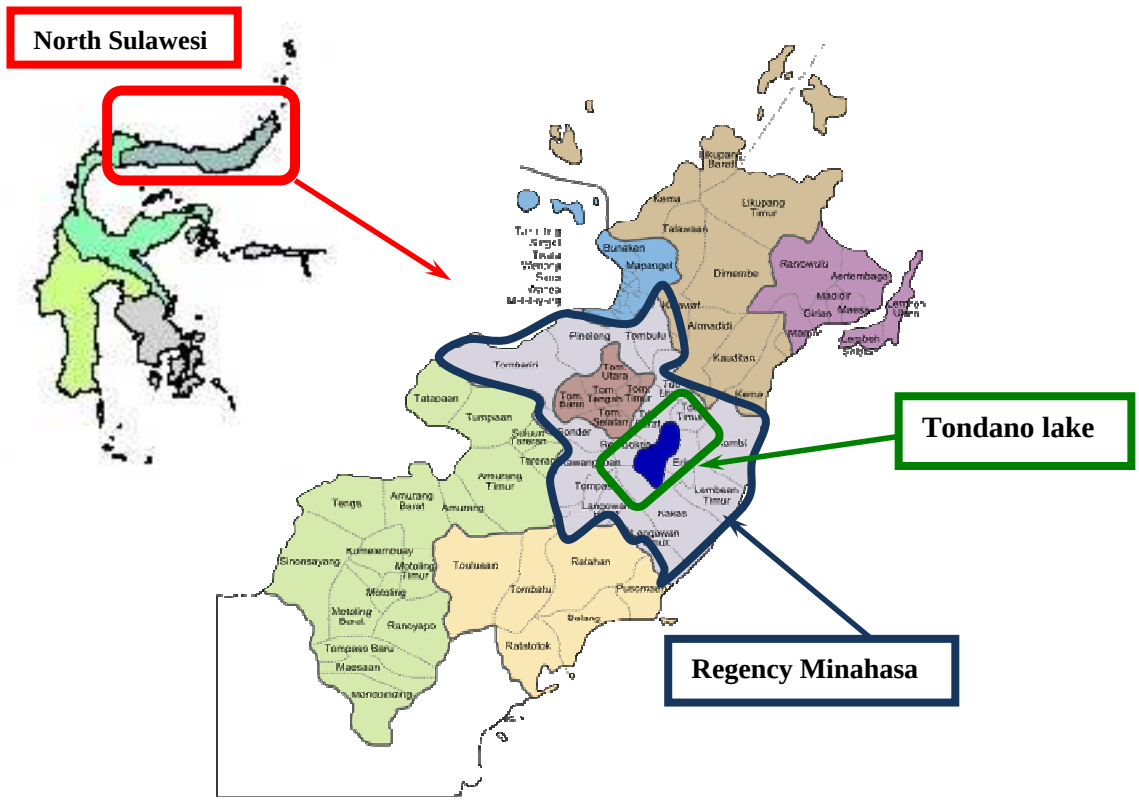


Figure 14 Sulawesi, North Sulawesi, Regency Minahasa (Minahasa, 2011; FAO, 2010)

5.2 Data collection

This case study makes use of data collected during the autumn 2010 in the northern part of North Sulawesi in the selected villages (Makalonsouw, Paslaten, Touure). For the study purposes, it has been created the semi-structured questionnaire (Appendix III.).

Data collection was coordinated by MSc. L. Šálek (Faculty of Forestry, Czech University of Life Sciences) and MSc. K. Halamová (Institute of Tropics and Subtopics, Czech University of Life Sciences) personally. The gathered data were immediately noticed in the field notebooks and later processed by the standard statistical methods using MS Office Excell. The instruction has been given in the Indonesian by the local field workers involved in the project, who translated the collected data in English. A piece of the information was gathered by the direct observation and personal communication with the project coworkers and local farmers.

Totally have been involved 87 households. The household heads (predominantly men) have been asked for the questions regarding to the crop production and forestry within the adjacent locality of Tondano lake. The household-based interview survey data has been used for comparison regarding to the records of involved households (farm characteristics, labor forces, agriculture production, forest importance, farmers expectation about the implemented project, income generation, agrochemical application). More than half of the interviewed farmers were represented by the age group of 40-59 (Figure 12).

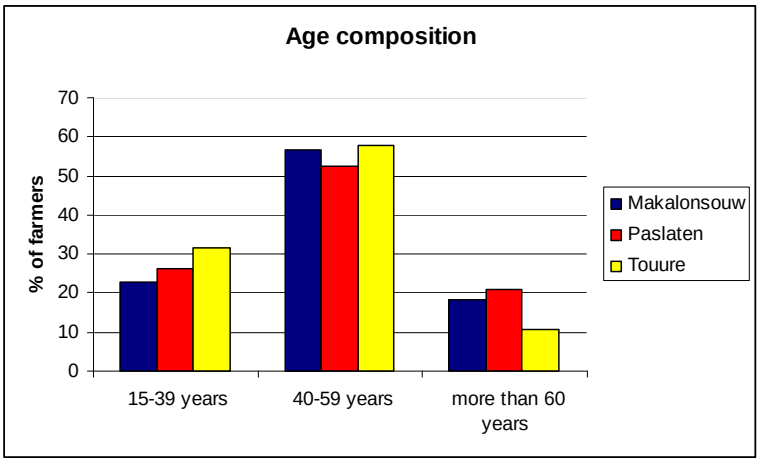


Figure 15 Age composition of interview farmers

Totally were included into statistic only 82 farmers interview (43 households from Makalonsouw and 19 households from Paslaten and Touure as well). Five of them were excluded from the data analyses because they have been classified as the out layers due to their extraordinary records. These occasionally occurred farmers run their business in larger scale in comparison with the rest of the interview farmers. The owners of these farms usually only manage the work and hired a lot of external labor forces. These records would misrepresent the general overview of the local situation.

During the data collection have occurred several problems such as unwillingness to share the data or unawareness of the asked information from the framer's site. Therefore in some cases the data are missing.

6 Results

6.1 Farm characteristics

Majority of Indonesian framers are smallholders (FAO, 2005) farming on very small plots of less than 0.5ha (IFAD, 2009). This characteristic is also valid for the selected locality where an average farm extends to 0.45 ha. The largest farms have been recognized in Paslaten village. The average farm in this village covers two up to three time larger area in comparison with the others. In the same time, the farms located in Paslaten village did not show large differences in their size (Figuer 6).

In farm production is involved cultivation of crops and tree in various arrangements. One of the special systems is a homegarden, which is the common part of the farm in Makalonsouw and Paslaten villages. Lower numbers of homegardens were found in Touure village, just the 58% of the farms.

Table 6 Farm size in selected villages

	average size (ha)	median	modus	maximum value	minimum value	standard deviation	coefficient of variation
Makalonsouw	0.3	0.3	0.3	1.0	0.3	0.16	55.64
Paslaten	0.9	1.0	1.0	1.0	0.5	0.23	26.05
Touure	0.4	0.3	0.3	1.0	0.2	2.24	60.45

6.2 Labor

Usually 1-6 workers are involved in a farm work. In cases of 2 up to 4 concerned workers, are usually involved just the family members. In case of more employed labor forces are increased the tendency to hide external workers. The average number of the labor forces working on the farm varies from 1 to 3 persons (Table 7). There has been not detected any correlation between number of the labor forces and the farm size. The numbers of workers is very variable. A very high variation coefficient in case of Paslaten village is caused by the very low mean (0.6). Farmers from this village employ just a little amount of labor forces.

Table 7 Labor forces among selected villages in North Sulawesi (unit: numbers of workers)

	mean	median	modus	maximum value	minimum value	standard deviation	coefficient of variation
Makalonsouw	3	3	2	6	0	1.9	60.9
Paslaten	1	0	0	3	0	1.2	184.4
Touure	3	2	2	6	3	1.1	40.1

38% of the farmers work on their farm everyday, 22% three times per week and 15% unevenly (Figure 16).

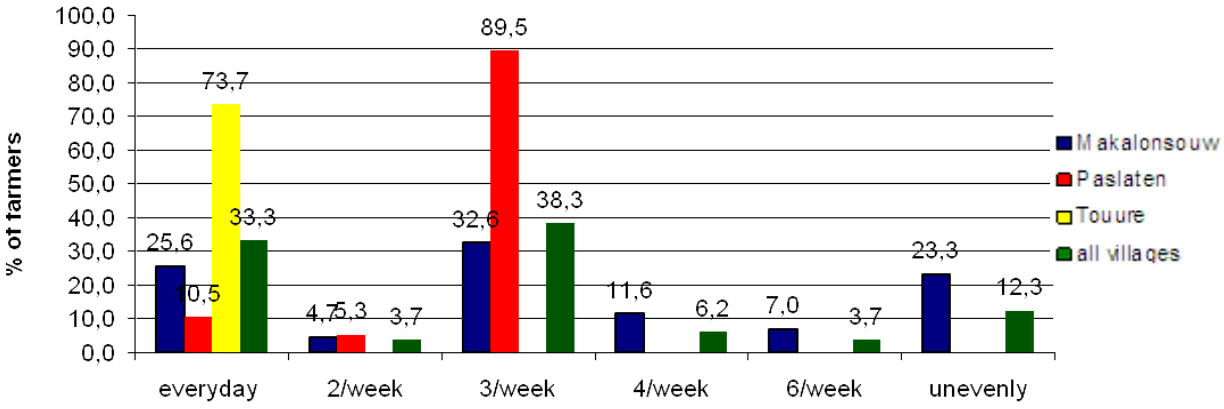


Figure 16 Number of working days

Farmers are occupied by the harvest just one time but up to eight times per year depending on the composition of grown crop and trees species. 38 % of the farmers harvest their fields two times per year 39 % three times per year. The number of the involved workers and number of harvest did not display any correlation. 50 % of the farm where the harvest is done two times per year uses two labor forces. In case of three harvest per year (46% farm), two or three workers have been involved.

6.3 Forestry

The majority of the farmers (93%) grows individual trees and also groups the trees for agriculture purposes. 50% of the farms manage the forest stand that was defined as a group of grown tree of min size of 0.1ha. The number of cultivated tree species was quite low. Just one up to six species have been recorded on each farm (Table 8).

Table 8 Number of cultivated tree species

	mean	median	modus	maximum value	minimum value	standard deviation	coefficient of variation
Makalonsouw	2	1	1	6	1	1.2	83.2
Paslaten	1	1	1	1	1	0.2	24.2
Touure	1	1	1	3	1	0.9	70.6
All villages	1	1	1	6	1	1.0	78.7

There have been identified 11 different species among the forest stands in selected villages (Figure). Bamboo and coffee also appeared in this group, although the farmers have been asked for the tree species. The reason for this misunderstanding originates in farmers perception about the tree as the construction material. Thanks to this fact, Table 9 shows the botanical classification of all species, which have been classed according this way. Champac, clove and mahogany were the most frequently cultivated species. Almost all respondent farmers (95%) from village Paslatan display the tradition of clove cultivation. 20% of all farmers are not satisfied with the species composition that they grown on their plots. There has not been recognized the correlation between the farm size and number of tree spices grown on farm or farm size and presence of forest on farm.

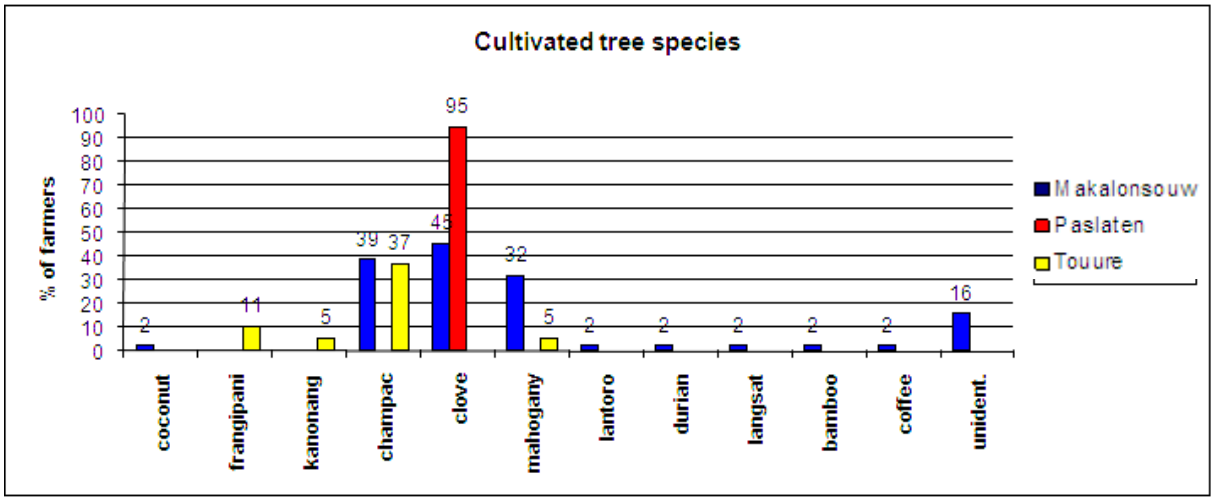


Figure 17 Cultivated tree species in particular villages

Table 9 Botanical classification of the cultivated plant and tree species

Common name	English names	Latin name	Family	Figure in Appendix
	coconut	*Cocos nucifera*	*Arecaceae*	Fig.3
frangipani		*Plumeria acuminata*	*Apocynaceae*	Fig.4
kanonang		*Cordia dichotoma.*	*Boraginaceae*	Fig.5
	champac	*Michelia champaca*	*Magnoliaceae*	Fig.6
	clove	*Syzigium aromaticum*	*Myrtaceae*	Fig.7
		Swieteni amacrophylla		Fig.8
	mahogany	*Swietenia mahagoni*	*Meliaceae*	
lantoro		*Leucena leucocephala*	*Fabaceae*	Fig.9
	durian	*Durio zibethinus*	*Bombacaceae*	Fig.10
langsat		*Lansium domesticum*	*Meliaceae*	Fig.11
	bamboo	*Bambusa spp.*	*Poaceae*	Fig.12
	coffee	*Coffea arabica*	*Rutaceae*	Fig.13

*vernacular names for species that have not been identified

(FAO, 2007; FAO, 2006, Nowak, Schulzová, 2006; Valíček *et al.*, 2002; Salazar et al., 1998; Morton, 1987)

Tree served to various purposes. Construction material utilized as veneer and saw wood production and a source of fuel have been highlighted as the most important reasons for the tree cultivation.

