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AGRICULTURE AND AGROFORESTRY

THE STUDY
ON
CRITICAL LAND
AND
PROTECTION FOREST REHABILITATION
AT TONDANO WATERSHEHD
IN
THE REPUBLIC OF INDONESIA

Volume III

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AGRICULTURE AND AGROFORESTRY

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AGRICULTURE AND AGROFORESTRY

CHAPTER 1 INTRODUCTION

This appendix presents firstly the agricultural background, present condition of agricultural and agfroforestry, current problems of agricultural activities. Based on the analysis of present condition of agriculture and agroforestry, and current problems of agriculture, and referring newly issued five years national development plan called as "PROPENAS (National Development Programme 2000-2004", improvement plan for agriculture and agroforestry improvement is presented.

Economic and agricultural background, especially in GRDP and labour force, and national policy of agriculture are generally stated in Chapter 2. The importance of agriculture sector in the Study Area is stressed in this Chapter. Since agroforestry system is recently recognized as an important area for crop production, soil conservation, education and training in agroforestry lags far behind other agricultural disciplines, leaving a definite shortage of experienced and qualified specialist. Scientific basis of agroforestry is also presented in Chapter 2.

In Chapter 3, the results of master plan study are presented. Present condition of agriculture, including crop production, animal husbandry and fishery, and agroforestry system in the Study Area, is stated. Agroforestry system in the Study Area is categorized into three, and is classified into 10 types of agroforestry system. At the same time, each type of agroforestry system is also evaluated with view point of soil conservation and productivity. Based on the analysis of above-mentioned facts, improvement plan of agriculture and agroforestry is proposed in Chapter 3.

In Chapter 4, the results of feasibility study of Intensive Area are presented. Present condition of agriculture in the Intensive Area, including crop production, animal husbandry and fishery, and forestry, is stated in this Chapter. Based on the analysis of present condition of agriculture and agroforestry, agriculture and agroforestry improvement plan is proposed. Improvement plan stressed the proper land use, improvement of agroforestry system, cultural practices, including cropping pattern, by strengthening agricultural extension activity. It is also stated that the farm income could be increased by improving agroforestry system and cultural practices of crops.

CHAPTER 2 GENERAL BACKGROUND

2.1 Economic Background

The Gross Regional Domestic Product (GRDP) of North Sulawesi has increased from Rp. 2,800 billion to Rp 3,770 billion during 1993 to 1997 at 1993 constant market price. The growth rate of GRDP is 8.4% in 1995, 9.3% in 1996 and 5.4% in 1997 (Table G 2.1). In 1998 it has sharply decreased due to economic crisis as shown below. In 1997, GRDP of North Sulawesi has contributed to 1% of whole Indonesia GDP, while the population of North Sulawesi has occupied 1.35% of whole Indonesia population.

GRDP of North Sulawesi Province at 1993 Constant Market

GRDP(Rp. Billion)				Growth Rate of GRDP (%)			
1995	1996	1997	1998	1995	1996	1997	1998
3,270	35,80	3,770	3,680	8.41	9.26	5.38	-2.4

Source: Dalam Angka 1998 Prov. Sulawesi Utara

Therefore, GRDP per capita of North Sulawsi is less than average GRDP per capita of whole Indonesia.

The GRDP of Minahasa District has increased from Rp. 850 billion to Rp.1,150 billion during 1993 to 1997 at 1993 constant price. The growth rate of GRDP is 9.4% in 1995, 15.0% in 1996 and 6.1 in 1997 (Table G.2.2). In 1998 it has sharply decreased to 1.9% due to economic crisis as shown below.

GRDP of Minahasa District at 1993 Constant Market Price

GRDP(Rp. Billion)			Growth Rate of GRDP (%)		
1995	1996	1997	1995	1996	1997
943	1,085	1,151	9.39	14.98	6.08

Source: Dalam Angka 1998 Kab. Minahasa

The GRDP per capita of Minahasa District has increased from Rp. 1,140 thousand to Rp.1,640 thousand at 1993 constant market price during 1993 to 1998. The growth rate of GRDP per capita is 6.7% in 1994, 9.1% in 1995, 14.7% in 1996, and it sharply decreased to 5.9% in 1997 and 1.9% in 1998 due to economic crisis.

2.2 Agricultural Background

The Government of Indonesia issued new five years national development plan called as “PROPENAS (National Development Programme) 2000-2004” replaced to former plan (REPELITA) in 2000. This plan prepared based on GBHN (National Fundamental Principle) and includes major development policies for the agriculture sector.

In this programme, it is declared that, in future, the development for agriculture and foods aims the leveling up productivity of small households, overcoming of poverty and putting high additional value on agricultural commodities through the connection with other sectors. The programme includes sub-sector programmes of agri-business development, stable food supply and water resource development and utilization.

Agriculture has been a significant sector in the North Sulawesi Province and in Minahasa District. Agriculture's share of GRDP accounts 34% of total GRDP in Minahasa District. Agriculture is the largest employ sector in Minahasa District, providing 54% of total employment as shown below.

GRDP and Employment by Industrial Sectors in Minahasa District (1997)

	GRDP (Rp. Bil)	GRDP (%)	Labour (No)	Labour (%)
Agriculture	394	34	161650	54
Mining and Quarrying	99	9	4,760	2
Industry	95	8	12,160	4
Electricity and water	10	1	720	0
Construction	160	14	13,580	5
Trade, Hotel and Restaurant	107	9	34,760	12
Transport and communication	94	8	18,810	6
Financial Service	40	3	990	0
Service	154	13	53,550	18
Total	1,151	100	300,980	100

Source: Dalam Angka 1998, Kab. Minahasa

GRDP by sub-sector of agriculture is shown below. Major sub-sectors are food crop and estate crop sub-sector, and they occupy some 80% of GRDP of agriculture sector. The growth rate of GRDP is the highest for fishery.

GRDP by Sub-sector

	GRDP (Rp.Million)			Growth Rate of GRDP (%)		
	1995	1996	1997	1995	1996	1997
Agriculture	356,920	375,230	394,450	6.98	5.13	5.12
Food Crop	139,820	144,460	146,560	5.45	3.32	1.45
Estate Crop	150,180	155,940	164,720	8.54	3.80	5.63
Livestock	30,860	33,990	34,420	13.50	10.15	1.28
Forestry	670	920	940	11.79	37.00	2.28
Fishery	35,390	39,920	47,810	4.12	12.80	19.76

Source: Dalam Angka 1998, Kab. Minahasa

2.3 Scientific Basis of Agroforestry

(1) Definition of Agroforestry

Since there have been a many specialist under different field concerning on agroforestry, their concept of agroforestry varied widely. There was a surge of enthusiasm to define agroforestry. As time passed, the definition proposed by the International Council for Research in Agroforestry (ICRAF) gained wide acceptance: "Agroforestry is a collective name for land-use system and technologies where woody

perennials are deliberately used on the same land management unts as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components". The definition of agroforestry proposed by ICRAF is also accepted in Indonesia.

(2) Effect of Agroforestry system on soil and biomass production

It is now widely believed that agroforestry holds considerable potential as a major land-management alternative for conserving the soil and maintaining soil productivity in the tropics. Farmers have known that they can get a good return by cultivating crops in forest clearance area and the return is decreasing year by year by continuous crop cultivation. One of the reasons of decline of the crop yield could be due to degradation of soil fertility by improper farming practices.

A forest ecosystem, unlike agricultural ecosystem, is closed system in terms of nutrient transfer. Under a forest ecosystem, soil fertility could be restored, while agricultural system could degrade soil fertility, if improper farming practices and soil conservation. The conversion of natural ecosystem to agricultural systems leads to decline in soil fertility, unless appropriate farming practices could be applied. These suggest that there is a big difference in the effect on soils between of tree ecosystem and of agricultural ecosystems. Following table shows that there is a big difference in the soil fertility of soil between in forest area and in the area which has long time been kept as grass land after clearance.

Soil Characteristics after Deforestation

	Depth (cm)	Clay (%)	Texture	pH	Organic matter (mg/kg)	Total-N (mg/kg)	CEC (me/kg)	Exch. Base (me/kg)
Grass land	0-8	15.8	LiC	4.4	15.7	0.7	64.2	8.1
	8-25	20.7	LiC	4.4	6.9	0.4	73.0	4.7
	25-58	36.3	LiC	4.4	6.9	0.5	97.7	9.2
Forest	0-11	31.0	LiC	4.6	29.4	1.57	136.6	7.1
	11-30	35.0	LiC	4.7	11.2	0.7	110.2	4.8
	30-60	40.5	LiC	4.8	10.7	0.7	121.8	5.0

Source Miyake 1985

This table suggests that forest protects soils from erosion, there is a big difference in clay content of surface soils between two soils.

The rates of soil erosion under agroforestry and other tree-based systems have been review by Wiersum (1986). Recorded erosion rates under agroforestry and other systems are shown below：

Soil Erosion under Different Land Use

	Erosion (t/ha/yr)		
	Minimum	Medium	Maximum
Multistorey Garden	0.01	0.06	0.14
Natural rain forest	0.03	0.30	6.16
Shifting cultivation fallow period	0.05	0.15	7.40
Forest cultivation, undisturbed	0.02	0.58	6.2
Tree crops with cover crops	0.10	0.75	5.60
Shifting cultivation fallow period	0.40	2.78	70.05
Taungya system cultivated period	0.63	5.23	17.37
Tree crops, clean weeded	1.20	47.60	182.90
Forest plantation, litter removed or burned	5.92	53.4	104.80

Source: Wiersum (1986)

Taking low rates of erosion as less than 2 ton/ha/year, moderate rate as 2-10ton/ha/year, and high rates as over 10 ton/ha/year, these systems can be grouped as follows:

Low : Natural rain forest, fallow in shifting cultivation, multistorey tree gardens, forest plantations (undisturbed), tree plantations with cover crops and/or mulch

Moderate: Cropping period of shifting cultivation, forest plantations (litter removed or burned), Taungya system cultivated period, tree crops (clean weeded).

This indicates that management practices, rather than particular types of land use, are more important in minimizing erosion potential. It is clear that maintaining a surface cover by plant litter, which is possible in most agroforestry systems, is the most effective way of reducing erosion.

Nitrogen-fixing trees are among the most promising components of agroforestry systems. Because of their ability to fix atomospheric nitrogen and contribute nitrogen to soil through leaf litter and the turnover/ decomposition of root debris and nodules, they have dominant role to play in maintaining soil fertility in agroforestry system. Kang et al reported that by employing nitrogen-fixing trees for agroforestry system, soil organic matter and nutrient status could be maintained as shown in below.

Effect of alley cropping on soil characteristics

Treatment (kg-N/ha)	Leuceana prunings	PH-H_2O	Organic C (mg/kg)	Exchangeable cation (m mol/kg) K	Mg	Ca
0	removed	6.0	6.5	0.19	2.90	0.35
0	removed	6.0	10.7	0.28	3.45	0.50
80	retained	5.8	11.9	0.26	2.80	0.45
LSD (0.05)		0.2	1.4	0.05	0.55	0.11

Source Kang et al Advance in Agron. 43

By continuous addition of *Leuceana* prunings, higher soil organic matter and nutrient status were maintained than when no prunings added.

There are some beneficial effects and adverse effect tree based systems, particularly

agroforestry. The effects of trees (agroforestry systems) on the soils are compiled based on Sanches and Young's review as shown below.

Effect of trees/tree crops on soil

Beneficial effect
a. Maintenance or increase of soil organic matter
b. Nitrogen fixation (Leguminosae tree)
c. Atomospheric input
d. Protection from soil erosion
e. Nutrient retrieval
f. Maintenance or improvement of physical properties
g. Modification of extremes of temperature
Adverse effect
a. Loss of organic matter and nutrient in tree harvest
b. Nutrient competition between trees and crops
c. Moisture competition between trees and crops
d. Production of germination and growth inhibitor

Source: Sanches (1987) and Young (1989)

How a plant influences its neighbours, and to what extent this influence is beneficial or detrimental, is a central issue in analyzing plant interactions in mixed crop communities. The interaction between neibouring plants is often described as competitive. Managing a mixed plant community effectively depends upon understanding the process involved and using designs and mixtures that will minimize competition, prevent unfavourable biological interference and exploit beneficial interactions. There is now a large amount of research data on the ecology of inter-cropping annuals, but few detailed studies have been conducted on plant interactions in communities consisting partly of woody perennials. The perennial usually has a greater and more long-lasting effect on the environment, and this adversely affects the performance of the annual. According to the competitive production principle, a mixture becomes successful only when both components can exploit available resources more efficiently when grown together than when grown in monocultural situations. The facilitative production principle may also come into play, that is, the environment of one species (the annual) is modified by the presence of a second species (the perennial) in such a way to facilitate the growth of the first species. Often, these principles operate simultaneously and inseparably.

It is common knowledge that the rate of photosynthesis depends on the intensity of solar radiation, the rate being rapid at lower intensities and slow at higher intensities. However, plants vary considerably in their response to light intensities in terms of growth rate and competitive ability. The components of a mixed plant community sharing light and solar radiation is a key factor in managing above-ground interactions in agroforestry.

Some of the available light and solar radiation is intercepted by the top layer of leaves of the overstorey species, while the rest of it is available to the understorey species. The curve of net photosynthesis saturates at 20 to 40 percent of full sunlight, and therefore a larger part of leaves of understorey species receiving more than this intensity should operate at full capacity. Therefore, theoretically mixed plant communities should have a better photosynthetic efficiency (biomass production) than monocultural stand.

In the mixed plant communities, key factor in below-ground interaction is the structure and efficiency of the root systems of individual components, which determine the uptake of and competition for nutrient and moisture. The root biomass of trees is usually 20-30% of total plant biomass, although it may vary from 15% to 50% of the total by influence of environmental conditions. In general, rooting densities of trees are lower than those of cereals and herbaceous legumes. The rooting density and distribution of particular plant depends on various site-related factors. Combining trees and crops increases rooting densities and reduces inter-root distances, which increases the likelihood inter-plant competition. One of the most important aspects of rhyzosphere interaction in agroforestry is competition for water and nutrient uptake. To avoid or minimize the effects of competition, rooting pattern of trees and crops should differ in terms of structure and depth.

Likewise, above-ground litter fall and below-ground turnover both serve to improve soil organic matter, this function of root turnover continues even when above-ground biomass is removed. The contribution of root to soil organic matter and soil fertility has received little serious attention. The ability of the root system to improve soil organic matter even where all above-ground biomass is removed, is a crucial factors. Ewel et al (1982) presented following data, by comparing root biomass with leaf biomass (not total above ground biomass) for a range of land use system in Costa Rica.

Biomass Distribution of Crops grown under Different Ecosystem

Unit: kg/ha

	Agricultural System			Forestry System		Agroforestry System			
	Young maize	Matured maize	Sweet potatoes	Gmelina plantation	Secondary Forest	Coffee Erithrina	Cocoa Cordia	Tree Garden	Planted fallow
Leaf biomass	330	1,000	1,070	3,120	3,070	2,720	2,040	2,450	2,480
Root biomass	390	1,150	410	1,280	2,170	2,350	2,720	3,070	4,220
Root/Leaf	1.18	1.15	0.38	0.41	0.71	0.86	1.33	1.25	1.70

Source: Ewel et al 1982 Agroecosyst

These data also show that root biomass in agroforestry systems is substantially higher than in other land use systems. The key making the best use for below-ground interaction in agroforestry lies in maximizing their positive effects and reducing tree-

crop competition.

(3) Economic Consideration

Economists argue that economic considerations will be the prime factor in deciding the usefulness of agroforestry system to the land user. Obviously traditional agroforestry systems have proved economically beneficial to the communities that have developed them. In other words, they have passed the 'economic' test. However, the land use problems facing tropical countries are such that not only must new agroforestry technologies pass this test, but also that the test itself must be more rigorous.

There are two major difficulties in realistically assessing the economic advantages of agroforestry systems. First, more attention has been paid to the particular problems which gave rise to various tree-based practices than to the practices themselves. Thus, we tend to be more concerned with developing new or improved land-use practices to cope with such issues as fuel wood shortages, than with increasing our understanding of the economic contributions of such practices. Second, as a result of this approach, only a few systems or practices have been subjected to this kind of economic evaluation. Even when such evaluations are done, most of them are carried out before the implementation of project, rather than after the project has produced field data.

Any objective assessment of agroforestry's impact on the farmer must examine both economic benefits and the costs. The analyses by Arnold (1987) of the positive and negative economic features of agroforestry are particularly relevant here.

Benefit and opportunity	Cost and constraints
Maintains or increases site productivity through nutrient recycling and soil protection, at low capital and labour cost Increases the value of output from given area of land through spatial or temporal inter-cropping of trees and tree crops Diversifies the range of output from a unit area, in order o increase self sufficiency, and/or reduce risk to income from adverse climatic, biological or market impacts on particular crops Spread the needs for labour inputs more evenly through the year, so reducing the effects of sharp peaks and though in activity, characteristic of tropical agriculture Provides productive applications for under-utilized land, labour or capital Creates capital socks available to meet intermittent costs or unforseen contingencies	Reduce output of annual crops where trees compete for arable land and/or depress crop yields through shade, root competition or allelopathic interactions Incompatibility of trees with agricultural practices such as free grazing burning, common cultivated field, etc., which make it difficulty to protect to trees Trees can impede cultivation of monocrops and introduction of mechanization, and thus increase labour cost and/or inhibit advance farming practices Where the planting seasons is very restricted, for example aid and semi-arid conditions, demands on available labour for crop establishment may prevent tree planting The relatively long production of trees delay returns beyond what may be tenable for poor farmers, and increases the risk to them associated with security of tenure

Source: Arnold (1987)

The methods of carrying out such analysis have been reviewed by a number of experts. Hockstra (1985, 1990) provides a detailed examination of the issues or obstacles that economists encounter, as well as the options that are available to them, in the appraisal of agroforestry project.

(4) Socio-cultural considerations

The social acceptability of agroforestry is influenced by biophysical, socio-economic and cultural factors. In recent analysis of this issue, Hoskins (1987) highlighted several factors, which must be considered, if new agroforestrty practices are to be adopted by farmers. Foremost among these are land tenure, labour availability and the marketability of tree products. In addition, the way in which agroforestry technologies are transferred to farmers must be adapted to suit the particular social contexts within which these farmers live.

1) Land tenure

There is less likelihood that long term agricultural strategies will be adopted in the areas where land tenure systems do not guarantee continued ownership and control of land. The incentives for investing in soil fertility improvement for future use of the land is low unless the benefit accrue to the tree planter.

Rights over land are often distinct from rights over trees. Tree tenure issues include the right to own or inherit trees, the right to plant trees, the right to use trees and tree products and the right to dispose of tree products. These various rights differ widely across cultural zones and have a major influence on the social acceptability of agroforestry initiatives.

Social acceptability is also closely linked with the economic feasibility of the system. Although prospects were high for the integration of tree planting into traditional farming system, social acceptability relied heavily on cost-sharing devices between government and rural farmers, the availability of an active extension service and the potential of some direct economic output from the trees in the system.

2) Labour requirement

Almost all agroforestry innovations demand changes in labour patterns, and labour requirement is always a factor which rural people take into consideration when deciding whether or not to adopt a new practice. Farm families have developed labour strategies based on using the inputs of most members of the family at various times of the year for different tasks. Obviously, additional

labour for persons already fully occupied at peak labour seasons is considered more costly than additional demands during a slack season. For example, alley cropping is a labour intensive practice and the costs of production increase considerably if additional labour has to be hired. Although these additional costs will be offset by increased benefits, the immediate need for additional labour could be a disincentive to the adoption of the practice.

In densely populated areas where labour is assumed to be in abundant supply, there area distinct labour peaks that coincide with the sowing and harvesting seasons of principal crops. Agroforestry systems could have the advantage of helping to spread the use of labour supplied by member a farming family more evenly through out the year. Labour intensity is one of main deciding factors in moving from traditional shifting cultivation practices to intensive agroforestry systems.

3) Marketability

Direct and immediate income from a land use system is a central issue in determining the social acceptability of that system. The processing and/or sale of agricultural commodities, and the rural industries based on these commodities, are essential sources of off-farm income for many farming societies. The major constraints affecting the viability of such enterprises are poor access to markets and raw materials and inadequate organizational management skills. An effective rural development through agroforestry is possible if policies supporting the establishment of appropriate market infrastructures and the development of the necessary skills are implemented.

4) Social Context

The best measure of the social success of new or improved technologies is the readiness with which farmers accept them. If innovation do not take account of the social context in which small holders operate, then the potential of such innovations will not be realized. If the extension effort used to transfer the technology in the first project had been modified to take account not only of the different agro-ecological conditions but also of the different social patterns, a higher rate of adoption might have been achieved. With minimum but suitably modified extension efforts, farmers willingly accepted new system.

There is now a considerable amount of information on the design of agroforestry practices to suit particular farming conditions and particular social and political contexts. The next crucial step is to collate this information and incorporate it

into the training of those responsible for transferring new or improved agroforestry practices. This involves developing technology-testing methods which can be easily understood and used by farmers in their own environments, and emphasizing the need for strong links between the technology transfer agent and the farmers so as to ensure effective feedback from the farmers to the researchers.

As new agroforestry techniques move into farmers' fields, overall development issues will also become increasingly important, and the need for in-depth analyses of these issues will become more apparent. Policies need to be designed which support agroforestry as an integral part of better land use planning and which strengthen small holders' access to new techniques. This applies not only the wastelands and denuded hillsides created by defective land use practices, but also to the prime lands that are soon likely to become wastelands if farmers continue to use poorly designed monocultural production systems.

CHAPTER 3 MASTER PLAN STUDY FOR THE STUDY AREA

3.1 Present Condition of Agriculture and Agroforestry

3.1.1 Land Holding Size and Land Tenure

Based on the statistics of farm area and number of farm household by related Sub-district, an average land holding size is estimated at 1.26 ha, composed of 0.15 ha of lowland, 0.57 ha of arable upland and 0.54 ha of estate land. The largest is 3.24 ha of Airmadidi Sub-district, followed by 1.77 ha of Kauditan Sub-district, with relatively large estate land, while the smallest is 0.67 ha of Tompaso Sub-district, followed by 0.69 ha of Sub-district Tomohon as shown in Table G.3.1 and summarized below.

Average Farm Size in Related Sub-district

Farm Size per household (ha)			
Lowland	Upland	Estate	Total
0.15	0.57	0.54	1.26

Source: BPS Povinsi Sulawesi Utara 1999

The result of farmers' interview survey carried out at 5 villages by the Study Team shows that average farm size is about 1.4 ha, ranging from 1.2 ha to 1.6 ha. Out of this average farm size, 64% is own land, 19% is hired and 17% is the agricultural land cultivated jointly by some persons (Tomoyo land). Details are shown in Table G.3.2 and Attachment G. I.

3.1.2 Agricultural Land Use

Agricultural land in the Study Area is topographically classified into two. One is flat area and the other is undulating and sloped area. The former is mainly distributed at the northern and southern part of the lakeside, and mainly used for paddy, palawija and vegetable cultivation. The latter is distributed in the whole study area and mainly used for tree crops cultivation and inter-cropping of annual crops with tree crops..

On the basis of the land use survey, the land use of agricultural land in the Study Area is shown in Table G.3.3 and summarized below.

Agricultural Land Use in the Study Area

unit: ha

District		Lowland Field	Upland	Mixed Area*	Estate	Others**	Forest	Total	Share
Minahasa	Area	5,973	5,237	6,935	21,361	121	4,261	43,887	95.0
	Share(%)	13.6	11.9	15.8	48.7	0.3	9.7	100.0	
Manado	Area	21	0	745	1,558	0	0	2,3,24	5.0
	Share(%)	0.9	0.0	32.1	67.0	0.0	0.0	100.0	
Total Area	Area	5,994	5,237	7,680	22,919	121	4,261	46,211	100.0
	Share(%)	13.0	11.3	16.6	49.6	0.3	9.2	100.0	

** Mixture of Upland and Estate* *** Pasture and Fish pond*

Some 95% of the Study Area belongs to Minahasa District. About 50% of the total agricultural land is used for estate crop. Larger part of estate crop area is distributed on undulated or hilly area and mountain foot, especially dominant in northern Sub-district Airmadidi and Pineleng. Upland and mixture area (mixture of upland and estate land) accounts for 28% of total. In the estate crop area and mixture area, several types of agroforestry systems have been practiced as mentioned later. Larger part of upland area is located around the Lake Tondano. The other upland area is scattered among the estate area. Both types of the land use system are much mixed or overlapped each other. Paddy field occupies 13% of total agricultural land and mainly located around Lake Tondano, especially Sub-district Langowan, Kakas, Tondano and Tooulimambot. Forest area remains only 9.2%, most of which is observed in Sub-district Airmadidi, Langowan and Tondano.

3.1.3 Crop Cultivation

The harvested area of major crops in the Study Area are estimated as follows:

Harvested Area of Major Crops in the Study Area (1998)

Unit: ha

Sub-district	Paddy	Palawija	Vegetables	Fruits	Estate Crops	Total
Langowan	1,400	887	165	30	581	3,063
Kakas	2,110	889	75	1	890	3,962
Tompaso	1,028	2,228	131	3	211	3,601
Remboken	604	1,597	123	5	235	2564
Tomohon	49	108	140	8	94	399
Tondano	1,926	2,833	113	20	393	5,285
Touliambot	2,310	2,831	222	2	674	6,039
Eris	344	285	25	1	382	1,037
Kauditan	454	267	20	13	2,138	2,892
Airmaditi	364	1,107	37	20	9883	11,411
Pineleng	74	976	46	21	4,133	5,250
Total	10,663	14,005	1,097	124	19,614	45,503
Share (%)	23.4	30.8	2.4	0.3	43.1	100.0

Source: Laporan Tahunan Dinas Pertanian Tanaman Pangan, Kab. Minahasa 1999

Estate crops occupy the biggest area (43%), followed by palawija and paddy. Major estate crops are coconut, clove and coffee. Coconut is mainly cultivated in the northern part of the Study Area, and clove is popular in central and eastern part of the area (north and east sides of Lake Tondano). Coffee is planted mainly in Tondano and Remboken Sub-districts.

There are two variety group of coconut in Minahasa District. One is traditional tall type and the other is hybrid coconut. Tall coconut varieties are Dalam Tenga and Dalam Mangpat. Hybrid variety includes PB121, Khina 1, 2 and 3. Leading variety of coconut in the Study Area is Dalam Mangpat.

Dominant variety of clove in the Study Area is Zanzibar which is originated in Maluku islands and re-imported from Zanzibar in East Africa. During the period from 1993 to 1998, Clove Management Agency (BPPC, Badan Penyangga Pengelolaan Tanaman Cengkeh) controlled price at low level ($ 0.6-1.5 /kg), while the price of clove was at $ 6-12 /kg during the period from 1977 to 1983. And farmers were forced to sell their commodities only to Cooperative (KUD). Most of clove farmers disappointed and idled maintenance of clove gardens. Considerable clove gardens had converted to other crops because of serious price declining. After late 1998, price of clove has been released from government control and has been governed by market. Since 1999 farmers start to renew old clove garden and maintain carefully.

Out of palawija, maize is predominant and the rests are ground nuts, cassava, sweet potatoes, etc. Palawija are mainly planted at the flat to gentle sloped area or mountain foot, and sometimes maize is also inter-cropped with coconut or clove under agroforestry system. Generally it is said that about 15% out of estate crop garden is inter-cropped with annual crops in Indonesia, however this rate is estimated at 30-40% in Minahasa District.

The harvested area and production of food crops in the Study Area are shown in Table G.3.4 and summarized below.