Fuelwood was the most frequently utilized source of heating (Figure 18). The price of saw wood fluctuates around 33 USD/m^3 in a local market. In case of redwood veneer, the cost reaches approximately 100 USD/m^3 (88-110USD). Almost half of the farmers are using the wood for handicraft production and majority of them do not relay on our wood and purchase them.

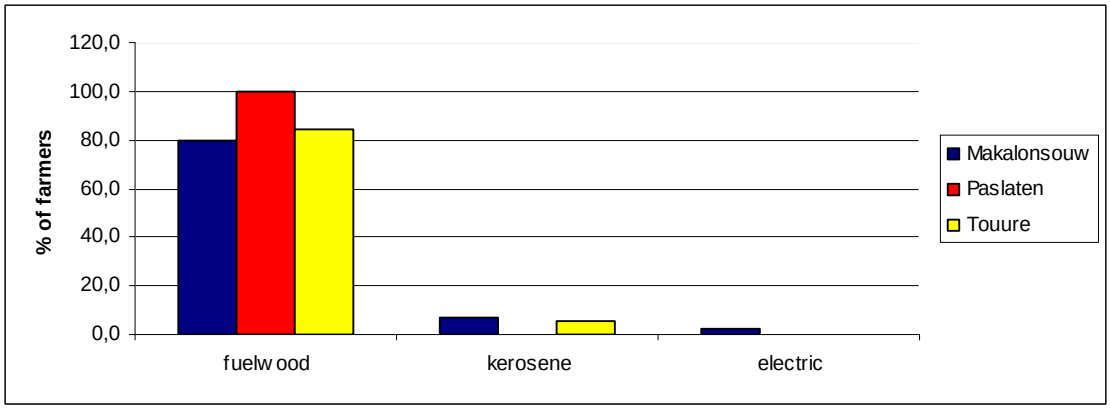


Figure 18 Source of heating

No farmers involved in this study own the nursery or buy the seedling from other nurseries. The price of the seedling is often considered as the obstacles. This is the reason why farmers deal with the seedlings shortage. They relay on the natural regeneration of the trees. 57% of the farmers collect the seed from their harvest.

6.4 Agriculture

According the farmers records, it has been determinated the key crops. In the total numbers, corn, red beans, red onion, tomato and flower species have been found at least on 20% of the farms. Particular results differed among the villages. Farmer's preferences regarding to the cultivation of particular are summarized in Table 10.

Several preferable combinations of grown crops have been recognized: tomato and red beans; nut and runner beans; onion and curcuma or lemon grass. There have been detected also mild correlations between followed crop combinations: red onion and red bean; papaya and runner bean; papaya and pineapple; various kinds of beans and spices; papaya and curcuma; papaya and lemon grass.

The crop composition has been changed in comparison with the crops grown by previous generation. 56 % of the farmers have confirmed that they quitted the cultivation of selected crops which their parents had used to grown. From that reasons, potatoes, vegetable, corn, lili flower, cassava, yum and carrot have disappeared from selected fields.

The low or unstable price on market and low production crops under local conditions were the main reasons that affected the farmer's decision making to quite growing of followed crops: langsat, corn, rice, lily flower, vanilla, tomato, cabbage, red bean (Azuki bean**)**, pumkin, onion and spring onion. The numbers of these farmers were insignificantly small (1.2-3.7%). The highest numbers were noticed only in case of corn (13.6%) and red bean (5.0%).

The majority of the farmers (80%) has display their interest in future crops and tree cultivation. The third of the farmers has shown their intention to grown some flowers. This interest is mainly driven by the high harvest rate along the year. 20 % of farmers would like to support their production of vegetable by potatoes, sweet potatoes, tomatoes, onion, red onion, carrot or water melon cultivation. Other plant in focus was clove that is considered to be a

very popular in North Sulawesi. It has been recognized increasing interest in growing of this tree species by 24 % of farmers. Coconut production has been playing by 22% of farmers. The last mentioned species were trees for timber production (eg: teak). Only 7% of farms are going to increase production of the timber species.

Table 10 Cultivated crops (in % of farmers growing particular crop or tree species)

	Cereals		**Tubers**	**Legumes**			**Vegetables**			**Fruits**					**Spices**				**Flowers**		**Other**	
	corn	**rice**	**cassava**	**red bean**	**runner bean**	**other beans**	**onion**	**red onion**	**tomato**	**pineapple**	**papaya**	**mango**	**mango**	**spices**	**curcuma**	**lemon grass**	**clove**	**flower species**	**antorium**	**timber**	**nut**
Makalonsouw	58	5	12	-	2	12	7	0	9	2	9	2	2	28	2	2	35	60	7	9	5
Paslaten	95	-	-	16	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-
Touure	11	-	5	84	-	-	-	84	100	-	-	-	-	-	-	-	-	-	-	-	-
All villages	56	3	7	23	1	6	4	43	28	1	5	1	1	15	1	1	19	32	4	5	2

6.4.1 Ornamental plants

Ornamental plants seem to play an important role on farms. Each farm grows one up to four ornamentals species. Anthorium, lily flowers, frangipani, seashore, rose, cactus and aloe vera have displayed the highest popularity which differed among the villages, as it is shown on Figure 19 With the low frequency, there have been recognized also water lily, palm, live apotheke, cocer beek, spinach, orchid, holands, mums, ginger, curcuma, amarylis, betelvine, bougenville and euphorbia. Botanical classification of mentioned plant species are summarized in the Table 11.

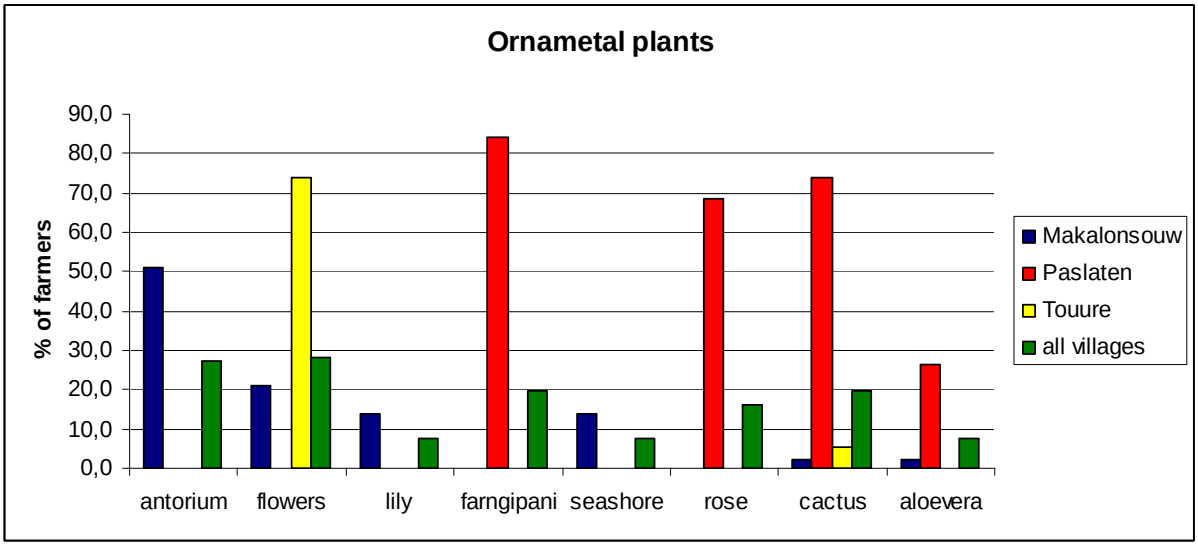


Figure 19 Cultivation of ornamental plants

There have been recognized positive correlations between cultivation of several crops combination: rose and frangipani, rose and cactuses, frangipani and cactuses and seashore flower and orchid. Ornamental plants are quite often also grown in association of medicinal plants.

Table 11 Botanical classification of ornamental plants

no.	English name	Common name	Latin name	Family
1	Tailflower, Anthurium, Flamingo flower		*Antorium spp.*	*Araceae*
2	aloe vera		*Aloe barbaderis*	*Liliaceae*
3	Amarylis		*Hippeastrum hybrid*	*Amaryllidaceae*
4		betelvine flower	*Peper betel*	*Piperaceae*
5	bougenville		*Bougainvillea spp.*	*Nyctaginacea*
6	cocor bebek		*Bryophyllum pinnatum*	
7	curcuma		*Curcuma longa*	*Znigiberaceae*
8	frangipani		*Plumeria sp.*	
9	ginger		*Zingiber Officinale*	*Znigiberaceae*
10	spinach		*Spinacia oleracea*	*Amaranthaceae*
11	water lily		*Nymphaea spp.*	*Nymphaeaceae*
11	water spinach	Kangkung	*Ipomea Aquatica*	*Convolvulaceae*
13	cactuss*			
14	holands*			
15	lily*			
17	mums*			
18	orchid*			
19	palm*			
20	rose*			
21	seashore flower*			

*ornamental species have not been recognized during the field research, therefore only vernacular names have been noticed

6.5 Farmer's expectation from the implemented project

The implemented afforestration project ("Rehabilitation of the Tondano Lake Area, North Sulawesi") was kindly accepted by almost all interviewed farmers (98%). They would like to be involved in the afforestration project because of the expectation gaining the seedlings. In average, usually are expected two new species that would be introduced by the project. The highest the interest has been recognized in case of flowers (42 % of the farmers) (Figure 20). 63% of the farmers have common interest in tree cultivation of which 18% call for timber wood cultivation (eg. mahagony, teak). The rest would like to obtain clove, coconut or champac seedlings.

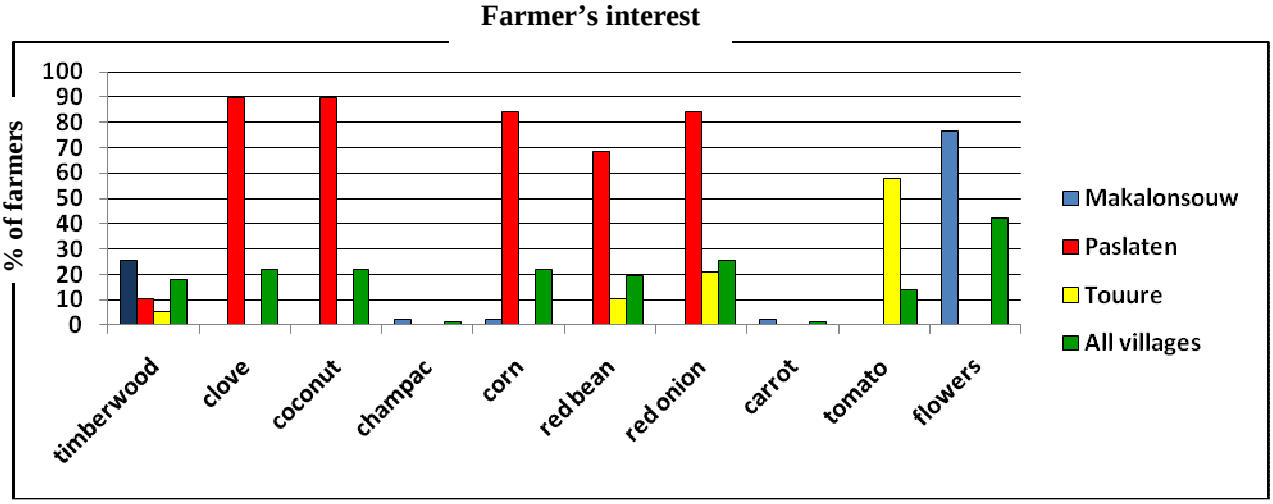


Figure 20 Farmer's interest in cultivation of certain plant species

6.6 Marketable products

Majority of the farmers enter the market with own production without any help of middlemen services. Just 10% of the farmers relay on collaboration with some association. Regarding to the marketable products, the main importance has been recognized in case of flowers which they were identified by 46% of farmers as the main sold product. Corn and red onion brought significant utility for 31% of farmers, as it is shown on Figure 21.

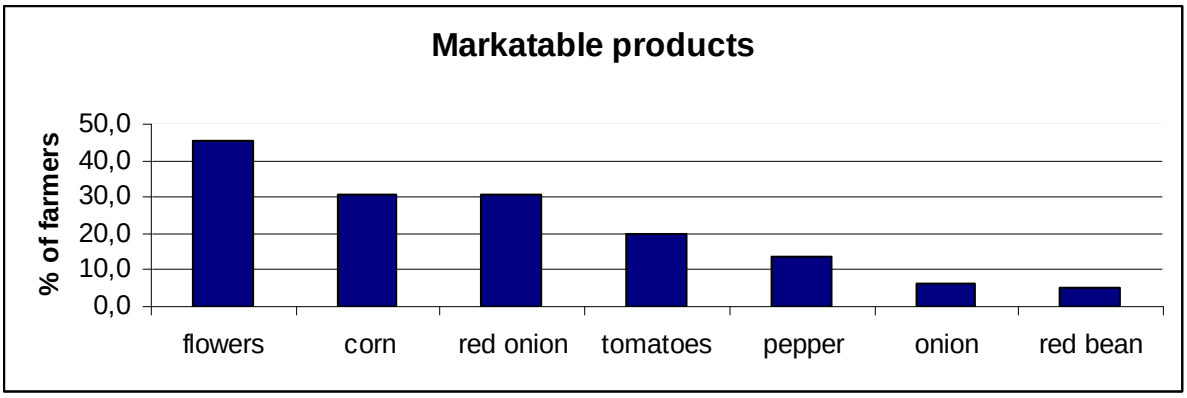


Figure 21 Marketable products according the main importance for local farmers

There has been detected quite large interest in information regarding to situation on market. More than tree fours of farmers seek after the information related to the situation at the local and also at the international market. The major sources of information are newspapers and television. Seldom are used information sources such as radio and internet.