Harvested Area of Food Crops in the Study Area (1998)

Unit: ha

Lowland paddy	Upland paddy	Maize	Cassava	Sweet potatoes	Ground nuts	Green grams	Soya beans	Total
9,946	53	13,387	69	46	213	0	12	23,726

Source: Laporan Tahunan, Dinas Pertanian Tanaman Pangan Kab. Minahasa

Production of Food Crops in the Study Area (1998)

Unit: tons

Lowland paddy	Upland paddy	Maize	Cassava	Sweet potatoes	Ground nuts	Green grams	Soya beans
47,477	191	35,946	1,059	263	227	1	13

Source: Laporan Tahunan, Dinas Pertanian Tanaman Pangan Kab. Minahasa

The major food crops are maize and paddy. Maize occupied 97% of total palawija area. In Minahasa District, maize is cultivated through the year with no distinct cropping season. Harvesting time of maize is as follows; 22% of total area from January to April, 29% from May to August and 49% from September to December. Major varieties of maize are Manado Kuning (58%), Kalingga (27%) and Hibrida (14%).

In Minahasa District, the double cropping of paddy cultivation has been carried out in 60% of total paddy field. Main varieties of paddy plant are IR64 (24%), Citanduy (19%), Kelara (8%) and Maros (5%). There are no distinct cropping season of paddy

cultivation, and harvesting time of paddy is as follows; 21% of total during the period from January to April, 42% from May to August and 37% from September to December.

Yield of major food crops is as follows:

Yield of Food Crops in the Study Area (1998)

Unit: kg/ha

	Lowland paddy	Upland paddy	Maize	Cassava	Sweet potatoes	Ground nuts	Green grams	Soya beans
Study Area	4,984	3,604	2,725	16,771	6,575	1,082	1,824	1,058
North Sulawesi	4,242	1,973	2,159	9,900	8,600	1,107		1,162
Indonesia	4,415	2,192	2,624	12,200	9,600	1,064		1,198

Source: Laporan Tahunan, Dinas Pertanian Tanaman Pangan Kab. Minahasa

Yield of food crops in the Study Area is relatively high comparing with the average yield of North Sulawesi Province and Indonesia. It is probably owing to favorable precipitation, relatively fertile soil and less meteorological disasters, despite of relatively high rate of diseases. However the yield of palawija planting under the tree or tree crops is comparatively low due to its unfavorable conditions. Generally the amount of fertilizer application is low compared with the recommendations (N: 70 %, P: 50 % K: 10 %) and chemical control of pest is not sufficient. Mechanization of farming lags behind.

Major estate crops are coconut and clove. The yield of coconut is a slightly higher comparing to average yield of Indonesia. However there are many of old trees, which productivity is lower compared with matured trees in the area, and now is refreshing time of coconut garden. The yield of clove has been declined recently due to poor crop husbandry because of decrease of market price of commodities. Harvested area, production and yield of estate crops in the Study Area is shown in Table G.3.5 and summarized below:

Production of Estate Crops in the Study Area (1998)

	Coconut	Clove	Coffee	Vanilla	Nutmeg	Cocoa
Area (ha)	14,270	4,180	580	320	160	110
No. of trees	1,919,400	857,000	582,200	650,200	32,000	109,400
Productive trees	1,882,100	839,600	525,450	584,800	27,100	81,900
Production (tons)	16,690	590	550	200	na	30
Yield (tons/ha)	1.17	0.14	0.95	0.64		0.24

Source: Dinas Perkabunan Kab. Minahasa 1999

Plant density of trees, under monoculture, is about 135 for coconut, 200 for clove and nutmeg, 1,000 for coffee and cocoa, and 2,000 for vanilla. These plant densities are almost same as recommendation. However, the plant density of tree crops varies with employed agroforestry system.

To improve the present condition of estate crops, the District Office of Estate Crop Service has promoted the replantation, rehabilitation and diversification of existing estate gardens, and supported farmers to make post harvest and marketing system effective and efficient.

Although total vegetable area amounts only 2.4% of total agricultural land in the Study Area, relatively large vegetable areas are observed especially near the town. Main vegetables are red shallot, leaf onion, chili, tomato, cabbage, Chinese cabbage and carrot.

In spite of fruits area being only 0.3% of total, there are various species of fruits, such as pineapple, banana, mango, papaya, langsat, rambutan, avocado, durian, mangostin etc. Fruit trees are planted mainly in home garden around the residential area except banana which is scattered all over the hilly and mountainous area. Main fruit area is observed in Airmadidi District along the Manado – Bitung road. No sericulture is observed in this area.

3.1.4 Agroforestry System

(1) Agroforestry system in Indonesia

There are developed three major types of agroforestry system in Indonesia, "*Tumpansgari*, "*Pekarangan*" and shifting cultivation. *Tumpansgari* is as same as Taungya system which combines stand of woody and agricultural species (herbaceous) during the early stage of establishment of plantations. This system had been introduced to Indonesia in 1850's from Burma and improved for a long time. The present system had been established in 1920's. *Tumpansgari* system is employed for establishing Teak *(Tetona grandis Linn. F.)* and fast grow trees such as Merkusii pine *(Pinus merkusii Jungh et De Vr)* plantation. During the early stage of establishment of plantation, upland paddy and maize are mainly inter-cropped, sometimes, cassava, Irish potato and vegetables are also inter-cropped.

The *Pekarangan* system originates in a homegarden. This system is a multi-storied cropping system associated with settlements. The varieties of species applied are plenty. The higher canopy is composed of coconuts and fruit trees, and the middle and lower canopies of coffee, cocoa, vanilla and herbaceous crops. Its original form is found in Central Java. In the home garden, lots of species of fruit trees, estate crops, multi-purpose trees and herbaceous crops are planted at a high plant density. The *Pekarangan* system has many types depending on different combination of species.

Now, there are many types of agroforestry system originated from the *Pekarangan* applied in Indonesia. These are multi-layer tree garden, plantation crop combinations

with shade trees and/or hedge trees, inter-cropping system of herbaceous crop with woody trees and tree crops, and hedgerow cultivation. Table G.3.6 shows the major trees and crops introduced for agoroforestry in Indonesia.

(2) Type of Existing Agroforestry System

As mentioned in Sub-section 3.1.3, Total agricultural land accounts for the Study Area consisting of estate garden, arable upland, mixture of estate and arable upland, lowland and the other category.

The harvested area of major crops in the Study Area is some 45,500 ha as described in Sub-section 3.1.3. The estate crops area accounts for 43% of total harvested area, but these are mostly mixed with herbaceous crops or other tree crops, and mono-culture of estate crop area is very limited. Many trees, tree crops and fruit trees are observed in upland field. It means that agroforestry system has been already introduced in the larger parts of the Study Area. It could be supposed that there had been serious soil erosion problem at few decades before and this problems might put spurs to incorporation of agroforestry system into the Study Area.

There have found five categories of agricultural land use system (farming system) in the Study Area. They are tree crop dominant agroforestry system (AGF-I), herbaceous crop dominant agroforestry system (AGF-II), inter-cropping system of herbaceous crops with tree crops (no dominant species (AGF-III), upland herbaceous crop farming (trees and tree crops area are less than 5% of total farm area, UF) and lowland farming (LF). The each category of agroforestry system in the Study Area could be classified into ten types according to the crops and plant density of each crop planted in the identical field as shown in the following table.

Type of Existing Agroforestry in the Study Area

Type	Woody perennials					Herbaceous crops
	Woody tree	Estate crops			Fruit tree	
		Coconut	Clove	Others		
AGF-I I-1	△	◎	△	X	△	△
AGF-I I-2	△	△	◎	X	△	△
AGF-I I-3	○	◎	○	X	○	△
AGF-I I-4	○	○	◎	X	X	△
AGF-I I-5	○	○	○	◎	X	○
AGF-I I-6	○	○	○	○	○	○
AGF-II II-1	△	○	△	X	△	◎
AGF-II II-2	△	△	○	X	△	◎
AGF-III III-1	△	◎	X	X	△	◎
AGF-III III-2	△	X	◎	X	△	◎

Note: Others include coffee, cocoa and vannila
◎ : Pre-dominant, ○: Dominant, △:Frequent, X: neglesible

The type of agroforestry system varies area by area. The distribution of each type of

agroforestry system in the Study Area is shown in Figure G.3.1 and Tables G.3.7 and G.3.8.

1) Tree Crop Dominant Agroforestry System

One Estate Crop Dominant Agroforestry System (AGF-I Type I-1, -2)

Estate crops dominant agroforestry system is mainly distributed in the northern part of the Study Area and the eastern side of Lake Tondano. In the estate crop dominant area, coconut is dominant in the northern area, northern part of Airmadidi Sub-district and Pineleng Sub-district, and clove vegetation increases with down to south, and it becomes dominant at the southern part of Airmadidi Sub-district.

2) Tree (woody trees and Tree Crops) Dominant Agroforestry System (AGF-I Types I-3, -4, -5, -6)

The tree crop dominant agroforestry system is divided into multi-storeies tree complex and upland annual crops being cultivated in the small area under tree crops and fruit trees. The multistorey tree complex is combination of tall trees medium height and short trees. There are two types of multistorey tree complex; one is well managed one (AGF-I Types I-5, -6) which area is now still small and distributed on gentle slope area of Airmadidi, Tompaso, Remboken, Tondano and Langowan. The other is poorly managed one (AGF-I Types I-3, -4), which is mainly distributed in steep slope area.

Under the second type of trees dominant agroforestry system, herbaceous crops are planted under the trees. In the old coconut garden, coconuts are planted randomly in 1950's to 1960's. An introduction of agroforestry system for these area, there are some difficulties for herbaceous cultivation, because of too small and irregular shaped area for herbaceous crops. The irregular shape of cropping area, irregular planting of coconuts and small space for herbaceous crops would interfere crop husbandry and lead to increase labour requirement for farming activities and also decreases the plant density. These causes uneven distribution of solar radiation. As a result, crop yield of herbaceous crop becomes low. Same phenomenon is observed in some clove garden.

Figure G.3.2. shows the prevailing agroforestry system in the Study Area, although it is low productive due to irregular planting and low crop husbandry. Under this system trees are planted randomly and the herbaceous crops are also planted irregularly. On the other hand, in the area where trees are regularly planted herbaceous crops is also planted regularly and the area is effectively utilized for herbaceous crops cultivation. It could be recommended that seedling

of coconut and clove should be transplanted regularly at the refreshing time.

(2) Herbaceous Crop Dominant Agroforestry (AGF-II Type II-1, -2)

Herbaceous crop dominant agroforestry system is mainly distributed in the south-eastern part of the Study Area. Under herbaceous crops dominant agroforestry system, many types of agroforestry system is observed. They are:

- planting of coconut or clove in farms of maize, pulses or vegetables;
- planting of trees, such as *cempaka*, fruit trees, such as mango banana and papaya, in maize or ground nuts field, with multipurpose tree such as *Gliricidia* as a hedgerow crops and
- hedgerow cropping using banana, cassava and *Gliricidia* as hedgerow crops.

In these case, plant density of trees is very low, and mainly these trees are planted at the border of the field or as hedgerow plants. Sometimes, they are observed old and non-productive trees in the field under extensive cultural practices. The herbaceous crop dominant agroforestry systems are mainly employed in the flat to gentle slope area.

(3) Non Dominant Crop Agroforestry System (AGF-III Type III-1, -2)

The third category of agroforestry systems is mixed cropping of herbaceous crop with coconut or clove. Under this system, coconut or clove is regularly planted at wide row considering the herbaceous crop cultivation (Figure G.3.3 and G.3.4). Under this system, herbaceous crops are intensively cultivated and the production of tree crops is comparable with monoculture. The plant density of these tree crops is similar to that of mono-cropping, only spacing is different. For example, under coconut mono-cropping, spacing is some 9 x 9 m (plant density at 125 nos. per ha) but under this system plant spacing becomes some 15 x 5 m (plant density at 130 per ha). Maize is cultivated between coconut row by row planting at the row-width at some 70 cm. According to Coconut Research Centre (BALITKA), a coconut yield of mixed cropping system is almost same as mono-culture, and planted area of maize occupies some 80% of field. Its production is estimated at 70% of that of mono-cropping. From these findings, it could be recommended that this system should be applied for flat and gentle sloped area .in the flat area and gentle slope area.

(4) Shifting Cultivation and Other Systems

According to the District Agriculture Service Office, shifting cultivation area is presently less than 50 ha in total. In the Study Area, it accounts for further small area.

There has been observed silvopastoral systems and agrosilvopastoral systems in very limited area.

3.1.5 Evaluation of Existing Agroforestry System

As above mentioned, there are ten types of agroforestry system in the area, the each system is characterized by the production of each category of crops, possibility of application of new cultural practices and resistance to soil erosion. Following table shows the characteristics of each type of agroforestry system.

Characteristics of Each Type of Agroforestry System

Type	Productivity					Resistance to Soil Erosion	Application of New Practice
	Trees	Estate	Fruit	Herbaceous	Evaluation		
I - 1	Negligible	High	Negligible	Negligible	Medium	Medium	Relatively Difficult
I - 2	Negligible	High	Negligible	Negligible	Medium	Medium	Relatively Easy
I - 3	Low	Medium	Negligible	Negligible	Low	High	Difficult
I - 4	Low	Medium	Negligible	Negligible	Low	High	Difficult
I - 5	Medium	High	Negligible	Negligible	High	High	Easy
I - 6	Medium	Medium	Medium	Medium	High	High	Relatively Easy
II - 1	Negligible	Low	Negligible	High	High	Medium	Easy
II - 2	Negligible	Low	Negligible	High	High	Medium	Easy
III - 1	Negligible	High	Negligible	Medium	High	Medium	Easy
III - 2	Negligible	High	Negligible	Medium	High	Medium	Easy

Productivity of AGF-I Types I - 5, - 6, AGF-II, Types II -1 and II - 2, AGF-III Types III-1 and III-2 is high, however, resistance to soil erosion of AGF-I Types I - 5, - 6, II -1 and II - 2, AGF-III Types III-1 and III-2 is not so high. On the other hand, the productivity of AGF-I Types I - 3 and - 4 is low, but the resistance to erosion is very high. The suitable type of agroforestry system varies place by place. The selection of suitable type of agroforestry system will be presented later.

The Office of Land Rehabilitation and Soil Conservation (BRLKT) is now promoting to employ agroforestry system for rehabilitation of forest and soil conservation, and established three demonstration plots in and around the Study Area (Palasten in Remboken District, Kayuuwi in Kwangkoan District and Rumoong Atas Tareran District). Coconut Research Institute (BALITKA) is also recommending coconut based agroforestry system in the flat to gentle slope area of Minahasa District, for increasing of agricultural income by effective use of land resources and soil conservation. It established demonstration plot close to Study Area (Molompa in Tombata District).

3.1.6 Animal Husbandry

Domestic animal population in Minahasa District in 1998 is shown in Table G.3.9 and summarized below:

Animal Population in Minahasa District (1998)

Cattle	Horse	Goat	Pig	Local Chicken	Duck
47,410	9,840	7,430	119,310	1,150,740	42,630

Source: Laporan Tahuman 1998/99 Dinas Peternakan

Reflected to local custom, population of pig is remarkably high in spite of sharp reduction by pig cholera in 1996. Most of cattle are used as draught animal for crop cultivation and considerable number of horses serve to transportation in town area. As shown in Table G.3.9, the trend of animal population in recent years shows a slightly increase for cattle, horse and chicken for meat, while even or slightly decrease for goat, local chicken and chicken for egg.

Livestock population in the related Sub-districts is shown in Table G.3.9. Population of each animal varies by Sub-district. Cattle are distributed almost evenly over the Area. Horse population is relatively high in the close to town areas. Sub-districts of Tomohon, Pineleng and Airmadidi are centers of pig raising. Poultry raising is popular in whole area, especially in Sub-districts of Kauditan, Tomohon and Langowan.

In Minahasa District in 1998, meat production is about 8,790 tons and egg production is about 1,990 tons, both of which show a decreasing tendency in recent few years as shown below.

Production of Meat and Eggs in Minahasa District

Unit: tons

	1994	1995	1996	1997	1998	Average
Meat	16,840	15,980	10,790	8,880	8,790	12,260
Eggs	2,480	2,940	2,570	2,350	1,990	2,470

Source: Laporan Tahuman 1998/99 Dinas Peternakan

Annual consumption of meat and eggs per capita is about 12 kg and 2 kg, respectively, in average and the consumption of meat per capita shows a decreasing tendency in a recent few years.

Annual Consumption of Meat and Eggs

Unit: kg/capita

	1994	1995	1996	1997	1998	Average
Meat	13.8	13.0	11.6	10.7	10.5	11.9
Eggs	1.4	1.6	2.9	2.7	1.9	2.1

Source: Laporan Tahuman 1998/99 Dinas Peternakan

According to GBHN Guidance in REPELITA VI in 1993, Livestock sector aims to achieve the following targets:

1) To increase production and productivity of livestock to reach self-sufficiency of protein,
2) To increase income derived from livestock and job opportunity, and to develop new fields,

3) To improve the food quality and nutrition of habitant with the diversification of food using animal products,
4) To develop the agri-business, and
5) To make the best exploit of natural resources for the intensification of livestock production with the consideration of environment conservation.

3.1.7 Inland Fishery

Fishery in the Study Area is carried out mainly in Lake Tondano. In addition, small scale fishery is also observed out at some reservoirs and rivers. Besides these, some types of fish cultivation are observed in small fishponds scattering at lowlands or valleys, parts of paddy fields, etc. In the related Sub-districts, the number of inland fishermen is about 1,000, and some 2,000 farmers run fishing as a side job. Recently the fish production by traditional method has decreased year by year because of over-fishing, over-catching of fry, overgrowing of aquatic-weeds (water hyacinth and other weeds), and water pollution caused by domestic waste. In addition, because of serious drought attacked the area, fish production by traditional fishing sharply decreased in 1998. Cage cultivation at lake-coast is gradually developping in stead of traditional method. Main fish species in Lake Tondano are carp, payangka, tilapia, gabus, gurame, mujair, etc.

Fish cultivation at small fishpond and paddy field has also declined in recent few years due to the increasing of production cost, reducing fish stock and serious drought in 1997 and 1998.

At present, inland fishery area and fish farm in related Sub-districts in 1998 are shown in Table G.3.10 and summarized below.

Inland Fishery and Cultured Area in Related Sub-districts (1998)

Fishery area (ha)			Fishery farm (ha)		
Lake	Reservoir	River	Fresh water	Paddy field	Brackish water
4,315	35	74	154	251	17

Source: Delam Angka 1998 Kab. Minahasa

Fish production in the Lake Tondano in recent years is as follows:

Fish Production in Lake Tondano

Unit:tons

	1990	1995	1996	1997	1998
Traditional Fishing	1,610	2,130	1,550	1,430	780
Floating net	120	1,490	1,520	1,280	1,350
Total	1,730	3,620	3,070	2,710	2,130

Source: Dinas Perikanan Tondano

Fishery office reported that Lake Tondano has a high potential for fish cultivation, however, the fish production in the lake is generally stagnant because of low quality and quantity of seeds, low level of fishing skill, insufficient infrastructure for fish cultivation, lack of funds, deteriorating lake water condition, etc. Generally fisherman could not continue their exertion, because of deficiency of fund to prepare large nets, the economic crisis caused by recent big droughts, the slow fish growing due to the low quality of seeds, etc.

There are 4 PPS and 68 PPL in BIPP for fishery extension in Minahasa District in 1998. Extension and training are carried out by visiting system through 206 fishery group, and followings are main target of extension for fish cultivation.:

1) Improvement of infrastructure
2) Preparation and arrangement of good water condition
3) Distribution of high quality food
4) Spreading of prime seed
5) Efficient pest control
6) Expansion of marketing of the products
7) Upgrading of fishery skill

Fish markets are generally opened at Tondano, Remboken and some villages of lake side, and a part of fish is brought to Manado and Bitung.

3.1.8 Farm Economy and Crop Budget

According to the farmers' interview survey, average farmers' yearly income and expenditure are shown in following table.

Farm Economy of Average Farmer (1999)

Unit: Rp 000

Item Income/year	Value	Item Expenditure/year	Value	Balance
Agriculture	5,421	Living	5,983	
Non-agriculture	3,903	Production cost	1,067	
Total	9,324	Total	7,050	2,274

Income from agriculture is about 58% and non-agricultural income is 42% of total income respectively, while living expenditure is about 85% and farm cost is 15% of total expenditure respectively.

Therefore balance amounts to about Rp. 2,300 thousand per year. The regional statistic data indicates that average regional income in Minahasa was Rp 2,109 thousand per capita in 1997. Comparing income in the with that in Minahasa District the farm

household income of the Study Area would be approximately even.

Besides, the farmers' interview survey indicates the interviewed farmers consume some 40 kg of fuel wood per week in average.

The crop budget of main crops is summarized below (See Table G.4.21):

Crop Budget of Major Crops

Unit: Rp 000

	Coconut	Clove	Coffee	Maize	Groundnut	Coepea	Vegetable	Paddy
Gross value	1,200	6,000	5,700	2,900	4,320	4,098	7,000	4,800
Input cost	1,130	4,315	3,060	2,548	3,140	2,868	7,258	3,305
Labour cost-1	650	3,115	2,060	1,648	1,800	1,568	6,058	2,225
Labour cost-2	480	1,200	1,000	900	1,340	1,300	1,200	1,080
Return-1	550	2,885	3,640	1,253	2,520	2,531	7,943	2,575
Return-2	70	1,685	2,640	353	1,180	1,231	6,743	1,495

Rreturn 1: Total Return- Paidl Cost, Return 2: Total return- Total Cost Labour cost 1: hired labour Labour cost 2: Family labour.

The most profitable crop is vegetable. However, since the price of vegetables is generally fluctuate, it is very difficult to increase vegetable cultivation area. Out of the food crops paddy is most profitable, most of farmers prefer to cultivate paddy as far as land is available.

3.1.9 Marketing

The marketing of agricultural commodities is dominantly governed by local collector. In the case of paddy, a larger part of products are collected by local collector and transported to rice mill, then polished rice is sold at market. A part of paddy is sold through KUD and others are sold directly to consumers at the market by farmer. Maize is mostly sold to collector and partly sold directly to consumer. Vegetables are firstly collected by local collector, and then sold to trader who bring it to city market, but considerable amount of vegetables are directly transported by to local market. Clove is firstly collect by local collector and sent to local factory or Jakarta through the collector and/ or trader. Coconut is also collected by local collector/trader and sent to factory in Manado.

Major markets in the Study Area are located at Tondano, Langowan and Kakas Sub-district around Lake Tondano. The market at Tondano opens from Monday to Saturday , and the market at Langowan and Kakas are held in three days a week. Market activity day, market size, a number of traders, and kinds of marketing goods are shown in Tables G.3.11 and G.3.12.

3.1.10 Agricultural Extension Service and Farmers Organization

Since 1997 the agricultural extension services has been integrated by BIPP (the agricultural information and extension centre). Each agricultural sub-sector prepares yearly basic action programme of extension and sends it to BIPP, and officials of BIPP carry out several services directly to farmers by following the action programme in their territory. Total number of agricultural extension worker of Minahasa District is 451 who are distributed as left table. For related Sub-district, 161 officials are working as of 1999, about 15 persons per Sub-district. Only 30% of extension workers have high education background as shown in following table.

Number of Extension Workers in the Study Area

Sub-district	Number
Head office	46
Sub-district	405
Langowan	20
Kakas	18
Tompaso	9
Remboken	8
Tomohon	25
Tondano	16
Tuolimambot	12
Eris	8
Kauditan	16
Airmadidi	17
Pineleng	12
Total	161

Source:BIPP

Number of Agricultural Extension Workers in Minahasa District

Educational back ground				
University	College	High school		Total
		Regular staff	Temporary staff	
25	108	254	64	451

Source: BIPP Kab. Minahasa 1999

Extension service is mainly carried out by door to door service, class at extension office and group discussion. In 1999 more than 100 of agricultural training programmes were completed for farmers of several sectors. Major programmes were provided for cultural practices and chemical control of pest and disease of food crops, estate crops, livestock and fisheries. In addition several kinds of agricultural information were delivered to farmers through extension offices (See Table G.3.13). However their activities are not so sufficient that farmers have complaints against present extension works.

Agricultural Training Held in Extension Office in 1999

Cultural practices	Post harvest	Pest control	Fishing	Mechaniza-tion	Agri-business	Basic extension	Total
62	6	23	1	0	5	12	109

Source: BIPP Kab. Minahasa 1999

In the related Sub-districts, 56 village-level cooperatives (KUD), however these cooperatives hardly function for local farmers. In addition, credit systems for farmers such as KUT and KPP are not handled well due to the lack of fund. Thus farmers have established about 1,000 farmers' groups by themselves under the supporting of the

government. These farmers' groups have been formed to increase income and upgrading farmers' ability. However, there is no big progress in the farmer's income. Farmer's groups are divided into 4 groups, which are beginner, advanced, medium and skilled, based on the grading system of BIPP.

Criterion for grading areas follows: (1) the ability to develop technology, (2) the ability to multiply basic assets, (3) the ability to corporate between farmers, (4) the ability to be aware of agreement and (5) the ability to formulate a planning. Each criterion is grading 0-1000. Total values divided by 5 is used to rank of farmers group. Grading value of each group is as follows:

- Beginner group (Pemula): 0-250,
- Advanced group (Lanjut): 251-500,
- Middle group (Madya): 501-750,
- Skilled group (Utama): 751-1000.

Most of them (87%) are still classified into beginner's class and none of them into skilled class due to shortage of guidance and running cost for maintain farmer's organization (See Table G.3.14).

Condition of farmers' Group in Related Sub-district

	Condition of Farmers' Group				
	Beginner	Advanced	Medium	Skilled	Total
Total	877	114	14	0	1,005
Share	87.3	11.3	1.4	0	100

Source: Laporan Tahunan 1999 BIPP Kab Minahasa

On the basis of present agricultural situation, BIPP concentrates to develop following policies :

1) to enlarge planting areas and increase quality of the intensification programmes,
2) to increase resource quality of the agricultural tools, including developing skills, of the extension workers and farmers by training and courses,
3) to mechanize agricultural practices,
4) to improve irrigation systems,
5) to ensure the government in order to give some subsidiaries for the poor farmers by credits,
6) to extend the roles and functions of the head of Sub-district and head of Villages as driving leaders,
7) to activate industrial development and cooperation between stakeholders and farmers,
8) to keep price stability by improving market systems between local, regional and international markets,

9) to support and assist trading development through agricultural seed/seedling quarantines, and
10) demonstrate agricultural technology on the farmer levels.

3.1.11 Current Problems in Agricultural Activities

(1) General

The District Office of Food Crops Service Minahasa (Dinas Pertanian Tanaman Pangan) points out the current problem in agriculture of the District as below:

1) Twenty three (23) percent of the paddy field in the District is still not well functioned, and the productivity of paddy is still stagnant. Average production of paddy can increase at least 15% through the optimization and intensification of field management.
2) The irrigation system is not appropriate, because only 35% of paddy field is irrigated at present.
3) The quality of human resources in agriculture sector (both of farmers and officials) are low. Farmers have still adopted the traditional farming, due to the lack of information for modern agricultural technologies.
4) Mass guidance action for agricultural intensification (BIMAS) programme is not sufficiently functioned at the field level, because of lack of understanding of local leaders.

The farm household survey conducted by JICA Study Team elucidated that about 100 farmers interviewed have several constraints under the present agricultural, marketing and living condition, and desire the several countermeasures shown in Table G.3.15 and 3.16 (See Attachment - G.1).