6.7 Income generation

It has been displayed a positive correlation between the farm size and the income generated on farm which varied from 450,000 IDR (52 USD[1]) up to 17,000,000 IDR (1957 USD) (Table 12). The farms with larger area tend to generate highest income (from the cultivation). According the records, 32% of the farmers lost their interest of their income generated on the farm. The unstable prices on the market significantly affected the income generated from farm. Therefore 15% of farmers could not estimate their income.

The higher income generation was observed on the larger farm. The farm income is a driven force that encourages farmers in their further efforts. The unstable price of particular product has been determinate as the crucial obstacles.

The large group (88% of farmers) pursues other job. They are hired by the other farm owners, keep livestock or work as carpenters. The external farm income significantly contributed to the total farm income. Farmers have generated 53% up to 68% of the of their total farm income outside the farmer.

[1] 1 USD = 8688.1 Rp. [2011-20-04]

Table 12 Income generation (unit: Indonesian rupiah - IDR)

	mean	median	modus	maximum value	minimum value	standard deviation	coefficient of variation
External job	11 413 636	12 600 000	12 600 000	36 000 000	500 000	8 069 362	70.70
Income from farm	7 038 235	9 500 000	10 000 000	17 000 000	450 000	4 539 574	64.50

6.8 Agrochemicals use

Fertilizer application is a common practice in studied villages. 93% of the farmers used to use some kind of fertilizer. There have been utilized four kinds of chemical fertilizer

- TSP- triple super phosphate
- urea
- PONSKA – compound fertilizer - 15 % N, 15 % P2O5 , 15 %K2O
- SP-36 - 36 % P_2O_5

More than 84 % of farmers apply urea and 56 % PONSKA. Only 9 % from all farmers used to use compost (Figure 22). No correlations between uses of any kind of fertilizer have been detected.

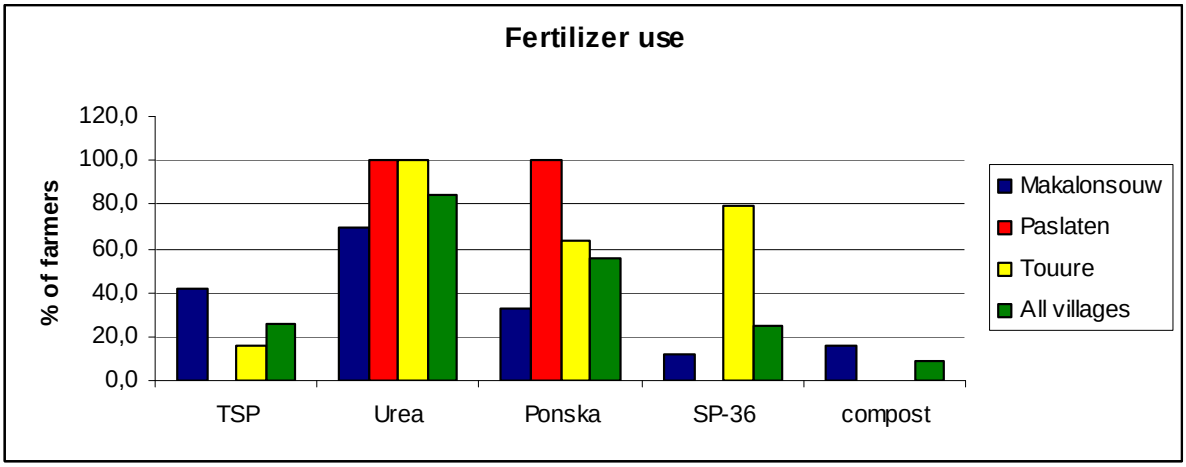


Figure 22 Fertilizer use

40 % of the farmer did not use any kind of chemical protection again pest. Even natural protection is not in focus. Only 3 % of the respondents used to apply natural pesticides to control the pest and plant diseases. 40% of the farmers use just one kind of chemical pesticide (Figure 23).

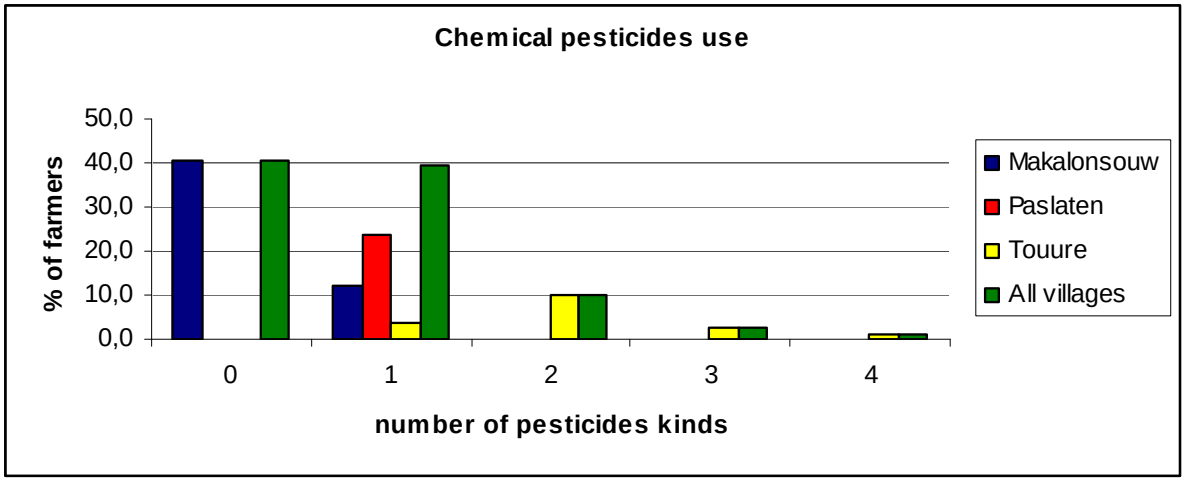


Figure 23 Numbers of chemical pesticides applied on the farms

There have been reported nine different kinds of chemical pesticide (Figure 24). Half of the farmers used to apply an insecticide "Decis". All respondents from village Paslaten have integrate this kind of pesticides in pest control. In total numbers, other kinds of pesticides have been used with much lower frequency. Around 40% of the farmers from village Touure decide to involved also preparations "Canon, Matador and Dusban" in their pest control management.

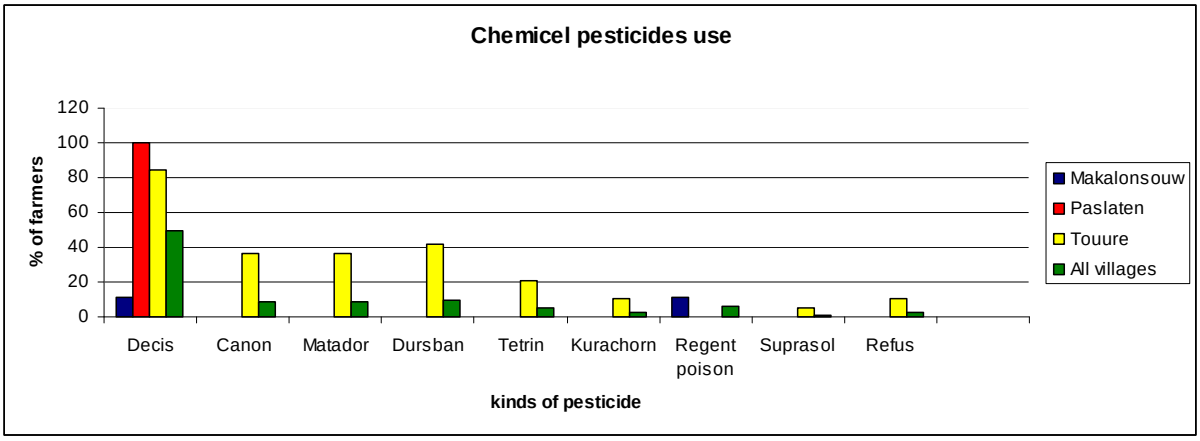


Figure 24 Various kinds of chemical pesticides

90% of the farms suffered from weed pressure, of which 9 % have not used any kind of herbicides. Followed species have been recognized as the intrusive weed on the farms: gulma, teki grass, mangkat, sentrasema, mimosa, kan-kano and piso grass. The local names were not matched to the scientific names during the field study.

It has been reported four kinds of herbicides (Roundup, Gramasone, Polaris and Basmilang) which have been integrated in pest control management of the selected farms (Figure 25). Almost 60% of the farmers apply one of the motioned agrochemical (Figure 26). If the farmers apply two or more herbicides, they do not prefer any combination of these agrochemicals. It was not detected any correlation between the use of any chemical or natural agents of pest control management.

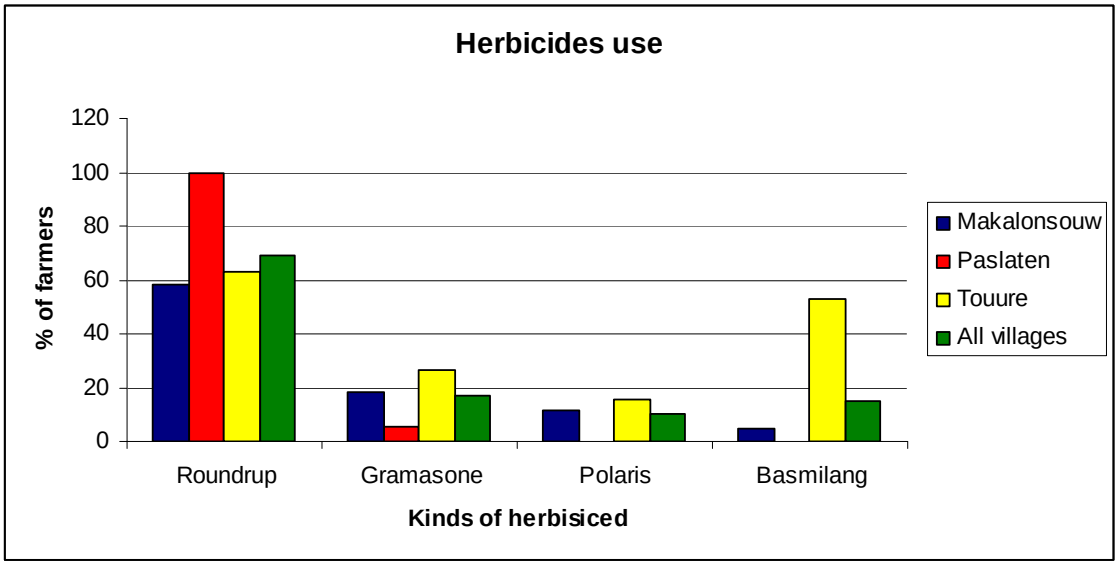


Figure 25 Herbicides incorporated in pest control management

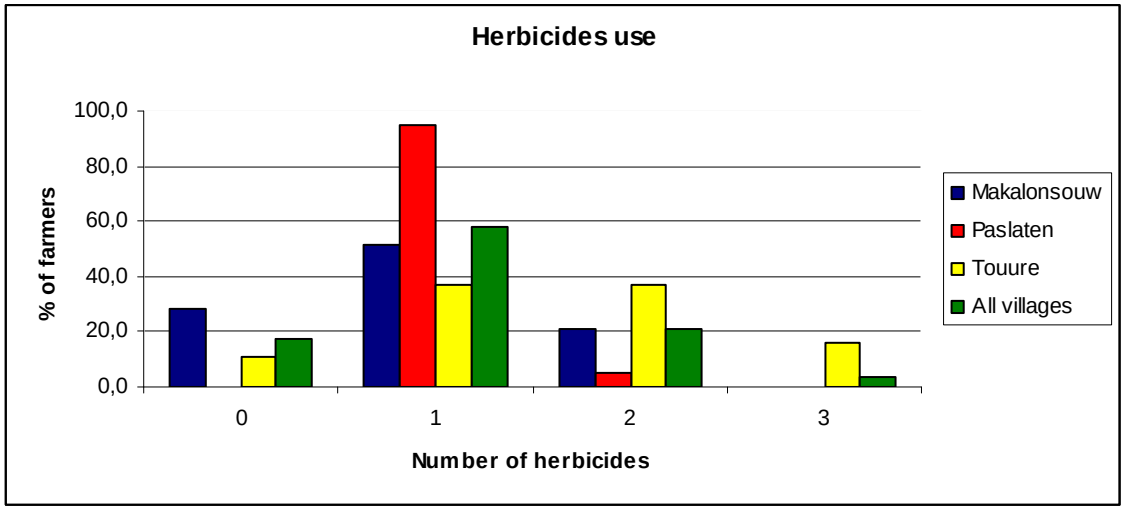


Figure 26 Number of applied herbicides

7 Agroforestry plan proposal

The improvements proposal is based on the hypothesis that agroforestry systems are in general more productive than the sole crop systems (Gregory, 2006). The agroforestry proposal gives the recommendations for local farming practices to promote the agriculture production in target area in Minahasa Regency.

The plan has been developed based on the available information mentioned in previous chapters in respect of natural conditions and need of the local people. The crop species has been selected according the farmers customs related to the grown species because they are a common part of local diet. Only native tree species have been selected for this proposal. The aim was to modify the crops and trees arrangement not to total turn the whole system. The modifications of the farm production systems have been suggested for each village involved in this study.

Due to the crucial constraint of slope, soil erosion and vegetation manipulation, the local environmental situation calls for the proper management and therefore the recommendations towards to this direction. Each subhead devoted to target villages starts with the table summarizing the main production characterization for better orientation in the proposal (Table 13-15).

7.1 Propagation material

The vigorous planting material plays a crucial role and the future success is highly depended on them. Otherwise farmers are losing the interest in further planting (Jaenicke, 1999). It is highly recommended to purchase the material needed for the establishment of the agroforestry fields in local nursery. However, the price of the seeds and seedlings was the most frequently mentioned constrains why local farmers cannot afford to them, therefore they have been given the instruction from the experts employed by implemented project, how to produce the quality material by their own just a part of the planting material is predicted to be purchase in some local tree nurseries.

7.2 The main features of farm production and farmers interest

7.2.1 Makalonsouw village

Table 13 Production characterization in Makalonsouw

Main production characterization	
Trees (group of trees)	93% of farmers
Forest	48% of farmers
Timber use	Fuelwood, veneer
Production constraints	Tree species, price of seedlings
Source of planting materials	Natural regeneration
Farmer's expectation from project	2 new species, flowers, timber wood
Often marketable product of own production	Flowers
Farmers future plans about crops/trees growing	Flowers
Main grown crops/tree	Corn, flowers, cassava, clove, spices

In Makalonsouw have been recognized the highest diversity in growing species. One of them was *Bambusa spp*. which do not server only as the construction material but is able to significantly reduce soil erosion (Areco Rwanda Nziza, 2010; van Tilburg, 2010). Agroforestry employed bamboo and agricultural crops providing the economical benefit (van Tilburg, 2010). The hedgerow of bamboo supported with Vetiver grass (*Vetiveria zizanoides* – Figure 14, Appendix) may provide the good erosion control on the severe vulnerable slopes. In case of larger bamboo production is it possible to use soybean intercropping during the initiation stage (Shanmughavel, Francis, 2001). Sinha A. defined other possibilities to fit to this purpose: tomatoes, potatoes or ginger.

The native tree species clove (*Syzigium aromaticum*) may be established in coconut plantations as was designed for Paslatan village. Definitely is highly recommended to avoid sole clove fields especially established on the slope.

Root of cassava usually reached maximum depth of 0.6m. Intercropping with one row peanuts provide good yields of both associated plants (Polthanee *et al.*). Establishment of Vetiver (*Vetiveria zizanoides*) hedgerows on cassava field have been evaluated by Vongkasem *et al*. as suitable solution for soil erosion control.

It has been recognized the high interest in flower production. Due to the fact that flowers are not commonly employed in agroforestry systems they have been not involved.

7.2.2 Paslaten village

Table 14 Production characterization in Paslaten

Main production characterization	
Trees (group of trees)	100% of farmers
Forest	79% of farmers
Timber use	Fuelwood
Production constraints	Tree species
Source of planting materials	Natural regeneration
Farmer's expectation from project	2 new species, clove, coconut, red bean, red onion, timber wood
Often marketable product of own production	Corn, red onion (pepper)
Farmers future plans about crops/trees growing	Coconut, clove, timber species
Main grown crops/tree	Corn, onion, bean

Coconut planting was one of the farmer's plans. Coconut trees are widely distributed in Minahasa Regency where most of the production comes from the smallholder's farm. The optimum cultivation conditions are found in lowlands up to 600 m above sea level (Waney, Tujuwale, 2002). It has to be considered that bare soils in coconut plantations result in heavy erosion due to runoff as was reported by Nimal Appuhamy. The intercropping with maize has shown as far as the higher yield in traditional mountains systems than monocropping systems. Crop cover has to be properly managed according the palm development and increasing shade under the storey. After 8 years, 80% of the soil is shaded (spacing 7.5 x 7.5m). The most of the roots are found near the bole (Nair, 1983), therefore is necessary not only proper soil cover but also establishment of deep-rooting other trees/crops. The legumes are light demanding and quickly cover the soil, therefore are suitable to involve them during first years of growing. The legume cover might be replaced by corn as well. In case of need, corn might be planted interplanted by onion (Figure 27).

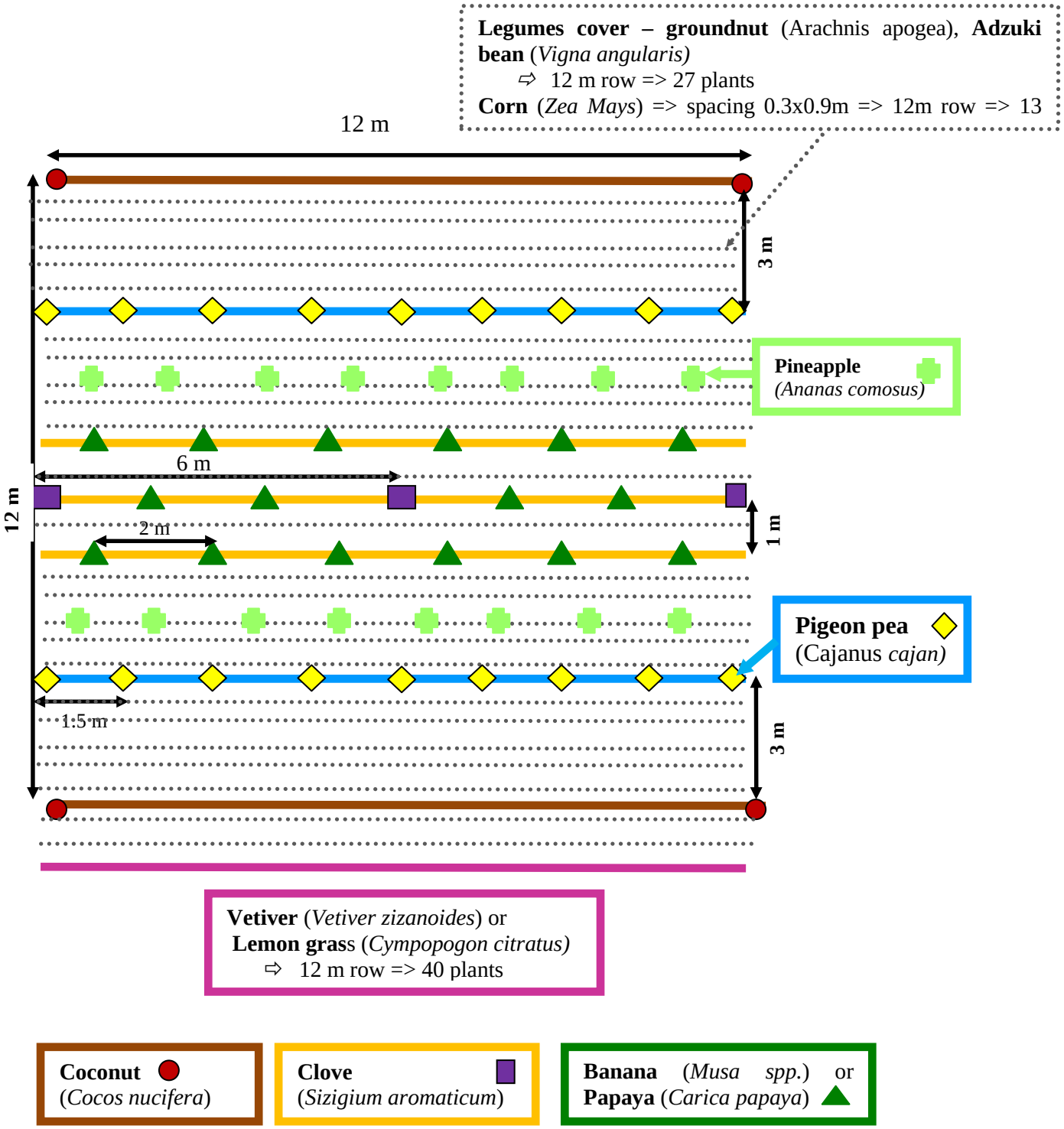


Figure 27 Agroforestry proposal

Clove is also one of the favorite tree in Paslaten. It requires partial shade therefore it is established after 5 years after coconut establishment. Clove and coconut trunks might be used as a support for pepper. *Cajanus cajan* (Figure 16, Appendix) is a native multipurpose fast-

growing legume shrub suitable for soil erosion prevention due to the 2m long roots bear. Edible seeds, fuelwood and wood for light construction are other products. It's noncompetitive with mixture of pulses or cereals (World agroforestry Centre-b, 2011). Due to this favorable characteristic, it is possible to cover the space between coconut – pigeon pea – clove by legumes (ground nut, red bean). The establishment of Vetiver (*Vetiver zizanoides*) or lemon grass (*Cymbopogon citratus*, Figure 15, Appendix) row is recommended as an erosion control. The deep roots of this grass are not competitive for the shallow palm roots but with the expanded shade of coconut palm during the years will be worsen the light condition. The grass row has to be shift foreword to more lighted place.

7.2.3 Touure village

Table 15 Production characterization in Touure

Main production characterization	
Trees (group of trees)	89% of farmers
Forest	47% of farmers
Timber use	Fuelwood, lumber
Production constraints	Price of seedlings
Source of planting materials	Natural regeneration
Farmer's expectation from project	2 new species, red bean, red onion, timber wood, tomatoes
Often marketable product of own production	Tomatoes (pepper, onion, beans)
Farmers future plans about crops/trees growing	Vegetable (tomatoes, onion) sweet potatoes
Main grown crops/tree	Corn, onion, bean, flowers, clove (spices)

Vegetable play an important role in Tourre village. Tomatoes and cabbages are not recommended to be grown on slope, because of the soil erosion problem as was reported by Daño (2002). The problems root in soil cover and therefore tomatoes are recommended to be grown in association with beans. Instead of that, it is suggested to place this system in the lowland or mild slope. To support the soil erosion prevention establishment of hedgerows is recommended.

Hedgerows are effective in reducing surface runoff and soil loss. At the same time it is a good source of green manure which serves as an organic fertilizer to the food crops. Furthermore, it is economical to install and it is not labor-intensive and the effectiveness is increasing with time (Daño, Siapno, 1992).

For hedgerow purposes, it was chosen the local fast growing legume tree Golden flame (Figure 17, Appendix) which quickly shades soil by the dense canopy which required pruning. Near to these trees can be established rows of coffee which tolerate shade. Golden flame wood is suitable for fuelwood and light construction and handicraft purposes. Bark contain dyes and tannins which used to be use in Indonesia for batik work and fishing net preserving (World agroforestry Centre-b, 2011). The tree species does not shade the light demanding tomatoes and beans plants. One row of the tomatoes might be replaced by other vegetable such as cabbage (Figure 28).

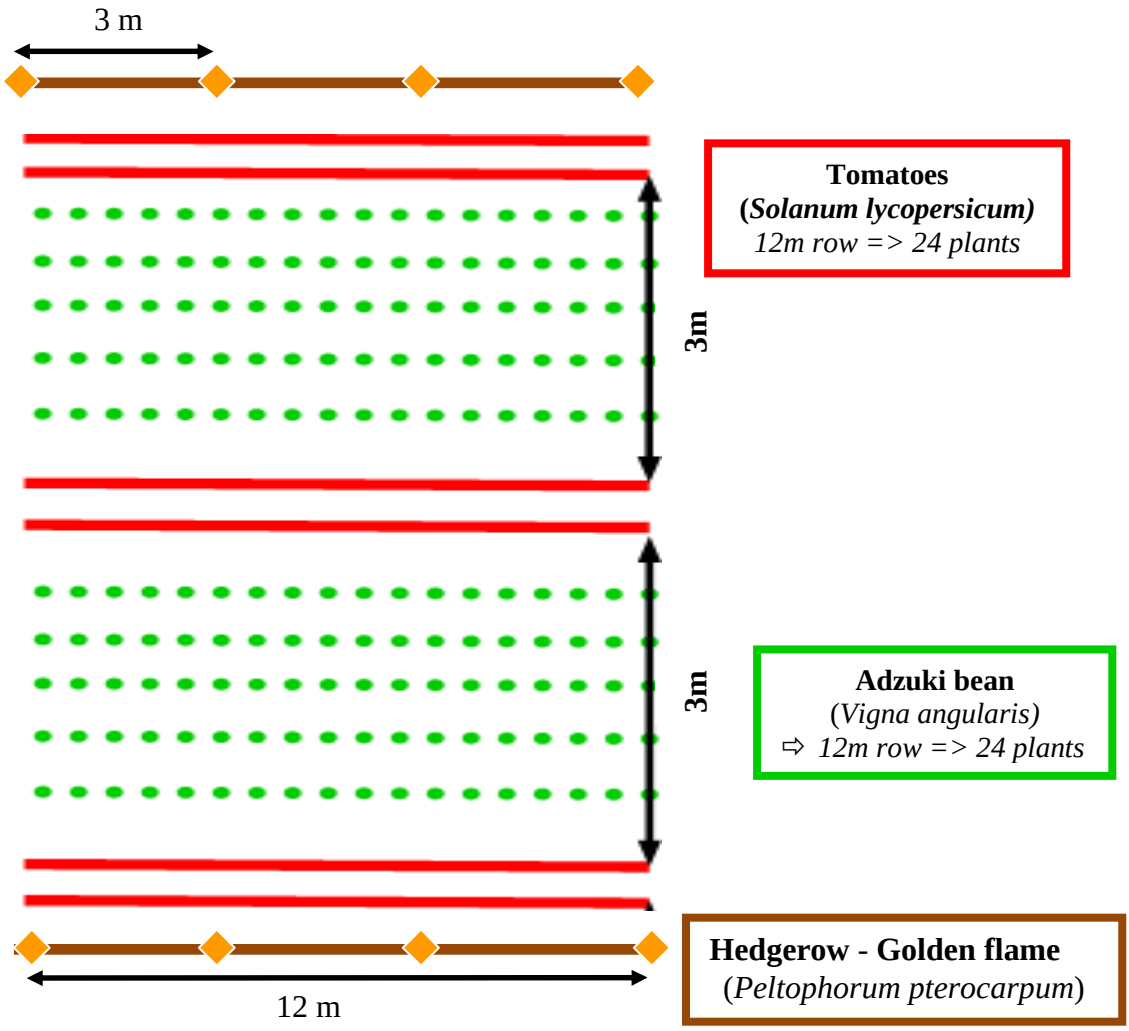


Figure 28 Agroforestry proposal II.

FAO (2005) reported that corn and also rice are the major Indonesian food crops. For this reasons, it was not expect that the farmers will be willing to give up the corn cultivation even the corn fields are prone to soil erosion. Corn provides dense cover but slow crop

development keeps long time soil exposed. The deep roots help to improve the structure of lower soil layers (GFO, 2011). Sivaraman and Palaniappan (1996) proved the beneficial association of maize, turmeric and onion. The mix canopy effectively intercepts more photosynthetically active radiation throughout the growing season than the sole cropping systems of mentioned crops. Thwala and Ossom presented during the 4th International Crop Science Congress the beneficial association of groundnut intercropping with maize in term of supported corn yield, soil enrichment and weed control (Fischer T. *et al.*, 2004) due to the soil cover and plant competition. The Figure 29 demonstrates the proposal for cultivation of four previously mentioned plants. Turmeric and groundnut are widely grown in target area (Šálek, Halamova, 2010). Turmeric might be replaced by pepper as well.