Many farmers complain on biological disaster, high production cost, low soil productivity and labour shortage from the view point of production. For marketing condition, most of farmers complain to low price and price fluctuation of agricultural commodities. For living condition, high constraints are found on labour shortage, lack of domestic water and poor road condition.

Based on the these constraints, major countermeasures farmers desire are shown in Table G.3.16. In spite of less priority in the present constraints, farmers put the high priority on protection of soil erosion as they recognize strongly its importance. Besides this improvement of domestic water supply, improvement of road condition and improvement of extension system are expected as the desirable countermeasure.

(2) Soil Erosion Caused by Clove Cultivation

It is often said that clove cultivation had been introduced and extended rapidly to the sloped area around Lake Tondano during the period from 1950-1980s. And it became a cause of serious soil erosion throughout the area in those days. To make sure it, JICA Study Team contacted with some farmers, who have cultivated clove since a few decades before, and interviewed how they experienced about soil erosion in those days.

1) Sub-district Toulimambot, Village Papakelan

Some farmers told that there had been serious soil erosion from 1970s to1980s. They began clove cultivation in 1950s to 1980s. Their clove planting area was around 2 ha. They employed clean cultivation method for clove. They weeded frequently to clear the soil surface for growth and harvest of clove. Such farm management invited serious soil erosion. The water color of the stream had been changed to brown with the eroded soil, when heavy rain came. They recognized soil erosion came out in their farm land and also saw some dark streams flew into Lake Tondano.

From the end of 1980 to 1990s, soil erosion settled down, because the price of clove decreased so much that farmers disappointed to carry out intensive management for clove cultivation. Although their clove garden still have kept the area as it was, tree population has decreased and a part of the area is gradually changing to shrubs due to poor management. One of the farmers told that the yield of clove products has reduced from former 600 kg/ha to only 200 kg/ha at present.

Now they pick the clove buds by hand using stepladder instead of dropping down them on the cleared land under the tree. They intend to cultivate clove again, if the price of clove would rise in future, but they told that they will take care of soil conservation under such a situation.

2) Sub-district Kakas, Village Kaweng

Some farmers remembered that in 1970s –1980s, when heavy rain came, there happened not only serious soil erosion but also two times of land collapse in their farm lands caused by clove cultivation. Their clove garden was 0.6 – 3 ha. In those days they used to clear soil surface of farmland for tree management and harvesting of clove buds. Therefore soil of the clove garden was very erosive. Farmers had recognized that the eroded soil used to flow into Lake Tondano when heavy rain came. Such serious soil erosion has settled down from the end

of 1980s. However they insist that soil erosion is still observed because of the erosive soil in this area though it is not so serious.

They said production of clove decreased from 100 litre/tree to only 20 litre/tree. So they have been discouraged to carry out intensive management for their clove garden. One of the farmers lost all of the clove trees in his 1 ha clove garden due to the serious plant pest and another farmer also lost most of his clove trees with same way.

To recover their income, some farmer began fishery, some migrated to town to work, and some is working for mining. They desire to cultivate clove intensively again, if the price of the clove rise up, and actually some farmers have started to rehabilitate their clove garden as the price of clove seems to be a little improved. They intend to protect soil erosion in their farm, if they would start again clove cultivation, but they wondered it may require high labour cost.

3) Sub-district Eris, Village Eris

Some farmers interviewed at the Village office answered that there were 7 times of big flooding in 1970s to 1980s, and every time serious soil erosion was observed in this area. In their own clove gardens, soil erosion were observed, and they remember small river close to their farm land changed color to dark brown with eroded soil. In those days they used to clean cultivation method for clove garden. Since 1987 when drought weather lasted, serious soil erosion has settled down. They improved clove cultivation method taking account of soil conservation, and in addition they have introduced *Calliandra* to make hedge rows for protection of soil erosion. However such farming practices requires high labour cost.

One of farmers told clove production has decreased from 1.5 tons/year to 0.3 tons/year because of extensive farming. However if the price of clove rise up, farmers will strengthen clove cultivation again. The head of Village told that he expected three countermeasures, they are, the improvement of credit system, extension of clove rehabilitation technology, and guarantee fund.

4) Sub-district Toulimambot, Village Paleloan

The farmers told that clove cultivation was introduced around 1970 - 1980, and their farm sizes of clove garden were about 1-2 ha for each, most of which were kept the size even now as it was. Main variety of clove is Zanzibar. They said that soil erosion from the clove gardens always occurred during 1970s –1980s

when heavy rain came. And they observed gully erosion developed on the sloped farm. Furthermore they insisted the soil erosion still happen even now, not only in clove garden but also in annual crop area, though their viewpoint sometimes confused. Perhaps, it will be a fact that soil erosion still continues in some extent at a part of steep sloped and improper farming area.

They recognize their soil conservation technology is insufficient, and extension services should be strengthened for improvement of soil conservation method. The head of village wants to construct a check dam at the upper stream of the village.

(3) Problems of Agroforestry System in the Study Area

According to the result of farm household survey, no farmer in the Study Area has a constraint on agroforestry system. The reason, why there is no constraint of farmers on agroforestry system in spite of the productivity being not so high, can be assumed that agroforestry system in the area has short history and farmers do not understand what is constraints on agroforestry system. By field reconnaissance, some problems were found. In the northern part of the Study Area, since trees are randomly planted in old coconuts garden, an area for annual crops are irregular shape and crop husbandry for annual crops are ineffective. In addition, irregular spacing of coconuts also prevents to increase coconut production and efficient farming practice. Trees can impede cultivation of herbaceous crops and introduction of mechanization, and thus increase labour cost and inhibit advanced farming practices. And inadequate planting system was observed in some places such as some kind of trees being planted without considering crop husbandry, herbaceous crop being planted under high density tree gardens. Sometimes, unsuitable agroforestry system is employed. For example in the area with high land resources, only low productive agroforestry system is employed. Selection of suitable agroforestry system is very important for not only crop production but also conservation of environmental condition. For this purpose, it is necessary to strengthen farmers knowledge by extension workers.

There is few extension worker for agroforestry system and their capability is quite low. This is one of the reason why modern agroforestry cannot extend the area. Therefore, it is necessary to increase the number of agroforestry extension workers and upgrading of extension worker by training.

3.2 Development Plan of Agriculture and Agroforestry

3.2.1 Basic Concept

It has been said that the ecological condition of Tondano watershed is degrading by sedimentation and environmental pollution. One of the main factors of sedimentation is soil erosion due to improper agricultural practices, improper land use and deforestation. As a result, there has been observed a small area of critical land which has some problems such as low agricultural productivity and adverse effect on the environment. Soil erosion is now decreasing by employing soil conservation technology and improved cultural practices, however, there are still some space to improve land conservation technique. It could be supposed that there would be high possibility of soil erosion, unless proper farming practice and adequate land use plan would be employed in future. Therefore, it is necessary to establish proper land use plan for each category land classified by zoning under consideration on vegetation, physical and social condition, present land use, and appropriate cultural practices for sustainable agriculture. As a larger part of the Study Area is sloped area, an agroforestry system is one of the most effective systems for soil conservation and increase of soil fertility and productivity. For this purpose, it could be discussed based on the land use plan, cultural practices, agricultural extension service, organization of farmers group, agricultural credit and farmers participation. Fortunately, since only less than 20% of total farm is tenant land in the study area, there is very little land tenure problem, which becomes sometimes a big barrier or agroforestry system in many countries

3.2.2 Selection of Suitable Agroforestry System

An agroforestry system is one of the most effective systems for soil conservation and increase of soil fertility and productivity. The agroforestry system in the Study Area has a short history and farmers could not adequately understand which is more effective agroforestry system. The system in the larger part of the area is still rudimentary, and there is a big space to improve this system for decreasing soil erosion and for getting high return. One of the reason of this is due to the shortage of expert of agroforestry and the shortage of number and capability of extension workers. There are two ways to decrease soil erosion and to increase land productivity by employing agroforestry system, one is to select the suitable agroforestry system and the other is to improve farming practices of each component. The suitable type of agroforestry system varies area by area. It could be determined by the combination of physical and social condition of the area. The suitable agroforestry systems could be determined based on the physical condition, required agricultural practices and soil conservation

technology, social condition and the characteristics of each type of agroforestry system. Following factors are considered for determination of the suitable agroforestry system:

i) physical condition such as topography, soil characteristics and potential of soil erosion,
ii) required agricultural practices and soil conservation technology, such as required vegetation, necessity of hedge crops and ridge row cultivation, and possibility of application of new technology,
iii) social condition such as access to the field and commodities, and
iv) characteristics of each type of agroforestry system such as productivity of each category of crops, possibility of soil erosion and application of new cultural practices for herbaceous crops.

The evaluation of each component and the suitable agroforestry system by different area are shown in Tables G.3.17, 3.18 and 3.19. These tables show that all the agroforestry systems are applicable for flat to gentle slope area, and the more productive system are suitable for flat to gentle sloped area. While agroforestry system, which has a strong resistance to soil erosion but less productivity are suitable for sloped area. The recommendable agroforestry system by area is also presented in Table G.3.18. This are only guide line or recommendation, applicable agroforestry system should be determined by considering on farmers requirement and communities requirement.

Fortunately, since only less than 20% of total farm is tenant land in the study area, there is very little land tenure problem, which becomes sometimes big barrier or agroforestry system in many countries.

3.2.3 Conservation Plan of Each Zone

(1) Protection Zone

Only Protection forest among State Forest is distributed within the Study Area. The first priority is to maintain well stocked forest stand. In the area main activities are rehabilitation and reforestation. According to the New Forest Law, protection forest can be used for environmental service and collection of non-timber products and cannot be used for other purpose. However, in some part of protection forest, inhabitants illegally encroach to the protection forest and carried out production activity and the capacity, for soil erosion and water and moisture keeping, of the encroached forest decreased. Since it is very difficult to recover or to rehabilitate protection forest, which is encroached by inhabitants, it could be recommended to employ social forestry system by participation of inhabitants in the area. As

inhabitants expect some returns from social forestry, it could be recommended to employ agroforestry system which has a same capacity of forestry for prevention of soil erosion and moisture keeping. As the area is situated in the steep slope area, tree/tree crop dominant agroforestry system which is highly resistance to soil erosion but not so high productivity (AGF-I Type I -3. -4) would be recommended.

(2) Buffer Zone

Buffer Zone is classified into two Sub-Zones: Mountain Buffer Sub-Zone and Waterfront Buffer Sub-Zone.

1) Mountain Buffer Sub-zone

Forest ecosystems play an important role as a regulator of ecological and hydrologic functions. In the Study Area, state forest and right forest have decreased by legal or illegal deforestation. In order to keep good environmental condition, it is important to maintain the forest areas by establishing buffer zone.

In the Mountain Buffer Sub-Zone, the area surrounding the Protection Zone is primary buffer zone in which vegetation type should be similar to the Protection Zone. Primary buffer zone is surrounded by secondary buffer zone and/or transitional zone where possibilities exist for production activity. Mountain Buffer Sub-Zone includes right forest area and arable upland area, and a larger part of the area distributes in sloped area. Generally a slope becomes gentle with an increase of distance from the Protection Zone. In the arable upland farm, there will be a high potential of soil erosion unless adequate land use and proper farming system, while potential soil erosion would be relatively low in the forest. For the soil conservation, proper land use and proper farming practices are, of course, important, and the civil engineering approach such as construction of check dam and formation of terrace is also necessary.

i) Right forest area

Some of the right forest area under good management and keep good forest capacity and productivity, however, some of them are under a poor management or no management and have poor forest capacity and poor productivity. As the forest area is very small in the Study Area, only 9 % of total, it is important to keep forest area and to keep forest capacity. The forest under good management could be recommended to keep as forest. The forest area, under poor or no management, which has a lower forest capacity for soil erosion, water and moisture keeping, should be improved or change land-use. For the poor managed right forest, it could be recommended to apply agroforestry system, which has a

same capacity of forest for soil erosion and water and moisture reservation. The suitable type of agroforestry system for sloped area is mulistorey tree garden (AGF-I Type I -3, -4, and -5) and for gentle sloped area, multistorey tree garden and/or non dominant crop agroforestry system (AGF-III Type III-1, -2).

ii) Sloped area and the area around the Protection Zone

Sloped area has a high potential soil erosion, therefore, the land-use system which is resistance to soil erosion should be employed. The suitable agroforestry system is tree/tree crop dominant type (AGF-I Type I-3, -4 and -5), especially multistorey tree garden. The vegetation of area surrounding the Protection Zone should be tree (tree crop) vegetation. Since the Protection Zone is distributed in the steep sloped area, the buffer zone surrounding the Protection Zone is also in the steep sloped area. Therefore multistorey tree garden type of agroforestry system could be recommended for the area. Generally, the slope becomes gentle with an increase of distance from the Protection Zone and limitation for crop cultivation also decreases and possibilities of employing higher productive agroforestry system.

In the some part of the Study Area, vegetable cultivation in a steep sloped area is observed. In the area, combination of contour ridge cultivation, ridge row cultivation, mulching and no tillage planting are employed for controlling soil erosion. This area is situated near the town and has a good access. When annual crops or vegetables are cultivated in a sloped area, it is required a special technique for controlling soil erosion such as contour ridge cultivation, no tillage cultivation, mulching and hedgerow cropping.

At present, the agricultural production in the slope area is stagnant at low level compared with flat area, because of land condition, poor management for crop and land due to poor access to the field and long distance from the settlement area. It is important to arrange good access by improving road condition and construction of new road for farmers in the area to improve soil conservation and crop production. Though it is important to employ proper land use and proper farming system, it is also important to prevent soil erosion by physical and technical approach such as construction of check dam and terrace.

iii) Gently sloped area and flat area

Generally, the slope becomes gentle with an increase of distance from the Protection Zone and limitation for crop cultivation also decreases by departing from the Protection Zone. As potential of soil erosion in the flat or gentle sloped

area is low, the highly productive agroforestry system, which are not highly resistance to soil erosion, could be employed in flat or gentle sloped area. In the area, all the types of agroforestry system are applicable and high productive agroforestry system, could be recommended in the area.