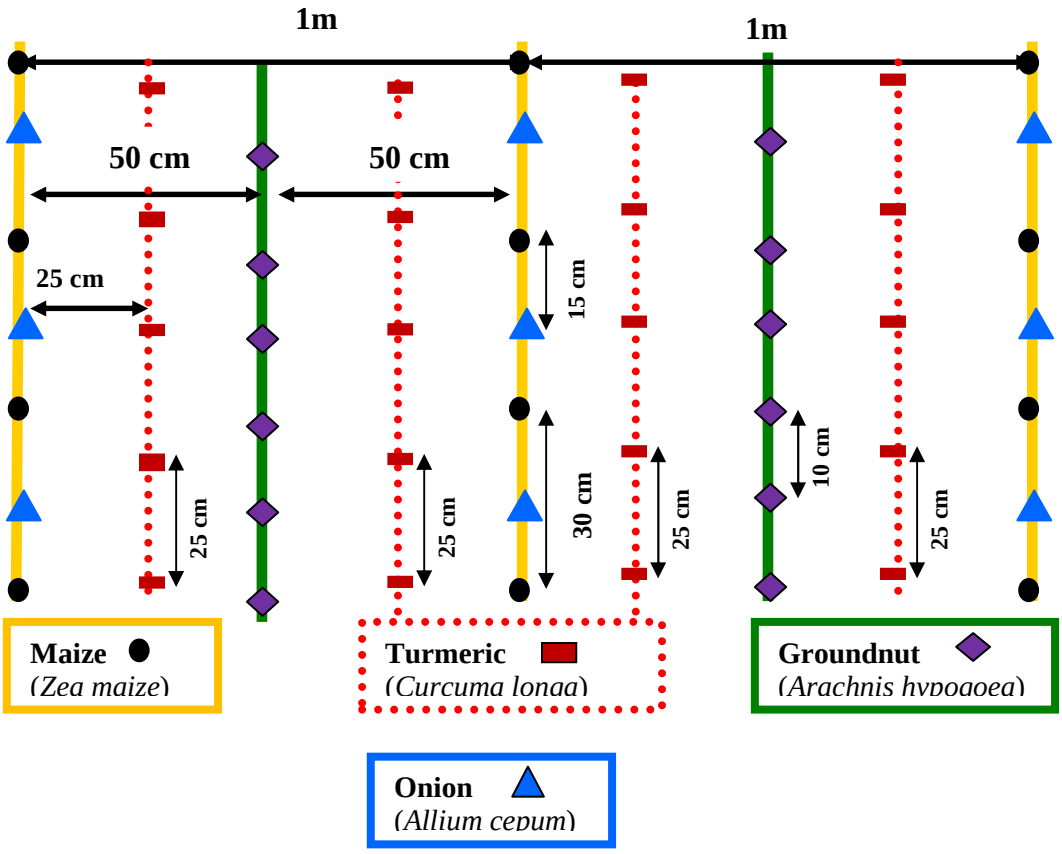


Figure 29 Mixture cropping system

7.3 Timber species

There have been suggested the system for timber production for all villages because the farmers just display their interest in growing of some tree species without any other specification. The proposal towards to the soil erosion control, because it is assumed that forest stand will be place on the slope. The target was to choose the local tree species providing a good quality timber and at the same time stabilize the soil (Table 16)

Table 16 Selected timber species

Tree species (palm*)	Planting space	Possible intercropping
Michelia champaca	2 x 2 m	
Gliricidia sepium	1.5 x 1.5 m	tea, coffee, cocoa, yam, vanilla, pepper, or corn
Swietenia mahagoni	5 x 5 m	
Peltophorum pterocarpum	4 x 4 m	
Arenga pineta *	9 x 9 m	legumes
Trema orientalis	5 x 5 m	coffee, cocoa
Pongamia pinnata	5 x 5 m	tea coffee

Glyricidia sepium (Figure 18, Appendix) can be grown in alley cropping with other crops not only to reduce the erosion but also to control weeds. *Glyricidia* might be placed on the border line of the farm or field as a living fence protecting against game (World agroforestry Centre-d, 2011).

In case of *Swietenia mahagoni* production has to be considered the development of the system. This tree competes with the other trees and crops for nutrients and water. Five years old trees significantly limit growing of the understory. The involvement of fast growing legume *Peltophorum pterocarpum*, which reaches in 3 years 9 m high, will provide nitrogen and stabilize the soil and additional the fuelwood of good quality and will be removed before the peak of competition for the water and nutrient will be reached.

The deep rooting (up to 10m) multipurpose palm (*Arenga pinnata*, Figure 19, Appendix) (Mogea *et al.*, 1991) is planted along the contour lines (Figure 30) for the slope stabilization. The space between the palm *Arenga* and *Swetania* rows might be covered by legumes during

the first three years. Due to the shade extend of the palm the space for legumes is shrinkage as it is shown on Figure 30.

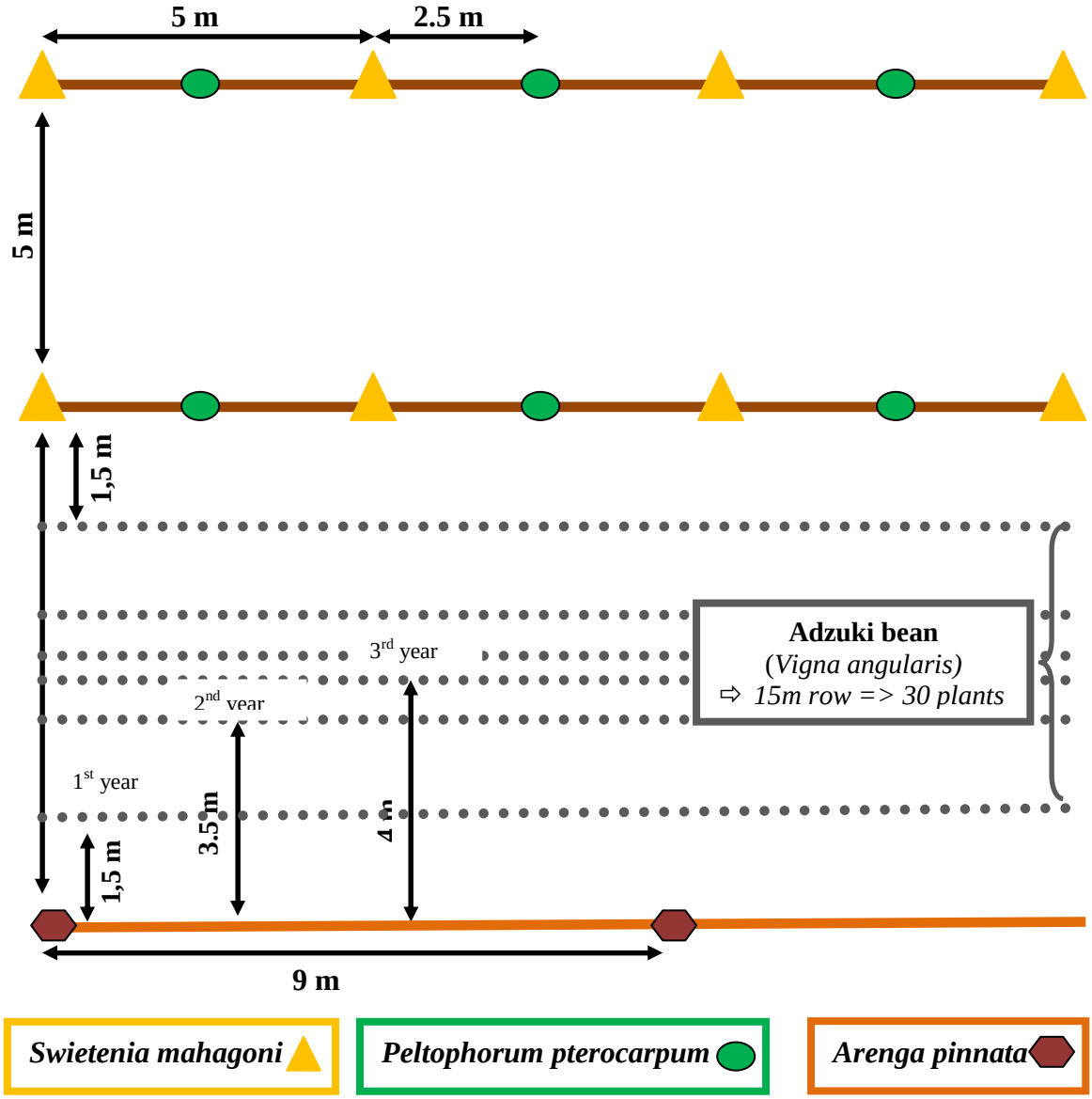


Figure 30 Agroforestry proposal III.

Swietenia mahagoni provides a high quality wood but the rotation cycle is quite long. In case that farmers are not willing to wait for the harvest so long time *Swetenia* might be replaced by other fast growing tree which also provide wood of good quality (*Trema orientalis Pongamia pinnata*, Figure 20, 21, Appendix).

8 Discussion and recommendations

According Tony Simons's statement in Practical guide for research nurseries (, farmers plant millions of trees in their fields in tropical regions. The crucial change has been recognized within the farmer's preferences regarding to the deliberately planted trees in chosen places on their farms (Jaenicke, 1999). Also Indonesia systems are dynamic and has been altering as was demonstrated on a particular example of Minahasa Regency.

8.1 SWOT analyses - forestry and agriculture in Minahasa

The SWOT analyses provide an overview of the local situation regarding to the agriculture and forestry in Minahasa Regency.

	Positive	**Negative**
	Strengths	**Weaknesses**
External factors	– Universities (forestry science) (Šálek, 2011) – High level of literacy (Ministry of Education of Indonesia, 2010) – Significant part of population is involved in agriculture sector (IFAD – 2, 2009) – Tradition of agriculture sector in Indonesia (IFAD – 2, 2009) – Fertile soil (Šálek, Halamová, 2010; National Coordination Agency for Surveys and Mapping, 1976) – Low numbers of negative net migration in North Sulawesi (Badan Pusat Statistik-e, 2009) – International market access (Šálek, 2011) – Highway around Tondano lake (Šálek, 2011)	–High level of poverty (UNDP, 2010) – Low level of average income (UNDP, 2010) –Level of unemployed in Indonesia (8.4%) (UNDP, 2010) –Slush and burn systems (Šálek, Halamová, 2010) – Soil phosphor unavailability for the plants (Agrostats, 2009) – High level of bribery index (Simanjuntak, 2008) –Technical assistance is missing (knowledge transfer from university to the "field") (Šálek, 2011) – Long term production (Šálek, 2011) –Dependence of paddy field on lake water table (Šálek, 2011) –Soil erosion around Tondano lake => soil is washed in to the lake (Šálek, 2011)

	Opportunities	Threats
Internal factors	– Developing projects (Šálek, 2011) – Research investigations (Šálek, 2011) – Production diversity (Šálek, 2011) – Ratification of Kyoto Protocol (UNFCCC, 2006) – Access to modern technologies => mobile phone and internet perception (Šálek, 2011) – Incorporation of traditional method in agroforestry systems (Šálek, 2011) – Opportunity of an excellent quality assortment production (Šálek, 2011) – Tree species reproduction material (possible import form Java) (Šálek, 2011) – Development of business chain (private sector) (Šálek, 2011) – Seed collection provide jobs (Šálek, 2011) – Biofuels production based on aren palm (Šálek, 2011) – Homegarden development (Šálek, 2011	– Deforestation rate (Global Forest Watch, 2011) – Biodiversity reduction (Šálek, 2011) – Level of corruption (Human Rights Watch, 2009) – Illegal logging (Human Rights Watch, 2009) – Frequent natural disaster incidences (IFAD, 2009) – Price at local/international market (Šálek, 2011) – Seedling shortage (Šálek, 2011) – Unpredictable development at market in frame of long term horizon (Šálek, 2011)

8.2 Farmers characterization

The majority of Indonesian farmers are smallholder, subsistence farmers cultivating small areas of land (FAO, 2005). The farmers from the adjacent area of Tondano lake are not out of the common run. A majority of these smallholders run a farm of an average size of 0.45ha. In general, almost half of the Sulawesi's farmers (42%) manage the area smaller 0.5ha (FAO, 2005). The small size is the common characteristics which still predominate in Asian agriculture in contrast to the large farm typical for region of Latin America (FAO-c, 2006).

Almost 40% of the farmers work on the farm as the fulltime job. These numbers differ among the particular villages even in one case (Paslaten village) where 80% of the farmers used to be occupied by the farm work every day. Rest of the farmers is gradually losing interest in

farming. This fact was also proved with the significant share of external job in the total farm income.

. The average numbers of the workers refers to the fact the smallholders run their farms predominantly just by own family member. With the rising number of involved labor forces is also slightly increased the tendency to hire some external forces. The increasing number of harvest per year also follows a tendency to hire more people

8.3 Farm production identification

The farms in Paslaten village have demonstrated a very similar extends. The village is situated in a locality with prevailed uniform conditions regarding to the terrain, soil and vegetation cover. The fertile soil in Paslaten is suitable for agriculture production (Šálek, 2011). Unfortunately, the localities with good agro-ecological condition display the inclination to the significantly lower biodiversity in farming systems that have been proved by farmer's records. Farmers from Minahasa Regency grow various crops and trees but in Paslaten village the most grown crop is corn. This crop used to be a reason that drives the decision towards slush and burn practices. The highest crops diversity was determinate in Makalonsouw.

Not only corn but also red beans, red onion, tomato and flower are quite popular crops. On the other hand particular farmer decide to quite growing of potatoes, vegetable, corn, lili flower, cassava, yum and carrot, corn and red bean. Potatoes production is not more attractive due to the significantly decreasing in average yield in Sulawesi, at about 9 tonnes/ha (in1998) falling to 6 tonnes/ha (in 2002) (FAO, 2005).

A high number of farmers (79%) are the owners of the forest or grow at least the group of tree in various arrangements. The scattered trees or group of trees severed mainly for the agriculture purposes. The smaller farms have demonstrated a tendency to higher biodiversity (European Commission, 2006). This attribute was not demonstrated by tree composition grown on farms. Tree cultivation has high popularity in Minahasa Regency but just the particular species. The biodiversity of the grown tree composition is quite low. Mahagony (*Swieteni amacrophylla*, *Swietenia mahagoni*), Champak (*Michelia champaca*) and clove (*Syzigium aromaticum*) are the most frequently cultivated species. Clove enjoys a noticeable popularity. The red wood tree are also popular among farmers due to a high price on market.

This drives an interest why many farmers prefer rather clove when many of them have complained for the low price on the market?

The interest in growing of timber was predicted but it was also expected with much higher degree of interest. It is possible that low numbers of cultivated timber trees or the low intention to involve some timber tree in farm production correspond with the illegal logging? Maybe also these farmers prefer such a kind of “trade”. Area of Forest Concession Estates in North Sulawesi was significantly reduced (Badan Pusat Statistik-c, 2009). This fact might have two reasons behind. The reduction of deforestation is one of them but also the other possibility is the uncontrolled logging without concession.

A significant part of the farmers are not satisfied with the grown tree species composition. Obviously the biodiversity especially for small subsistence farmers provide a benefit in form of various products that reduce their dependency on one source of livelihood.

There have been observed also other important reasons regarding to the tree cultivation. The wood used as a fuel source has been highlighted. The increasing need of fuelwood is driven by the termination of kerosene state subsidies (Šálek, 2011). The raising wood consumption might deep the problem with the illegal lodging.

The important part of farmyard is also a homegarden that is an agriculture system promotes the biodiversity on farms. These systems were not in a special focus of the research. Thanks to the fact, that homegardens have long tradition in Asia, they represent the topic for interesting studies of local biodiversity.

The tradition of agriculture in Indonesia was demonstrated also with the intension to go on in husbandry. The future plans for farming includes flower, vegetable such as potatoes, sweet potatoes, tomatoes, onion, red onion, carrot or water and clove, coconut, champak, teak, mahagony, and other timber tree. Almost half of the farmers would like to support the flower production because of the high harvest rate and possible distribution on national or international market.

8.3.1 Production orientation

Flowers, corn, red onion, tomatoes, pepper, red bean have been determinate as the farm products with a significance regarding to the market. Many farmers are interested about the situation on international market. Here is risen a precondition that farmers would like to enter this market. No farmer's records did not refer to the significance of marketable products regarding to timber products. One third of the farmers are not more interested in income generated on the farm. Their production is mainly oriented on the subsistence production.

Farmers are aware of the long time production of timber species. This could be the reason, why they do not grow them in high amount. Also the high interest in fuel wood obviously would toward their interest in fast growing trees. Implementation of fast growing trees with good marketable timber would be warmly accepted.

8.4 What is behind the popularity of clove?

The popularity of clove cultivation was demonstrated by the results of field research. What encourage the local people to relay on this tree? Many farmers currently grow clove and some other would like to extent already established cultivation and other would like to start the cultivation.

The production is surely promoted by the tradition of clove in Indonesia. Cloves are grown throughout the country and Sulawesi is one out of three major producing Indonesian island (FAO, 2005). The clove flavored cigarette became very popular as was reported by Valíček (2002). Any farmer's records did not show any significance among the marketable products in spite of that, clove is one of the twenty most important crops which play a significant role in Indonesian export and might be the product sold out at international market. A lot of farmers show their interest in international market. The presumption to enter this market is to offer appropriate product.

8.5 Does the local community follow the numbers of Indonesian statistics?

According the farmers records, it was determinate the decreasing trend in cultivation of sweat potatoes, some flower species, cassava, yum and carrots and other vegetable that were not specified more. Some farmers decide to quite growing of corn, rice, some flowers species,

vanilla and many vegetable species (such as tomato, cabbage, pumpkin and onion). The management of water regime makes more difficult the rice cultivation. Rice is grown in lowlands where the fall of water level is highly depended on the on the Tondano lake water table. Therefore water releasing from the field is difficult (Šálek, 2011). According FAO (2005) other problem might be origin in phosphor deficiency. In case of Sulawesi's lowland rice soil, more than half of the paddy fields cope with the low of just medium phosphor amount.

The Indonesian statistics, quote figures concerning converse trend in four cases: maize, rice, sweet potatoes and cassava, by which were detected the huge increase of production in term of harvested area (in ha). The production increase was driven by the intensification programs. Governmental supported increase of national food production by means of a good supply of agricultural inputs (i.e. fertilizers, pesticides). The rice production was promoted by the fertilizer application. 52% of the total consumed fertilizer in Indonesia is applied to rice (FAO, 2005).

In particular case, as it shown in the Table…, the production rose by more than 100% (Badan Pusat Statistik-d, 2009). Based on this records, it is estimated that the cultivation of maize, rice, soybeans, cassava, sweet potatoes and also peanuts is shifting from the smallholder interest to the larger scale agriculture production and therefore it is demonstrated expressed the production rise in spite of decreasing interest of smallholders.

Table 18 Changes in production of selected crops during the 2001-2011

Type of Food Crops	Harvested Area	Production in tuns/ha	Annual total yield
Maize	105%	64%	241%
Paddy	68%	14%	91%
Soybean	136%	10%	161%
Peanut	45%	16%	68%
Mungbean	-4%	26	22%
Cassava	134%	27%	197%
Sweet Potato	148%	12%	179%

(Badan Pusat Statistik-d, 2009)

Corn, beans, vegetable and also flowers remain quite important and the most frequently cultivated crops.

8.6 Initiation of cultivation play a crucial role in future development

The high quality inputs play a crucial role in further interest of farmers in agroforestry practices that go hand in hand with the landscape protection. If the nursery is not able to provide highly-quality seedling, deforestation would be encourage and devastating of the landscape would carry on (Jaenicke, 1999).

The nursery is highlighted as the significant obstacles in further success development of local agriculture sector. Cultivation of any crop or tree start with the material of good quality but without them maximization of the success is not ensured. Nurseries have a high potential for technology generation that fits to the need of particular area (Roshetko *et al.*, 2010). Framers from Minahasa Regency do not use a service of nursery even the seedlings shortages is considered to be a significant obstacle. One reason is a high price of seedling and seeds. The high interest in afforestation project implemented Regency by Czech University of Life Science in Minahasa point out the problems regarding to the seedlings because expectation of seedling acquisition. Farmers wish to gain some new species demonstrate the dissatisfaction with the current grown crop and tree composition.

The deeper focus on the problems of nurseries was not involved in the field research. Due to the lack of information is recommended further research regarding to the nursery practices. In case of missing of this service in Minahasa Regency is suggested to start this business under proper supervision because it seems to be a gap at the local market. If someone takes a change of this challenge to run this business, whole agriculture sector in Minahasa Regency benefits.

8.7 The role of agrochemicals

Indonesia is a producer of fertilizers (urea, superphosphate and ammonium sulphate). During the period 1998 – 2002 were produced 6.5 million tones, mostly for domestic use. The fertilizer use has been driven by local government by the fertilizer subsidies. The level of soils fertility had declined in uplands farming partly due to inadequate fertilizer application. The fertilizers are time to time not available at rural areas on time and of the right type. Farmers often apply low and unbalanced dozen, usually just urea for food crops. The frequent application of this fertilizer has been observed also in Minahasa Regency. The adjacent locality of Tondano lake is covered by the soil of volcanic origin (Agrostats, 2009; UISS,

2007) which have been evaluated as very fertile (Andosols of Europe, 2005) with a high potential for agriculture production (UISS, 2007) but under proper management because farmers cope with phosphorus difficulties (Agrostats, 2009). The local fertilizer consumption shows the farmers awareness of this problem. Among the used fertilizers have been except of urea recognized only those containing phosphor.

Regarding to the currently grown crop and tree structure, it was selected the recommendation of fertilizer application that served as a general guideline for Indonesian agro ecological condition.

Table 17 Range of fertilizer rates recommended for crop / tree species

Crop/tree	Fertilizer (kg/ha)		
	Nitrogen	**Phosphor (P_2O_5)**	**Potassium (K_2O)**
Cassava	55 – 75	20 – 40	20 – 40
Lowland rice	65 – 95	40 – 50	5 – 25
Maize	65 – 95	30 – 50	10 – 30
Potatoes	85 – 125	50 – 90	20 – 40
Shalot	70 – 150	40 – 75	10 – 60
Sweet potatoes	50 – 70	20 – 40	20 – 40
Tomatoes	65 – 110	45 – 75	10 – 50
Mung bean	20 – 30	25 – 45	0 – 15
Long bean	35 – 65	30 – 70	10 – 30
Cabbage	60 – 110	40 – 80	5 – 35
Clove (inmuture)	10	15	10
Clove (muture)	110	110	140
Fruit trees	100 - 150	100 - 150	100 -200

(FAO, 2005)

Local farmers fertilizer only on the crops. The forest stand (or smaller group of tree) relay just on the “natural nutrient” capacity. Almost nobody manage on his farm compost. It is highly recommended to give the instruction about this technique to possess another source of quality fertilizers based on farm sources.

Pest control management is waiting for the assistance. 40% of the farmers does not use any type of pesticide (chemical or natural) even the majority of farm face to the continuous problem with weed pressure. Here is missing the information what is the constraints limiting

the use of the pest control. In cases of money shortages, the farmers would start to grow some plants/trees species producing the natural pesticides. In case of insecticides, would be recommended to grow native tree - Neem (*Azaderachta indica*), which wood of good quality is also used as a construction material or as a high quality fuel wood. Deep roots also stabilize the slope sides, which prevent the landslide (World agroforestry Centre-c, 2011). Other solution might be the establishments of proper agroforestry systems employed the trees such as *Glyricidia sepium* which serve as the weed control mechanism in allay cropping system (World agroforestry Centre-d, 2011). Integrated pest management is a frequent and crucial challenge for the farmers all over the world and also for the extension experts which might be helpful to find the appropriate solution for target area.

8.8 Is agroforestry able to deal with the local issues?

In worldwide sense, the agriculture is the reasons why 50% of the world's forests have been lost (Hoehn *et. al.*, 2010). The afforestration practices in Indonesia follow the Millennium goals of UN and contribute to the sustainability of the local environment. Agriculture and forestry practices, which play an indispensable role in the life of a significant part of the local people (Wood explorers, 2008) also pose a potency to support and improve the food self-sufficiency of the farmers.

The multipurpose trees in agroforestry systems provide the products of annual crops and at the same time the wood and non wood products which are might significantly support the food security of the farmers (Wood explorers, 2008). The need to combat this problem is also required by the 16 % of the total Indonesian population suffering from undernourishment (UNDP, 2010).

The increase of food production has already proved the ability of one world's populous regions to be self sufficient in this task and ensure the food security at the same time. Unfortunately, Indonesia has also huge experiences with the frequently occurred natural disasters (FAO – e, 2010). UNDP (2010) estimated the numbers of people affected by various disasters such as drought, earthquakes, epidemics, extremes temperatures, floods, insect infestation, storms, volcanoes and wildfires. The value refers to the annual average of 4,935 million of affected people.

The success of this country is not strong enough to overcome this reality and still high number of people is malnourished. 28% of Indonesia's children are underweight and 42 % suffer from stunted growth (FAO – e, 2010). Due to this findings, is necessary continuously promotes and encourage the farmers in their efforts to be self-sufficient and be aware how to cope with the natural disasters and their possible impact and how to avoid or minimize the risk by the appropriate agriculture practices under local conditions.

Millions of Indonesian's livelihoods and their food security are depended on renewable natural resources (FAO – e, 2010). Therefore it is defined the crucial task to follow the sustainable management of the local resource to make them sufficient and to ensure to satisfy not only the current needs of local people but also the needs of the next coming generations.

8.1 Future of Agriculture

The most important reason for deforestation is the forest clearing for agriculture purposes. The land use conversion has being the common practices in Indonesia (Dechert *et al.*, 2004). Many hectares of forest were cleared with the intention of plantation establishment but significant part of the land lay fallow (Global Forest Watch, 2011). The land conversion is a typical feature not only for the North Sulawesi and adjacent locality of Tondano lake but also for the Central Sulawesi's uplands which has follow very similar fate (Dechert *et al*., 2004).

Derecht *et al.* (2004) reported the effort to replace the traditional practices of shifting cultivation by the permanent cultivation systems. The introduction of income generating cash crops under unsustainable management deeper the problem of soil erosion. Clearing of the forest followed by the annual crop cultivation (such as *Oriza sativa, Zea mays*) lead to soil deterioration due to declining soil organic matter (Dechert *et al.*, 2004). The annual crops are very important for the famer and they would never give up their cultivation. The agroforestry has potential to improve such as situation. The continuous vegetation cover provide litter and shading to the soil. The legumes species incorporated in this scheme provide an advantage of additional nitrogen supply that supports grow and consequently the yield of associated crops or trees (Beer *et al*., 1998). The maintenance of the soil fertility at the good level will not encourage the people to continue in shifting practice.

The locality in the Tondano lake vicinity was also one of the target area where the land used were altered. Inappropriate land use systems conversion brought also the difficulties with.

Currently, the situation starts to turn out but there is still lack of soil restoration. The crucial problem lays in soil profitability. Local people need to be guide how to use the unexploited land and at the same time to contribute to the soil rehabilitation (Research team - Mott MacDonald and CULS, 2010).

There were observed the trend of increasing population in urban areas. Due to this fact, it was observed the changes in the pattern of interest in area of employment from agricultural to industrial sectors particularly among the young people. This tendency is driven by the availability of facilities in the urban areas such as education, health and other social aspects. (Effendi, 2006). The programs supporting the livelihood generation in rural area are need to prevent migration of the poor to urban areas, which seek there after “better life”.

The rapid improvements of education level results in migration especially of young people from rural areas due to their unwillingness to work in agriculture. They rather move to work in other sector. Rapid commercialization of the agricultural sector replacing the labor inputs by capital inputs is a common character that reduces the numbers of labor forces in agriculture sector, but this issue was not involved in field research and will be not uncovered in this theses. The migration of some family members might be sometimes driven by creation of multiple sources of income that reduce the effects on the family in case of failure of one of their income source.