The fuel wood consumption in the Study Area is estimated by farmers interview survey at some 40 kg per farm household per week and a larger part of farmers are mainly collecting from their fields, estates and bushes. Therefore, it could be recommended to employ multipurpose trees for their agroforestry system not only to supply fuel wood but also to supply organic carbon to soil and to protect soil erosion. Especially, it could be strongly recommended hedgerow cropping by using leguminous trees which increase soil fertility by fixing atmospheric nitrogen and supply of organic carbon.

2) Waterfront Buffer Sub-Zone

Waterfront Buffer Sub-Zone can be classified into two, alongside of river and lakeshore. For the area of alongside of rivers, it could be recommended to establish a green belt or to employ agroforestry system depending on topography and width of basin. For narrow basin, green belt is suitable while for wide basin green belt and AGF-I can be recommended. For the area of lakeshore, it could be recommended firstly to establish green belt along the edge of the lake except swamp area and secondly to employ agroforestry system considering on the land condition. AGF-I Type I-6 for the area, close to settlement area, and AGF-I Type I-3, -4 for the other area.

Changing a view into the waterbody of the Lake Tondano, the water quality of the Lake has recently been degrading, due to the several human activities in and around the Lake. As one of these activities, the development of fish cultivation by cage at the lakeshore could be involved, because a considerable amount of residual feed and dung of fish would contaminate the lake water. Therefore the control of increasing cage cultivation in future is an important countermeasure for the protection of water quality of the Lake.

(3) Farming Zone

In this area, an intensive agriculture is acceptable, especially in the flat area. The farming pattern varies area by area depending upon the natural and social condition. In flat area, mono-cropping or mixed-cropping of annual crops under multiple cropping system are recommended and agroforestry systems are also recommended. Suitable agroforestry system in the flat area would be AGF-II (Type II-1 and -2) and AGF-III

(Type III-1 and -2). Considering the fuel wood consumption and maintaining soil fertility, hedgerow cropping of leguminous trees would be recommendable.

In the sloped area, AGF-III (Type III-1, -2) and tree/tree crop dominant agroforestry system AGF-I (Type I-5 and -6) could be recommended.

3.2.4 Improvement of Cultural Practices

Cultural practices of paddy and vegetables in the area are now advanced, however, those of other annual upland crops, especially maize, is extensive in some parts and the yields are still low. The cultural practices of some upland crops in a larger part of the area employ soil conservation technique which have still some space to improve. As an extensive maize cultivation sometimes accelerates soil erosion and decreases soil fertility, this cultural practice should be improved to keep sustainable agriculture. For improving cultural practices, it is necessary not only to increase yield but also to consider sustainability of agriculture. It is very effective for soil conservation and increasing soil fertility to employ contour ridge, mulching and hedgerow cultivation by using multipurpose Leguminosae trees. At present, maize occupies more than 90% of palawija area, and the return from the maize cultivation is not so high compared with other crops. It should be considered crop diversification by employing leguminous crops which increase the soil fertility.

In the larger part of the Study Area, coconuts and clove trees are now at replanting time. It was believed that serious soil erosion occurred at few decades before was due to land clearance for planting clove and clean cultivation of clove. Therefore, it could be recommended that planting clove should be carried out without land clearance and after growing of cover crops, cereals or pulses. Clove seedlings should be cultivated in the clean circle at early growth stage and never under clean cultivation. In addition, employment of hedgerow cultivation could be effective.

In old coconut garden, coconuts were randomly planted in 1950 to 60's. Introduction of agroforestry system for this area, there would be some difficulties for herbaceous crop cultivation, because of small and irregular shape of area for herbaceous crops. It could be recommended that coconut should be regularly planted at refreshing time, considering on employment of agroforestry.

3.2.5 Improvement of Agricultural Extension Service

Farmers request more intensive door to door service and supply of information on new cultural practices. Since there are not enough extension workers for intensive agricultural extension service required by farmers, it is necessary to employ more

effective extension method. Followings are examples of effective agricultural extension service, extension service should

i) collaborate with other related institutions,
ii) adopt group guidance method by organizing farmers group and establishing demonstration plot,
iii) provide the chance of farmers training programme.

As already stated, a larger part of farmers in the Study Area have no constraints for agroforestry, although there could be observed many problems in their agroforestry system. Agroforestry system has only recently recognized as an important area of scientific inquiry. Since it incorporates the management of trees, tree crops and herbaceous crops on the same pieces of land, the knowledge and skills to manage agroforestry are broad and varied. Research and extension of each category of trees and crops have been carried out by different institution and there is little corporation on agroforestry among them. As a result, education and training in agroforestry lags far behind other agricultural disciplines leaving a definite shortage of experienced, qualified trainers in agroforestry. Therefore, it is urgently need to increase the number of agroforestry extension workers and also upgrade them by training.

3.2.6 Improvement of Farmers' Group

On village level, there are many farmers' organizations or farmers' group, but larger part of them is not so active, because of shortage of running fund and management know-how. These farmers' organizations have been formed to increase income and upgrading farmers' ability, however, there is no big progress in the farmers' income. To activate these organizations, it is necessary capacity building of organization and local leaders through technology transfer. Technology transfer can be expected through agricultural extension service, public service from university and other institutions. For receiving the technology transfer, group guidance is the most effective.

In order to increase concern of farmers in the Study Area on suitable agricultural management and keeping good environmental condition, it needs to establish community base development. For this purpose, it should be discussed on the farmers' requirement, upgrading technologies, and capital arrangement for the requirement to develop the programme at community level.

Programme for community base development can be established through several ways. They are adoption new cultural techniques of group discussion.

CHAPTER 4 FEASIBILITY STUDY FOR THE INTENSIVE AREA

4.1 Present Condition of the Intensive Area

4.1.1 Land Holding Size and Land Tenure

Based on the statistical data of farm size by Sub-district, the farm size in Intensive Area is estimated at 1.30 ha which is composed of 1.62 ha in the East Area, 1.02 ha in the South and 1.20 ha in the West. There are 2000 of landless farmers (Burutani, agricultural labourer), or 20 % of farm households in the Intensive Area.

4.1.2 Agricultural Land Use by Farming Category

The Intensive Area is divided into three Areas centering Lake Tondano from different agricultural land use and agricultural practices as discussed in Main Report: the East Area, the South Area and he West Area. The agricultural land in the Intensive Area is classified into four areas from a view point of slope. There are 0-8 % sloped area (Flat), 8-15 % sloped area (Gentle slope), 15-25 % sloped area (Moderate slope) and more than 25 % (Steep slope).

The present agricultural land use can be classified into five categories considering agricultural practices, cultivated crops and trees. These are Agroforestry-I (AGF-I), which is tree and tree crops dominant agroforestry system, Agroforestry-II (AGF-II), which is herbaceous crops dominant, Agroforestry-III (AGF-III), which is inter-cropping system herbaceous crops and tree crops, Upland herbaceous crop farming (trees and tree crops area are less than 5% of total field area, UF) and Lowland farming (LF). The area of each category by slope and Areas are summarized below, and details are presented Table G.4.1.

Agricultural Land Use by Farming Type (East Area)

Unit: ha

Category	Steep slope	Moderate slope	Gentle slope	Flat	Total
AGF-I	1,465	218	0	0	1,683
AGF-II	13	144	0	32	190
AGF-III	167	106	0	0	273
Upland-F	0	54	0	45	99
Lowland-F	0	0	0	388	388
Total	1,645	522	0	465	2,632

Agricultural Land Use by Farming Type (South Area)

Unit: ha

Category	Steep Slope	Moderate slope	Gentle Slope	Flat	Total
AGF-I	116	113	0	0	229
AGF-II	0	8	307	343	658
AGF-III	0	385	79	0	464
Upland-F	0	0	6	532	538
Lowland-F	0	0	0	125	125
Total	116	506	392	1,000	2,014

Agricultural Land Use by Farming Type (West Area)

Unit: ha

Category	Steep Slope	Moderate slope	Gentle Slope	Flat	Total
AGF-I	140	837	0	0	977
AGF-II	0	539	335	35	909
AGF-III	0	1210	20	0	1,231
Upland-F	0	20	760	344	1,124
Lowland-F	0	0	0	125	125
Total	140	2,606	1,115	504	4,365

Agricultural Land Use by Farming Type (Intensive Area)

Unit: ha

Category	Steep slope	Moderate slope	Gentle slope	Flat	Total
AGF-I	1,722	1167	0	0	2,889
AGF-II	13	692	642	409	1,756
AGF-III	167	1,701	100	0	1,968
Upland-F	0	74	767	919	1,760
Lowland-F	0	0	0	638	638
Total	1,902	3,634	1,509	1,966	9,011

Note: Steep slope; slope more than 25%, Slope; slope 15-25%, Gentle slope; Slope; slope 8-15%, Flat; slope 0-8%.

AGF-I is mainly distributed in steep slope and moderate slope area, and negligibly distributed in gentle slope and flat area. AGF-II is mainly distributed in moderate sloped, gentle slope and flat area, and slightly in steep slope area. AGF III is mainly distributed in slope and slightly in steep slope and gentle slope area. Agroforestry system covers some 80% of total agricultural upland in the Intensive Area. UF is mainly distributed in gentle slope and flat area, and slightly in moderate slope area and negligibly in steep slope area. LF is distributed only in flat area.

Farmers apply AGF-I mainly for steep slope area, which has a high erosive potential, and UF for gentle slope and flat area, which have a low erosive potential. This selection of farming type for each slope area is reasonable, however, there is found improper land use such as UF being carried out in steep slope, although its area is very limited. UF in steep slope has a possibility of increasing soil erosion.

In the East Area, agroforestry system covers 96% of total agricultural upland area. AGF-I is predominant and occupies 75% of agricultural upland area, because a larger part of agricultural area belongs to steep slope area. AGF-II and AGF III cover 8% and 12% of total upland agricultural area, respectively. UF area is very limited and distributed in moderate slope and flat area. The soil fertility in this area is not so high.

The South Area is stretched to down area of the Protection Forest, and the slope and undulation are relatively gentle. In this area, agroforestry system covers 82% of total agricultural upland area and there is a little difference in covering area among each agroforestry system. Some 40% of flat are under agroforestry system. AGF I distributes in steep slope and slope area, AGF II mainly in gentle slope and flat area,

AGF III mainly slope area and UF in flat area.

Due to fairy undulated topography which is composed from many small hills and hollows, land use is very complicated in the West Area. Agroforestry system covers 75% of total agricultural upland area. AGF-III occupies the largest area. However, there is no big difference in covering area among each agroforestry system. UF area occupies 25% of total agricultural upland and is mainly distributed in flat and gentle slope area, and slightly in the slope area.

There is a big difference in agricultural land use type among the Area. In the East Area, agroforestry system is dominant and upland farming is negligible. In the West Area, on the other hand, UF is occupied some 25% of total and distributes in not only flat but also gentle slope area. In the South Area, AGF II distributes not only gentle slope but also in flat area. UF distributes only in flat area.

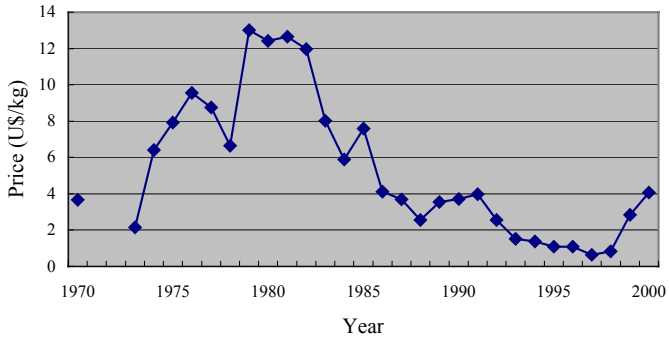
4.1.3 Major Trees and Crops

Major trees and crops introduced for agroforestry system in the Intensive Area is shown following table and the trees and tree crops which has a possibility of introduce for agroforestry system are shown in Table G.4.2.

Major Trees and Tree Crops

Estate crops	Fruits	Trees
Clove	Durian	Cempaka
Coconut	Mango	Albivizia
Coffee	Avogado	Trema
Vanilla	Langsat	Mahoni
Cinnamon	Jack fruit	Nyatou
Cocoa	Citrus	Gliricidia
Sugar palm	Banana and papaya	Calliandra

Clove, coconut, coffee, vanilla, cocoa and cinnamon are popular estate crops in the Intensive Area. Clove is the dominant species of estate crops followed by coffee and coconut. The planted area of other species of estate crops is limited compared with these three crops. Since the altitude of the Intensive Area is more than 700 m ASL, oil



Trend of Price of Clove

content of copra is low, therefore, coconut is mainly cultivated for fresh coconuts. The planted area of coconut is very small compared with that of clove, although the planted area of coconut in Minahasa District is comparable with that of clove. Clove is the main estate crop in the Intensive Area. Its planted area is increasing gradually from 1970's to 1986. After 1986, its area had been kept at constant as shown in Table G.4.3. Because the price of clove showed a decreasing tendency from 1983 and it had been kept at very low price from 1992 to 1997 under government control as shown in right figure.

The low price of clove make farmers lazy for maintenance of clove and to discounting renewal of clove garden where the trees become too old to produce. Then a large number of trees are infected by disease and suffered by nutritional problems. After late 1998, the price of clove is put at the out of government control and has been governed by the market. The price of clove is increasing from 1998 and becomes the same level of early 1980's in 2000. From 1999, farmers start to renew old clove garden and to maintain carefully clove garden. At present, the production of clove is 60,000 tons per year and the demand is 100,000 tons per year. Considering present situation of clove market, it could be said that clove based agroforestry system is hopeful in the area. Sugar palm, which is extensively cultivated, is also found in all over the Intensive Area.