8.2 The importance of the afforestation projects

Indonesia has already lost an estimated 40% (64 million ha) of forest cover during last 50 years (Globel Forest Watch, 2011). UN-REDD program (2009) (Reducing Emissions from Deforestation and Forest Degradation) considered the deforestation and forest degradation as the serious problem not only in the regional but also in the world scale. Deforestation was classified as the serious problems also by Emil Harwell, a Human Rights Watch consultant, who stated in Jakarta Globe (2009) that Indonesia logging industry is facing corruption, illegal logging and forest mismanagement. According the Human Rights Watch estimation, roughly half of the Indonesia's timber was logged illegally in recent years.

The corruption perceptions index (CPI) 2010 has reached 2.8 on the regional level (Transparency international - a, 2011). It was observed a little progress in this problem. The CPI has been improved by 0.2 during the last two years. Obviously, it is still one of the crucial

challenges that Indonesia faces (Transparency international - b, 2011). On the contrary, the CPI for North Sulawesi has shown the worsen situation. Effendi (2006) mentioned the information that the CPI characterized particularly the capital city of North Sulawesi Manado reached 5.12 in 2004. Two years later, Simanjuntak (2008) uncovered much lover number 3.98 for year 2008. In spite of this, this low number does not prove evidence about the perception of the local people. Other two variables give a deeper look on this problem:

- Perception of Business Persons Respondent on Local Government Effort to Curb Corruption => Manado 4.93
- Perception on Local Law Enforcement Effort to Prosecute Corruption Case => Manado 4.55

According these two variables and records for Manado, it was estimated the fact that local business people perceived that local government and law enforcement make an effort to curb corruption, but the corruption and bribery are still common (Simanjuntak, 2008).

A leader of a German-Indonesian sustainable management project (Mr. Solichin) interviewed several local people during the illegal logging in forest of South Sumatra. The received responds reflect the common way of local people perception. They break the local law as an everyday practice being aware of the high level of corruption in their country. Even the common man that Mr. Solichin met in forest admitted, that police can be always bribed and therefore he do not care about it (DW-World.de, 2011).

This situation directly reflected by the value of bribery index in case of police which reached 60% at country level and shows that police is still considered as the most vulnerable to bribery and confirms the worse situation in Indonesia (Simanjuntak, 2008). The problem does not root in people's ignorance. The awareness of corruption law published by Simanjuntak (2008) reached 98% (of public officials). The issue is related to the people and their life quality.

Simanjuntak (2008) revealed in the report "Measuring Corruption in Indonesia: Indonesia Corruption Perception Index 2008 and Bribery Index" that 40% of the public officials offered bribe would probably take bribery, if circumstances is right. Than is obviously risen a question: What is the right circumstance? Is this also a case of forestry?

Mr. Solichin stated that Indonesian forestry is in urgent need for reforming local systems and changing the perception of the local people (DW-World.de, 2011). Each man usually thinks about

own benefit, how to generate the livelihood for themselves and his family without being aware of the impact for the future. The afforestation project offers the local people to become a famer or probably in the most cases to improve farmer's practices and at the same time to avoid environmental losses, because according numbers of IFAD-2 (2009) a significant part of Indonesians live on agriculture. Due to this fact, risen the importance of the natural resources and related livelihood generation.

Agroforestry under appropriate management generates multipurpose products that decrease the farmers dependency on one products as it is in case of palm oil plantations and give the farmers and give the farmer new way of husbandry. The sufficient amount of quality products ensuring the livelihood for the farmers and their families might be a way how to divert their attention from illegal practices.

The subject of illegal logging and related problems in forestry frame have come up as the important and interesting topic during writing this theses and therefore it was not included in the field survey. However, asking of local farmers for their experience with illegal practices would rather break their willingness to share the other information regarding to the purposes of the implemented project. Probably not many people would like to be included in a survey that admits that went beyond the law. Studding of this subject is highly recommend because the systems prevailing in the country define the limits that would pushed the people to change their perceptions and behavior , which seems to be a crucial point for the change turning the forestry situation in Indonesia.

8.3 Changes in legislation would modify the future

The forest industry is facing the corruption, illegal lodging and the forest mismanagement (Harwell, 2009). These innervations are driven by low price product export to the Asian countries which undercut prices of legitimate producers (Harwell, 2009). This situation calls for the police action and legislation adaptation at the state level.

At the local level, the particular farmers have to be driven by own encouragement to generate their livelihood by agroforestry/forestry practices. This could be reached only by the comprehensive perspective for the farmers that need to meet their daily needs and be strong enough to be able facing the difficulties that are threaten with (natural disasters and economic situation).

The farmers have to be self-sufficient. The production has to cover their own consumption or they have to have the access at the "fair" working market and generate the money for purchasing other products at local market. To reach the success, the farmers need to be led during the implementation of the proposal for the innovations. They should understand the benefits of sustainable agriculture management. To this purpose serves the implemented project and agroforestry plan.

It is highly important to cope with problem of illegal logging and because it does not affect only the farmer's livelihood but also the local ecosystem suffering from the burning of the remaining forest mass after the illegal logging and completely miss the way of sustainable recourses utilization.
Emial Harwell also mentioned in Jakarta Globe (2009) the problem with transparency of the data relating to the country's forests (timber production and tax revenues). The lack of accurate information is obvious. The Forestry Ministry deals with difficulties to manage or protect the nation's forests without access to the accurate information.

8.4 Afforestation vs. international goals achievement

The various goals have been marked out by various international organizations which release plenty of reports with the same wish to encourage the people around the world to be aware of the natural resources significance, which call for the sustainable way of management. The people affected the environment and therefore the exploitation of natural resources deeper also the socioeconomic problems.

The United Nations warns that shortfalls in meeting agreed actions on combating poverty and raising living standards are endangering achievement of the Millennium Development Goals. A UN report, The Global Partnership for Development at a Critical Juncture, finds serious gaps in the realization of commitments only five years away from the deadline for achieving the Goals (United Nations Department of Public Information, 2010). Ensure of environmental sustainability is one of the goal covering also reduction forest area losses (UNDP, 2007). Therefore integration of trees cultivation in common farm practices in Minahasa Regency would enhance fulfillment of these goals.

Afforestration (which includes activities such as agroforestry) are also eligible for inclusion in a carbon market within the Clean Development Mechanism of the Kyoto Protocol (Ginoga *et*

al., 2009), which Indonesia ratified almost 7 years ago (03/12/04) (UNFCCC, 2006). Forestry is mentioned in Kyoto protocol as a one of the possibility how people would improve adaptation to climate change (UN, 1998), which was mentioned by Minister for the Environment Republic of Indonesia as the cause of the high natural disaster incidences (Hilman *et. all*, 2010). The grown biomass such trees accumulates green house gas CO_2. The fixed amount of this gas might be transformed in country benefits of various forms.

Dr. Panangian Siregar, State Minister for the Environment Republic of Indonesia, highlight in report "The First National Communication on Climate Change Convention" the strong support of UNFCCC (United Nations Framework Convention on Climate Change) objective by their country, which imply that Indonesia is bound to the rights and obligations, stipulated in the Convention. One of the obligations is to communicate actions taken to mitigate climate change (UNFCCC, 2004). Was this really fulfilled with disappearing 2 million ha of forest area each year since 1996 as was reported by Global Forest Watch (2011)?

Prof. Dr. Gusti Muhammad Hatta, Minister for the Environment, admitted that deforestation and land-use change (1.1 million ha/year) accounts for 51 % of the country's annual greenhouse gas emissions. The total numbers of released emissions are under global average and therefore these numbers do not induce the discomposure (Hilman *et. all*, 2010). In spite of this fact, would not be better to significantly reduce deforestation and encourage afforestration to reduce these numbers? The connected "savings" would be transformed in CO_2 credits which pose the benefit at the international market. Not only monetary profit would be generated but also the environmental. According IFAD – 2 (2009) a significant part of Indonesian population is depending on the natural resources. Thanks to this reality, the "savings" would represent the impact with broader sense including related poverty and food safety problems reported by UNDP (2010). Now, it was outlined how the issue turns back to the fulfillment of Milleniums goals particularly to "Eradication of poverty and hunger".

Indonesian Government put the challenge of climate change on the list of the highest country priorities, which promises a national emission reduction (Hilman *et. all*, 2010). The future numbers of deforestation and afforestation rate will prove, if this was really the applied tool for emission reduction. Against the success achievement work the uncontrolled illegal logging and also the level of corruption in country reported by Human Rights Watch (2009).

9 Conclusion

The sustainable management of natural resources is one of the key factor affected the future success of the country development due to the high dependency of a significant part of the local population on agriculture. It is necessary to support the local farmer and advice them in sustainable way of agriculture management. The generation of the livelihood ensuring the good living stands might significantly reduce the negative effects of unsuitable practices that have a negative impact on local environment.

The agroforestry practices seem to be the way how to satisfy the need of farmers and improve the local environmental problems. The high tree species involvement in the farming systems provides a possibility how to meet their need for wood used for fuel, construction or market purposes. The establishment of the systems based on the fast growing tree species providing a quality wood is considered to be the best solution that fit the farmer's expectations. It is believed that the promotion of the wood production would slight down the illegal lodging that significantly contribute to the Indonesian forestry industry.

The farm production is a dynamic system that has been changing around the years. Here is defined the possibility to towards the production in right direction with a respect of local needs and environmental conditions without overexploitation of natural resources.

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Apendixes

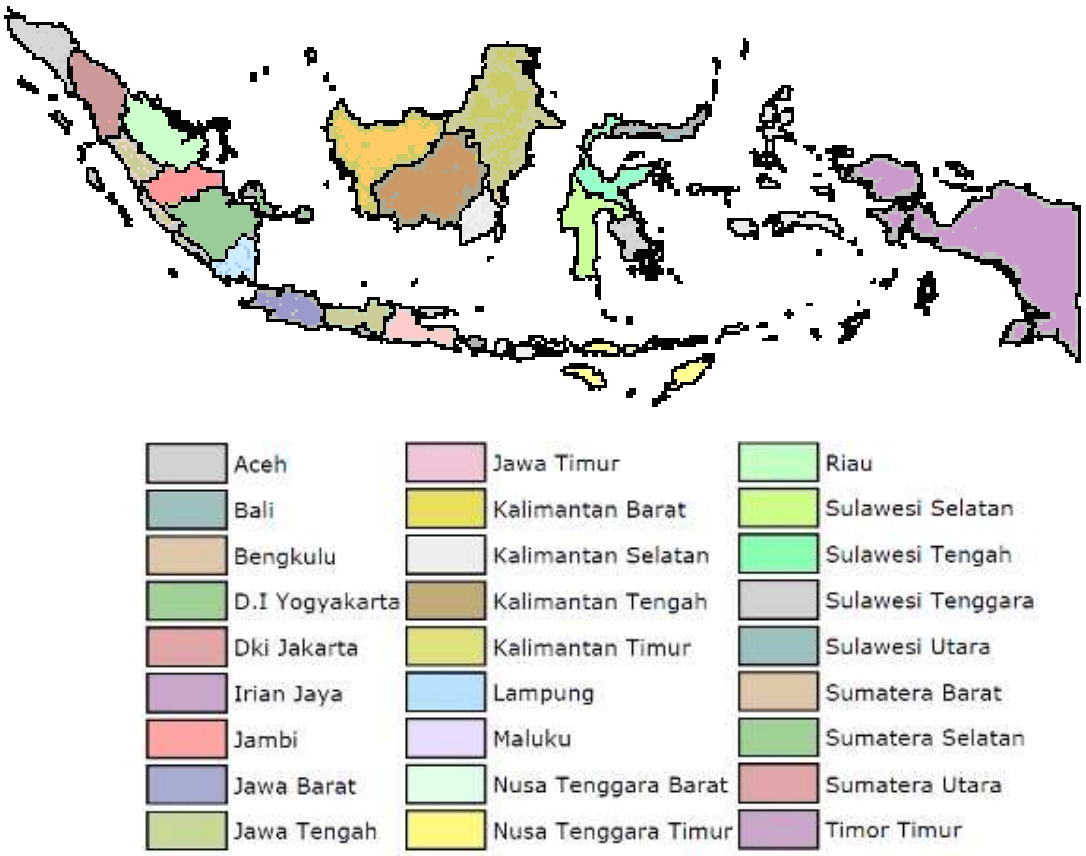

Figure 1 Administration of Indonesia (FAO, 2010)

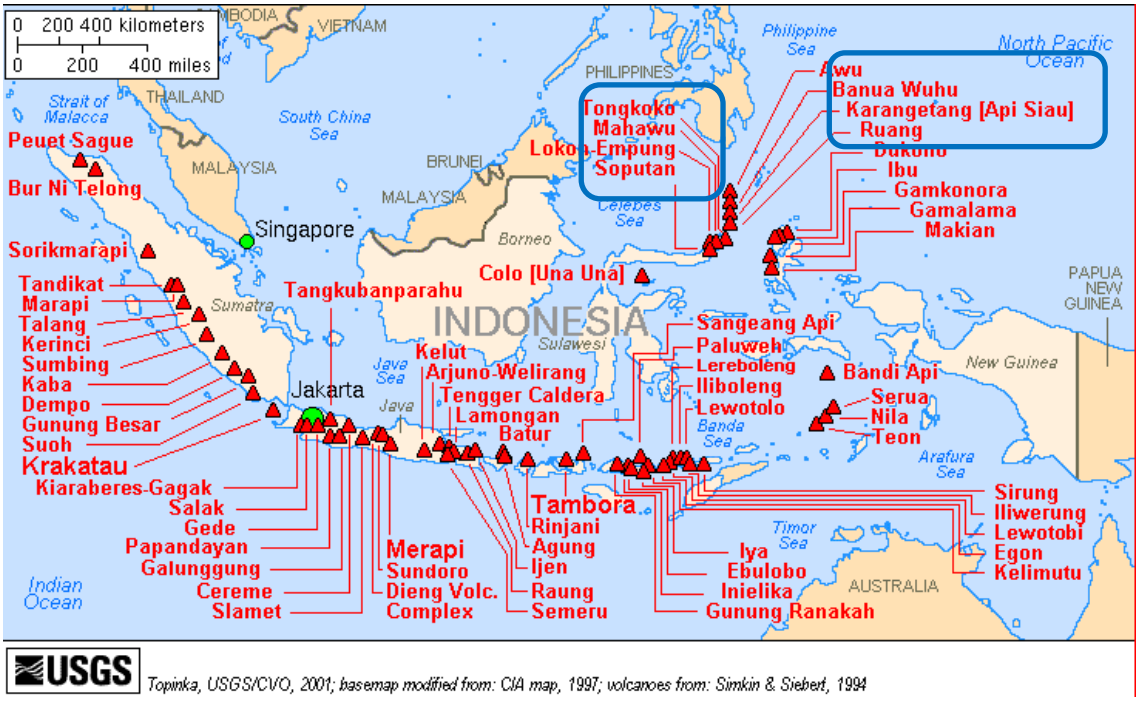

Figure 2 Indonesian volcanoes (Topinka, 2002) – blue frames are highlighting the volcanoes located in North Sulawesi

Table 1 Major tree species in various forest stands

Forest type	Family	Genera (species)	Family	Genera (species)
Tropical rain forests	*Anacardiaceae*	*Gluta (G. renghas)*	*Ebenaceae*	*Diospyros*
	Datiscaceae	*Octomeles (O.sumatrana)*		*Intsia*
		Anisoptera, Dipterocarpus (D.oblongifolius)	*Legemimoseae*	*Koompassia*
				Saraca
	Dipterocarpaceae	*Dryobalanops, Hopea, Shorea, Parashorea*	*Lythraceae*	*Duabanga*
			Lauraceae	*Eusideroxylon*
			Moraceae	*Ficus*
		Vatica	*Myrtaceae*	*Eugenia*
	Araucariaceae	*Agathis*	*Sapindeaceae*	*Pometia*
	Apocynaceae	*Dyera*	*Sapotaceae*	*Palaquium*
Montane rain forests	*Cunoniaceae*		*Lauraceae*	
	Cannabaceae	*Trema*	*Magnoliaceae*	
	Dipterocarpaceae		*Monimiaceae,*	
	Ericaceae		*Myrtaceae*	*Leptospermum*
		Quercus	*Pinaceae*	*Pinus (Pinus merkusii)*
	Fagaceae	*Castanea*	*Raponea*	
		Nothofagus	*Sapindaceae*	*Dodonaea (D.viscos)*
	Hamamelidaceae		*Ulmaceae*	*Ulmus*
			Ulmaceae	*Parasponia*
Sub-alpine rain forests	*Araliaceae*	*Schefflera*	*Myrsinaceae*	*Rapanea,*
	Araucaria		*Myrtaceae*	*Leptospermum*
	Asteraceae	*Olearia,*		*Xanthomyrtus*
	Cupresaceae	*Libocedrus*	*Podocarpaceae*	*Dacrydium,*
	Ericaceae			*Podocarpus*
	Fagaceae	*Quercus*		
Monsoon forests	*Arecaceae*	*Borassus flabellifer*	*Curculionoidea*	*Schleichera oleosa*
		Corypha utan	*Datiscaceae*	*Tetrameles*
	Casuarinaceae	*Casuarina junghuhniana*	*Lamiaceae*	*Tectona grandis*
	Anacardiaceae	*Lannea grandis*		
	Burseraceae	*Garuga primata*		
	Casuarinaceae	*Casuarina junghuhniana*		

(World explorers, 2008)

Table 1 Continuation: Major tree species in various forest stands

Forest type	Family	Genera (species)	Family	Genera (species)
Monsoon forests	*Fabaceae*	*Acacia leucophlea,* *Acacia tomentosa,* *Albizia chinensis* *Albizia lebbeckioides* *Butea monosperma* *Caesalpina digyna* *Cassia fistula* *Dalbergia latifolia* *Tamarindus indica* *Dichrostachys* emerea	*Santalaceae* *Stereospermum suaveolens* *Tetramelaceae* *Tiliaceae*	*Santalum album* *Stereospermum suaveolens* *Tetrameles nudiflora* *Actinophora (A. fragrans)*
Mountain monsoon forests	*Casuarinaceae* *Cyatheaceae*	*Casuarina (C .junghuhniana)* *Cyathea*	*Myrtaceae* *Pinaceae*	*Eucalyptus* *Pinus (P.merkusii)*

(World explorers, 2008)

Table 2 Timber species (Forest Concession Estates)

Vernacular name	Latin name	Family	Production ('000 ha)
Agathis	*Agathis spp.*	*Araurariaceae*	6 034
Bakau	*Rhizophora apiculata, Rhizophora candelaria, Rhizophora conjugata*	*Rhizophoraceae*	110 205
Bangkirai	*Shorea gluca, S. laevis, S. spp.*	*Dypterocarpaceae*	77 818
Benuang	*Octomeles sumatrana*	*Datiscaceae*	36 450
Damar		*Sonneratiaceae*	1 491
Duabanga	*Duabanga grandiflora, D.moluccana*	*Sonneratiaceae*	0
Indah			59 699
Jelutung	*Dyera costulata, D. polyphylla, D.lowii*	*Apocynaceae*	17 431
Kapur	*Dryobalanops spp.*	*Dypterocarpaceae*	268 621
Kruing	*Acacia Mangium*	*Leguminoseae*	369 933
Meranti	*Shorea spp*	*Dypterocarpaceae*	4 062 671
Mersawa	*Anisoptera spp.*	*Dypterocarpaceae*	105 334
Nyatoh	*Palaquium spp.*	*Sapotaceae*	39 141
Palapi	*Heritiera javanica*	*Sterculiaceae*	15 756
Ramin	*Gonystylus spp.*	*Gonystalaceae*	67 707
Resak	*Upuna borneensis* *Vatica rassak, Vatica tonkinensis*	*Dipterocarpaceae* *Fagaceae*	6 756
Rimba Campuran	*Mix tropical hardwood*	*non-Dipterocarp species*	1 249 338

(ICRAF, 2011,; Badan Pusat Statistik –g, 2009; Wood explorers-b, 2008)

Figure 3 *Cocos nucifera* **(**Elevitch , 2008)

Figure 4 *Plumeria acuminata* **(**Rohwer,2000)

Figure 5 *Cordia dichotoma* (FAO, 2006)

Figure 6 *Michelia champaca*, (BIOTIK, 2010)

Figure 7 *Syzigium aromaticum* (TropTropicals.com, 2011)

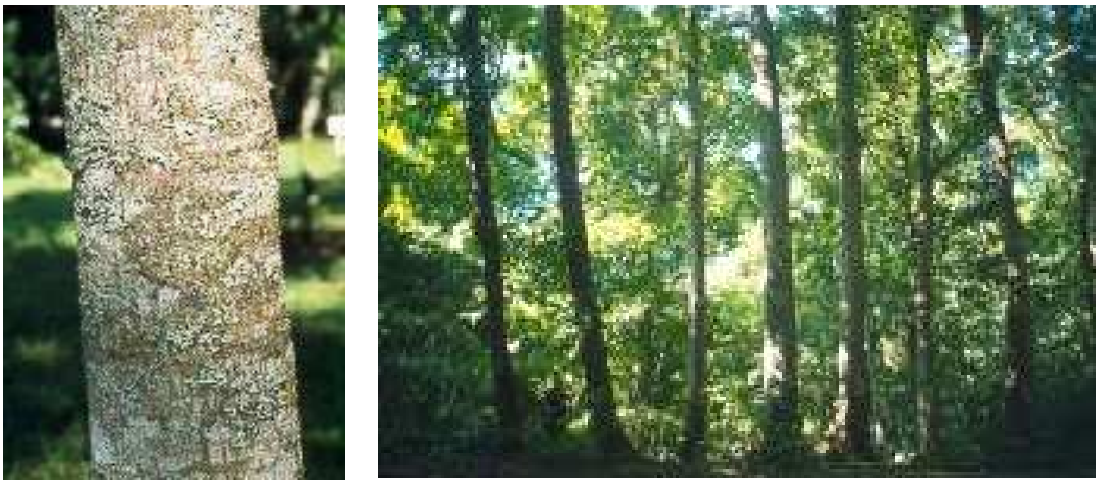

Figure 8 *Swieteni macrophylla* (Ecoport, 2001, Danida Forest Seed Centree)

Figure 9 *Leucaena leucocephala* (Tropical Forage, 2008)

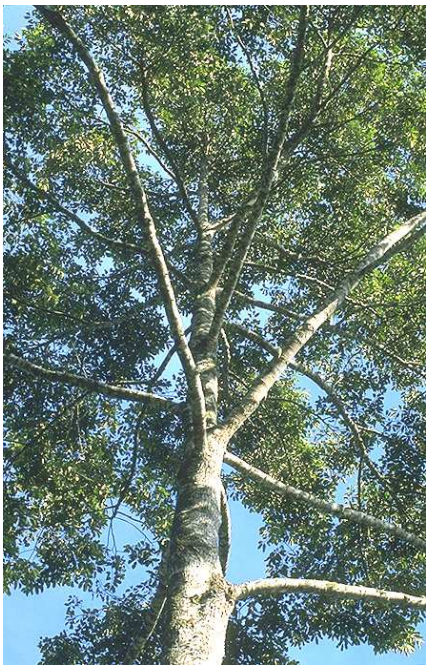

Figure 10 *Durio zibethinus* (Ecoport, 2001)

Figure 11 *Lansium domesticum* , (Ecoport, 2001;Morton, 1987)

Figure 12 *Coffea arbica* (Ecoport, 2001)

Figure 13 *Bambusa spp.* (Ecoport, 2001)

Figure 14 *Vetiveria zizanoides* (Ecoport, 2001)

Figure 15 *Cympopogon stratus* (Ecoport, 2001)

Figure 16 *Cajanus Cajan* (Ecoport, 2001)

Figure 17 *Peltophorum pterocarpum* (Ecoport, 2001)

Figure 18 *Glyricidia sepium* **(**Elevitch , 2008)

Figure 19 *Arenga pinata* (Ecoport, 2001)

Figure 20 *Trema orientalis* (Ecoport, 2001)

Figure 21 *Pongamia pinnata* (Ecoport, 2001)

Apendix II

Semi structured questionnaire

Screening for project "Rehabilitation of the Tondano Lake Watershed with emphasis on the Minahasa District, North Sulawesi"

This is the questionnaire which will be used for the analysis of socioeconomic situation of people living around Lake Tondano. It will serve only for the project designer and the results will be issued only in statistical evaluation of the requests. Individual questionnaire will not be for public disposal.

1. Name
2. Age:
3. Village:
4. How big is the area you farm?
5. Do you share your field within community or just with your family?
6. How many people do work in your field? Are they only your family?

Agriculture:

7. How often do you work on your field? (if you farm in more fields specify each apart)
8. How many harvests do you have per year?
9. Do you appaly chemical fertilizers? If yes, please, write down the exact name and its utlization.
10. Do you use any natural fertilizers?
11. Do you face the problems with pests and plant illnesses? If yes, specified them.
12. Do you use any chemical pesticides (chemicals against pests or plant diseases)?
13. Do you use any of natural pesticides?
14. How often do you weed? Which species do you considered as the weeds on your fields?
15. Which herbicides (chemicals against weeds or unwanted plants) do you use? If yes, which one?
16. How much money do you spent for agrochemicals (fertilizers, pesticides, herbicides) annually?

17. How much money do you spent for seeds / seedling per year? Where do you get the seeds / seedlings?
18. Or do you collect seeds from previous plants and grow your seedlings alone?
19. Name crops you grow including fruits and spices: (subsequently according to extension and importance)
20. If there are some you don't grow anymore, can you say why?
21. Do you remember any plants, crops which had been planted in the past and you don´t see them anymore? Plants which your grandparents or parents used to grow and they disappeared from the fields and from local markets?
22. What plants would you like to plant, but you don't have enough money to buy seeds or seedlings and why would you like to plant them (for your household, to sell in the market, etc.)?
23. What plants would you like to get and start to plant from this project?
24. Do you want to collaborate with this project? What do you expect from it?
25. What are your main crops you sell on the market?
26. Do you sell your harvest you yourself on the market or do you sell it to some commercial or do you collaborate and supply some company or shop? Do you sell it within some association of farmers (your neighbors)?
27. How much money do you get from your farming per year? (specify if it is clear yearly income just for you or for all your family or for all your association of farmers)
28. Is the farming only one job opportunity for you. If not, please, can you specify the annual income from other jobs.
29. Are you interested in the situation of demands and offers on the local market? Where do you get this information? (going to the market, other villagers, meetings with other farmers)
30. Are you interested in the situation of demands and offers on the international market? Where do you get this information? (internet, newspapers, people you know…)
31. Don´t you mind to plant new crops you don´t know, but which have high potential to be sold on the market or which would increase your harvest? (for example sweet potato)
32. Do you have a homegarden?
33. Which flowers and ornamental plants do you plant?
34. What medicinal plants grow on your field and homegarden?

35. Do they grow widely or did you plant them?
36. How many medicinal and aromatic plants (including spices) do you use and how do you use them (cooking, medicine, cosmetics, etc.):
37. From where do you have those plants - field
    nature
    market - in which form(dry, powder, fresh, liquid)

Forestry

1. Do you have individual trees or group of trees for timber?
2. Do you have forests (group of trees larger then 0,1 ha). If yes, which area?
3. Do you use trees for you agriculture production (shade forming trees, supporting trees – for instance for pepper, vanilla etc., living fences, fodder production)
4. Which tree species including palms do you grow?
5. For cooking and water heating (washing) do you use fuelwood, charcoal, gas or electric power? If you use fuelwood or charcoal, how big amount per day?
6. For planting tree species do you use seedlings from a forest nursery or from your production (seeds collected from trees or natural seeding)?
7. If you sell the timber, you sell it to the wood processing company (sawmill, furniture workshop, veneer company etc) or to a timber merchant?
8. If you sell the timber, can you write the price per cubic meter according to tree species and assortments?
9. If you want to increase the timber production which restraints you need to get over (seedling shortage, price of seedlings, tree species composition etc.)?
10. Do you use wood for your handicraft production (tools, dishes, arts, small cabinetry, etc.) If yes where you get the wood, from your farm or you buy it? How much wood do you spent per year for this purpose?
11. Are you aware that planting of the timber tree species needs time (the fast growing tree species 10- 15 years but the most valuable and high priced timber at least 60 years)

Date :

Thank you for your cooperation