In Indonesia, the most widespread agroforestry system is rubber agroforestry which occupies over 2.5 million ha. The biodiversity levels of this system often approach to those of natural and secondary forest and its soil conservation capacity is very high. However, since this system required large area, it is very difficult to introduce to the Intensive Area.

Major fruit trees are banana, durian, mango, langsat, avogado, jackfruit, rambutan, citrus and papaya. These trees are planted in home garden and upland field close to dwelling area. Banana and papaya are sometimes planted as hedgerow crops. It is very difficult to find the orchard in the area.

Popular trees used for agroforestry system in the area are *Cempaka, Albizia, Trema, Mahoni, Nyatou, Caliandra* and *Gliricidia. Kordia* and *Erythrina* are only found in the South Area. Although *Piper* and *Ficus* are autogenesis plant, they have been found in agroforestry system in whole area. These trees contribute to soil conservation and are used for building material and fuel. Recently, *Cempaka* and *Mahoni* are planted in the whole Intensive Area by recommendation of forestry department. *Calliandra* and *Gliricidia* are also used as hedgerow trees. Bamboo is the most popular species in the area used for agroforestry system and distributed all the Intensive Area. Sugar palm

are also extensively cultivated in whole the Intensive Area.

Teak *(Tectona spp.)* is the most popular species for agroforestry in Indonesia and high value. Golden teak (*Tectona spp.)* has been proposed to employ for agroforestry system in the Intensive Area at the interim report meeting. However, the climatic condition of the Intensive Area is not adequate for growth of golden teak which requires relatively long duration (4 to 6 month) of dry period. And it requires a long period from planting to harvesting (some 50 to 80 years). Therefore, golden teak could not be employed for agroforestry system in the area as new tree species.

Major food crops in the area is maize, followed by pulses such as ground nuts and cow peas, vegetables such as tomatoes, chili, leaks, carrot and cucumber, and root crops such as cassava and sweet potatoes. Cassava and sweet potatoes are also used as hedge crops.

The characteristics of major crops are as follows.

(1) Maize

Maize is a predominant crop in this area. It is cultivated not only mono-culture but also inter-cropping with estate crops. As maize can cultivate through the year, generally it is cultivated 2 times a year, and rotated with pulses or vegetables. Most of varieties are composite type, while hybrid type with high productivity is still low.

(2) Pulses

Groundnuts and cowpeas are usually cultivated as a rotation crop in arable upland and inter-cropped with estate crops. Groundnuts are mainly cultivated at west part of Intensive Area, Sub-district Tondano, Remboken and Kawangkowan. Cowpeas are cultivated in same situation as groundnut. But its dominant area is southern part of the Intensive Area, Sub-district Tompaso, Langowan and Kakas, where groundnut area is very limited.

(3) Vegetables

Major vegetables in Intensive Area are tomato and leaf onion. Tomato is commonly planted in small parcels in home gardens. Commercially it is planted mainly at southern mountain foot. Generally the fruits of tomato are very small because of characteristics of variety, no fruits thinning depending on the market demand. It is directly sown without raising seedling in nursery. The farmers in southern area are eager to cultivate tomato because of relatively high profitability. Leaf onion is also one of the main vegetables. Vegetable area is scattered all over the Intensive Area, though its planting scale is so small that total cropped area is not much.

(4) Paddy

Most of paddy fields in the Study Area is located at out of the Intensive Area. From the viewpoint of watershed conservation, paddy fields do not have any problem, but it protects soil sedimentation in Lake Tondano. Almost all of farmers are eager to paddy cultivation. In a flat area and the terraced area, farmers would like to cultivate paddy plant if irrigation water is available. Problem seems to be high water level in most of paddy field where natural drainage is difficult due to the high lake water level. Paddy can be cultivated through a year. Most of farmers cultivate paddy two times a year. Mechanization of farm practices is under progress, while mechanization of upland crop cultivation is far behind.

(5) Clove

Clove gardens in the Intensive Area are mainly stretched in eastern sloped land and many small gardens are scattered all over the area. Dominant variety is Zanzibar, and some traditional varieties, such as Siputih and Sikotok are observed. Decades before, clove cultivation was rapidly spread in the Lake Tondano watershed. After Clove Management Agency (BPPC, Badan Penyangga Pengelolaan Tanaman Cengkeh) began to control the price and marketing of clove, farmers were forced to sell their products only to cooperatives (KUDs). There are no processing factories in North Sulawesi Province. Almost all products are sent to Surabaya in West Java where tobacco companies are concentrated.

(6) Coconut

Coconut is predominant estate crop in North Sulawesi Province. Coconut plantation area is more than 300,000 ha and distributed at relatively low elevation area. However, coconut is not suitable to the area higher than ASL. 500 m due to the low content of oil caused by low temperature. As almost all of the Intensive Area is located at higher than ASL 500 m, coconut trees are mainly observed in the tree complex at hillsides and the border of upland or estate land. Most of coconut trees are not planted for copra production, but for fruit production.

(7) Coffee, Cocaoa and Vanilla

Long before, coffee had been introduced at the western part of Tondano watershed area, after 1970s coffee plantation was changed to clove garden, and now it is anticipated again as an estate crop with relatively high return. Cocoa is also anticipated as an estate crop as same as coffee. It began to introduce mainly in hilly area of west of Sub-district Remboken and Tondano and some small plots of cocoa are observed in the

whole of the Intensive Area. Though the damage by cocoa moth is worried, protection method will be developed. Vanilla is usually cultivated with shade tree (*Glyricidia*) in the hilly tree complex area. The cultivated area is scattered with small size. Generally maintenance of vanilla is not intensive.

4.1.4 Agroforestry System in the Intensive Area

Three categories of agroforestry system have been found in the Intensive Area; they are tree or tree crops dominant Agroforestry system (AGF-I), herbaceous crop dominant agroforestry system (AGF-II) and intercropping system of herbaceous crops with tree crops (no dominant species, AGF-III). Agroforestry system in the area could be classified into six types according to crops and plant density of each crop planted in the identical field is shown in the following table.

Type of Existing Agroforestry in the Study Area

Type	Woody perennials						Existing in the Intensive Area
	Woody tree	Estate crops			Fruit tree	Herbaceous crops	
		Coconut	Clove	Others			
AGF-I I-1	△	◎	△	X	△	△	No
AGF-I I-2	△	△	◎	X	△	△	Yes
AGF-I I-3	○	◎	○	X	○	△	No
AGF-I I-4	○	○	◎	X	X	△	Yes
AGF-I I-5	○	○	○	◎	X	○	Yes
AGF-I I-6	○	○	○	○	○	○	Yes
AGF-II II-1	△	○	△	X	△	◎	No
AGF-II II-2	△	△	○	X	△	◎	Yes
AGF-III III-19	△	◎	X	X	△	◎	No
AGF-III III-2	△	X	◎	X	△	◎	Yes

Note: Others include coffee, cocoa and vannila
◎ : Pre-dominant, ○: Dominant, △:Frequent, X: neglesible

(1) Tree Crop Dominant Agroforestry System (AGF-I)

1) One Estate Crop Dominant Agroforestry System (AGF-I Type I-2)

This type is mainly distributed in steep slope and slope area of East Area, and partly South and West Areas. Clove is the main crop and some multipurpose trees and fruit are also planted at very low plant density. Recently, timber tree species, such as cempaka and mahogany have been planted in the clove garden with a density of 20 to 100 plant per ha. Herbaceous crops are planted between trees, but its area is very limited (5-20% of total area).

Type I-2

2) Tree (Woody Trees and Tree Crops) Dominant Agroforestry System (AGF-I Types I-4, 5, 6)

This type is divided into multi-storey tree complex and upland annual crops are being cultivated in the small area under tree crops or fruit trees. There are two types of multi-storey tree complexes; one is well-managed one, which occupies very limited area and distributed in gentle slope area of Longawan, Remboken and Tondano and home yard area (type I-5 and 6). The other is a poor-managed one (Type I-4), which is mainly distributed in steep slope area of whole Intensive Area.

(2) Herbaceous Crop Dominant agroforestry System (AGF-II)

This system is mainly distributed in gentle slope and flat area. In a larger part of Intensive Area, clove based AGF-II (Type II-2) is popular and coconut based AGF-II (Type II-1) is very limited or negligible. In this type, followings are observed.

Type II-2

- Transitional stage from tree garden and secondary forest to upland farm (some trees remain in the field)
- Planting of clove in farm land of maize/ pulses/vegetables in upland farming area
- Planting of timber trees or fruit trees in farm land of maize/ pulses/vegetables
- Hedgerow cropping using coffee, banana, cassava, *Gliricidia* and *Calliandra*

In this type, the plant density of trees is very low (clove: some 50 plant/ha, fruit tree and timber trees: 10-30 plant/ha). Banana, coffee, papaya and some fruit trees are also planted at the border of field and *Cempaka*, Durian, Mango are planted inside of field. In some fields which is transitional stage from tree garden or changed from tree garden to upland field, there is found low or no productive trees inside of farm.

(3) Inter-cropping System (AGF-III)

This system is mainly distributed in moderate slope area. In a larger part of Intensive Area, clove based AGF-III (Type III-2) is popular and coconut based AGF-III (Type III-1) is negligible. This type is classified into two categories. One is well-managed and the other is rudimentary agroforestry

Type III (Well managed)

system. Rudimentary agroforest system includes a system changed from AGF-I and transitional stage from estate crop garden or tree complex to upland farming. In the well-managed system, clove is regularly planted with wide row considering the herbaceous crop cultivation. The plant density of clove is slightly lower compared (150-200 pl./ha) with that of mono-culture (200-300 pl./ha). Maize/pulse are cultivated between clove rows at a row interval of 70 to 100cm for maize and 50 to 150cm for pulses by ridge row cultivation. The area of this system is very limited and occupies less than 10% of AGF-III area, however, its area is now increasing by planting clove at planned spacing in maize or pulses field and by improving rudimentary system at the time of replanting of clove tree. On the other hand, under rudimentary agroforestry system trees are not always planted regularly, the productivity of tree crops could be lower compared with that of regularly planted tree crops. The random planting of trees disturbs herbaceous crop cultivation under tree crops. Therefore, productivity of rudimentary agroforestry could be lower and require more labour force for herbaceous crop cultivation.

Type III

(4) Shifting Cultivation and Other Agroforestry System

The area of shifting cultivation is very limited, and it is very difficult to find shifting cultivation area in the Intensive Area at present.

There are a large number of cattle in the related Sub-district and most cattle are used for draft animal. Since there is a limited pasture, farmers should utilize the fallow period of herbaceous crops under AGF-II and AGF-III as a grazing land for their cattle. The fallow period of herbaceous crops ranges two to four months. This could be said there is a type of agrosilvopastoral system, and this system is mainly found in Langowan, Remboken and Kakas Sub-districts.

Provincial forestry service would like to introduce agrosilvopastofishery system, however, this system cannot find in the Intensive Area at present.

(5) Improper Agricultural Land Use in the Steep Sloped Area

There is steep sloped area along the road surrounding Tondano Lake. There can be found improper land use along the road of lake shore.

Improper Farming

These areas are formerly secondary forest or under tree dominant agroforestry system. Farmers cleared these land for maize cultivation with less consideration on soil conservation.

Another improper land use can be found in Village Kawatak, of Langowan Sub-district and in Village Tandegan of Eris Sub-district. These areas are formerly secondary forest and old clove garden. Recently farmers cleared these field for replanting clove or planting annual crops.

Present condition of these field is shown in Table G.4.4 and summarized below.

Improper Land Use in the Steep Sloped Area

	Kakas	Remboken	Tondano	Langowan	Eris
No. of place	6	3	7	1	1
Slope (%)	50-58	27-36	36	73	31
Area (ha)	2.2	0.9	2.2	14.0	1.5

(6) *Alan Alan (Imperata)*Grassland

The area of *Imperata* grassland area could be estimated at less than 10 ha in the Intensive Area by field reconnaissance. It is distributed in Tondano, Remboken, and Eris Sub-district. The largest area of *Imperata* grassland is estimated at less than 1 ha. It could be estimated that these area can be easily improved by planting trees densely.

4.1.5 Crop Production

(1) Planted Area

The planted area of major tree crops under different category of farming system is estimated by field reconnaissance. The estimated planted area is shown Table G 4.5 and summarized below.

Planted Area of Tree Crops by Different Farming Category

Unit: ha

Farming	Coconut	Clove	Coffee	Other estate crops	Fruit	Hedge tree	Other trees*
AGF-I	141	993	116	95	165	58	1,067
AGF-II	12	137	0	0	14	44	185
AGF-III	28	333	27	15	48	49	549
UF	4	4	0	0	2	44	120
Total	186	1,466	143	110	228	195	1,922

Other estate crops include cocoa, cinnamon and vanilla
Other trees include timber trees, fuel wood trees and shade trees

Planted area of Major Tree Crops by Area

Unit: ha

Area	Coconut	Clove	Coffee	Other estate crops	Fruit	Hedge tree	Other trees*
East	83	846	55	47	64	48	616
South	49	196	19	10	19	46	616
West	54	424	69	53	146	101	972
Total	186	1,466	143	110	228	195	1,922

Other estate crops include cocoa, cinnamon and vanilla
Other trees include timber trees, trees fuel for wood and shade trees

In the Intensive Area, major tree crop is clove. Clove gardens are relatively concentrated in middle or steep sloped in the East Area, and small scaled clove gardens are scattered in the medium to gentle slope of the South and the West Area. Coffee, cocoa and vanilla are planted in small scale, and scattered in and around the tree dominant agroforestry areas on hilly slopes. Coconut is also scattered in the hilly tree complex areas and residential areas mainly for home consumption. Fruit trees are mainly planted in home garden and the area close to residential area.

Other trees area amounts 1,920 ha. Species of these trees and their area is presented in Table G. 4.6. Major species are sugar palm, bamboo, *Albizia* and *Ficus spp*. Some of the trees are planted and others are autogenous. A larger part of these trees are found in AGF-I, especially in steep sloped area. These trees forms tree complex with some estate cops and fruit trees in steep slope area. These trees are also observed in almost the Intensive Area. Tree density is relatively high in AGF-III and very low in UF area. From these facts, it could be supposed that a larger part of agroforestry system in the Intensive Area is now transitional stage from forest to AGF-I Type I-2, I-5 and AGF-III Type III-2, or forest to UF. There could be big space to improve agroforestry system.

Hedgerow cultivation is popular, and there is not much difference in the hedgerow area among the farming category. Hedgerow area could be estimated at some 200 ha in the Intensive Area, the hedgerow area and hedgerow plant are shown in Table G.4.7. Dominant hedgerow plant is *Gliricidia* which occupies some 75% of total hedgerow area.

The planted area of major upland crops under different category of farming system by the Area is shown Table G.4.5 and summarized below.

Planted Area of upland Annual Crops by Different Farming Category

Unit: ha

	Maize	Groundnuts	Cowpeas	Cassava*	Vegetables
AGF-I	142	0	1	6	0
AGF-II	1,631	83	32	11	118
AGF-III	1,617	90	41	4	36
UF	1,953	150	55	10	187
Total	5,343	323	129	32	341

**: includes sweet potatoes*

Planted Area of Upland Annual Crops by Area

Unit: ha

	Paddy	Maize	Groundnuts	Cowpeas	Cassava*	Vegetables
East	621	623	3	9	3	1
South	200	1,785	19	83	1	155
West	200	2,935	301	37	29	185
Total	1,021	5,342	323	129	32	341

**: includse: sweet potatoes*

Maize is dominated in overall flat and sloped upland areas, and is mainly planted by mono-cropping in flat area and inter-cropped in a part of estate gardens situated sloped areas. Some pulses such as groundnuts and cowpeas are cultivated as rotation crops. Groundnuts are often observed in the West Area, while cowpeas mainly in South Area. Vegetables such as tomato, leaf onion and chili are observed mainly in flat area under UF close to residential area. Other vegetables are very limited. Cassava is generally planted along the border of farm.

The cropping intensity of herbaceous crops under different category of farming system by the Area is shown Table G.4.5 and summarized below

Cropping intensity under Different Farming Category by Area

	East	South	West	Whole area
AGF-I	0.538	0.480	0.491	0.517
AGF-II	1.154	1.411	1.317	1.335
AGF-III	1.240	1.447	1.256	1.299
UF	1.379	1.522	1.246	1.338

Cropping intensity of annual crops varies with farming category and area. Generally speaking, cropping intensity is higher for UF and decreases with an increasing of tree density in the field. It is higher for South Area than for East and West Area. In the South Area, intensive agriculture is carrying out. From the view point of agro-climate, there are high possibility of double cropping, however cropping intensity is under 1.5 in the Intensive Area. Farmers always don't use their farm land fully for crop production and some plots are kept as temporarily fallow land to conserve soil fertility and to feed animal. Since there are not enough grazing land, farmers should temporarily use their farm land for grazing and crop residue is used for animal food after harvesting of crops.

(2) Crop Production

The amount of crop production is shown in Table G. 4.8 and summarized below.

Crop Production

Unit: tons

Crop	Location			
	West	East	South	Total
Tree crops				
Coconut	54	83	49	186
Clove	106	212	50	368
Coffee	66	52	18	136
Cocoa	17	2	0	19
Vanilla	2	2	1	5
Herbaceous crops				
Maize	9,720	2,407	6,225	18,352
Ground nut	319	6	22	347
Cowpea	52	23	125	200
Cassava	435	45	15	495
Vegetables*	1,358	14	1,197	2,569
Paddy	2,903	5,069	1,920	9,892

** Production is estimated by the yield of tomato.*

Since there is no difference in the crop yield among the area, crop productin is governed by the planted area. In the East Area production of tree crops is high compared with other area, while that of field crops is low compared with other area. On the other hand, production of tree crops is low in the South Area, but that of field crops is high in the South Area.

4.1.6 Present Farming Practices

At the flat or gentle sloped area, farming practices of annual crops seem to be fairly good. Maize is cultivated as main upland crop and occupies some 90% of planted area of palawija. Pulses are introduced for crop rotation, and supply nitrogen to the soil by atomospheric nitrogen fixation, though those planted percentage is still lower. Mechanization of farming is far behind, and most of farming practices are carried out by man power and draught animal power even in flat area. In the paddy cultivation, land preparation and threshing is partly mechanized. There are a number of draught cattle, it is required a grazing land, however there is not enough grazing land, and animals are grazed at temporary fallow land. This is one of the reason why the cropping intensity of upland farm is less than 2. From view point of soil erosion, these areas seems to be well maintained as a whole.

At the medium to steep sloped area, a larger part of farmers employed agroforestry system and they practice contour farming and ridging for not only for annual crops but also for tree crops. Some farmers make ridges very methodically, while some farmers do it roughly. Sometimes they make simple terraces with dry grasses or crop residues collected from harvested fields and introduce hedgerow trees like *Gliricidia,*

Calliander, etc., mainly at downside of farm for protection soil from erosion. In steep sloped area, no tillage cultivation of maize is often observed, for soil conservation and saving labour cost. Generally farming practices in sloped areas are observed slightly extensive comparing with flat area, and farm input supply seems to be flexible depending on price trend of farm input and output. At the steep sloped area, small scale upland farming is sometimes observed, especially in parts of the East and West Area.

These sloped areas have high soil erosion potential, if improper farming would be employed. But serious erosion is observed in limited area at present. If farmers continue an extensive farming in the sloped area, serious soil erosion would occur. However, there are some rooms to increase productivity under present condition by improving farming practices. If farmers would employ intensive farming practices to get high productivity without considering soil conservation at sloped area, agricultural production would not be sustainable.

In the Intensive Area, seed quality is not so good because most of seeds are farmers' own sesds, quantity of fertilizer application and chemical application are lower than recommendation of extension office. Cropping intensity is still lower. Biological disasters are often observed in vegetable gardens. Transportation condition and post harvest facilities are not sufficient. But the environmental condition is preferable for agriculture, because abundant trees (estate trees, hedgerow trees, multipurpose trees) contribute soil fertility through organic matter supply to farm area.

4.1.7 Crop Budget of Major Crops

Farm input, farm output major crops at present condition were estimated based on the collected data through the field survey and interview at concerning local government offices. The estimation are shown in Table G.4.21 and summarized below.

Crop Budget of Major Crops

Unit: Rp 000

	Coconut	Clove	Coffee	Maize	Groundnut	Coepea	Vegetable	Paddy
Gross value	1,200	6,000	5,700	2,900	4,320	4,098	7,000	4,800
Input cost	1,130	4,315	3,060	2,548	3,140	2,868	7,258	3,305
Labour cost-1	650	3,115	2,060	1,648	1,800	1,568	6,058	2,225
Labour cost-2	480	1,200	1,000	900	1,340	1,300	1,200	1,080
Return-1	550	2,885	3,640	1,253	2,520	2,531	7,943	2,575
Return-2	70	1,685	2,640	353	1,180	1,231	6,743	1,495

Rreturn 1: Total Return- Total Cost, Return 2: Total return- Paid Cost, Labour cost 1: hired labou,r Labour cost 2: Family labour.

4.1.8 Farm Economy

(1) Farm Economy

Based on the result of farm household survey, information from BIPP and District Food and Horticultural Crop Service, the farm economy of average farmer of each Area is estimated. The results is shown in Table G.4.9 and summarized below.

Farm economy Average Farm Household

Unit: Rp 000

	East	South	West	Intensive Area
Gross Income				
Agriculture	8,114	6,932	7,079	7,375
Non-Agriculture	3,290	2,450	2,700	2,813
Total	11,404	9,382	9,779	10,188
Expenditure				
Living	6,700	5,560	5,830	6,030
Farm Cost	4,257	3,398	3,579	3,745
Total	10,957	8,958	9,409	9,775
Balance	447	424	370	414

Farm size

Unit: ha

	East	South	West	Intensive Area
Farm size	1.62	1.09	1.20	1.30
Low land	0.18	0.12	0.12	0.14
Upland	0.60	0.85	0.84	0.76
Estate land	0.84	0.12	0.24	0.40

Income from agriculture ranges from 71% to 74% of total. There is no big difference in ratio of agriculture income to total among the Areas. The total income and income originated from agriculture are also high in the East Area, because of larger cropping area. The living cost is higher for the East Area than for the South and West Area.. The balance ranges from some Rp 370 to 447 thousand, average at Rp 414 thousand.

(2) Farmers' Intention for Crop Production in RRA Survey

According to RRA survey, the representatives of farmer put on income sources on maize, paddy, clove, pulses, vegetables etc. Almost all farmers in the Intensive Area gave the highest priority on maize and paddy cultivation. The second priority varies with Sub-districts, to clove and fishery in Eris, to cowpea in Langowan, sugar palm, duck and fishery in Kakas, to vegetables and pulses in Tompaso and Remboken, and to estate crops, vegetables and fruits in Tondano. Generally farmers intend to focus on what they currently cultivate in area by area.

4.1.9 Animal Husbandry

Livestock population in the related Sub-districts is as follows.

Livestock in Related Sub-districts (1999)

Livestock	Cattle	Horse	Pig	Goats	Chicken	Duck
Heads	12,418	4,914	14,250	1,622	300,419	23.130

Source: Laporan Tahunan Dinas Peternakan 1999 Kab.Minahasa

Major livestock in the Intensive Area is cattle, pig and chicken. The dominant varieties of cattle are BACAN (Mixed Bali) and PO (Prime Offspring). About 90% of cattle are used for draught and 10% for beef production. Generally cattle is fed with concentrate (maize, rice bran, oil waste, etc.) feed and grasses which mainly grow on temporary fallow field and roadsides. Pig and chicken are rearing at local residential area, and this Area is the center of duck rearing in Minahasa District.

Local markets for livestock are held once a week at Longawan and Kawangkoan. Trading routes of livestock are as follows:

(1) Draught cattle

Farmer --- Farmer
Farmer --- Collecting trader --- Inter-island trader
Farmer --- Local Market --- Collecting trader --- Inter-island trader

(2) Beef cattle, Pig

Farmer --- Collecting trader --- Slaughter house
Farmer --- Slaughter house

District Livestock Office pointed out the following current problems on animal husbandry.

Farmers' awareness for cattle uses are still low. Farmers uses cattle only for draught. The facilities and funds for cattle development are not sufficient. To increase of quantity and quality of livestock, it is necessary to upgrade knowledge of government staffs and farmers.

4.1.10 Inland Fishery

(1) Outline of Inland Fishery

Lake Tondano has brought up several species of fishes for a long time. The main fish species are shown in following table:

Fish Species in Tondano Lake

Common Name	Local Name	Scientific Name
Spanglet	Payangka	Ophocara aporos
Java Tilapia	Mujair	Tilapia mossambica
	Nila	Oreochromis nilotica
Murrel	Gabus	Ophiocephalus striatus
Common Carp	Ikan Mas	Cyprinus carpio
Catfish	Lele	Clarias batracus
Grass Carp	Ikan Koan Rumput	Stenopharyngodon idellus

In recent years, natural fish resources has declined due to over fishing and deterioration of water quality of the Lake. Furthermore the accidents happened in 1995 and 1996, at that time watercolor of the Lake suddenly changed to brown resulted to death of huge number of fish, causing by a meteorological phenomenon (later explained in (8)), accelerated to the declining. In addition traditional fishing no longer brought about much income because of its low economic efficiency. The number of traditional fishermen is shown in Table G.4.10. Recently number of traditional fishermen are decreasing, and now half of them are actually inactive.

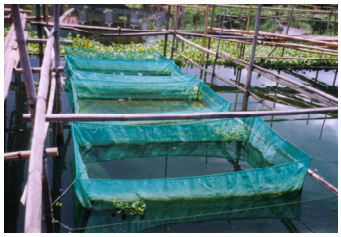
In 1984/85 Provincial government introduced fish cultivation technology using floating net cage into Lake Tondano. Fishermen began to change their traditional fishing to the fish cultivation by modified net cage system, so called "Pen System", using bamboo fence. At same time price of clove started to decline and many farmers tried to do fish cultivation instead of clove cultivation. Then, fish cultivation has increased rapidly year by year. In Lake Tondano, currently about 482 households are carrying out fish cultivation by total of about 5000-6000 net cages (Table G.4.10)

As fish cultivation has been enlarged, it is worried that water quality of Lake Tondano might be deteriorated by residual feeds and fish feces coming from fish cultivation. According to the water analysis data, water quality of Lake Tondano has already declined considerably. The mechanism of water deterioration is still not analyzed but it could be said that fish cultivation may accelerate it to some extent though there is no evidence revealed quantitatively. Despite, now it seems to be noticed that the influence of endless escalation of fish cultivation on the environment of Lake Tondano

Site of Fish Cultivation

(2) Present Condition of Fish Cultivation

Study Team conducted interviews to concerning persons. Out of concerning Sub-districts on the lakeside, Eris is the biggest fish cultivation site, which has about 330 households cultivating fish, followed by Kakas, Tondano, Remboken and Touliambot. The results of interview with questionnaires (See Attachment-G.2) are summarized in Tables G.4.11 and G.4.12.



Fish Cultivation by Net Cage

Almost all fish cultivation sites are located at lakeside or close to the lakeside. Every site is constructed with lots of bamboo fences hanging net cages for fish cultivation. At the middle of the fish cultivation site, each fisherman usually sets a small bamboo cottage where he often stays for management of cultivating fish. Average number of net cages per household is estimated at about 10-12.

The size of a net cage is generally about 30 cubic meters.. About seventy percent of cultivated species is Tilapia (*Nila*) and 30% is Carp (*Ikan Mas*). Number of fish fry per cage is about 1000 to 1500 amounted to 30 kg. One cage of fish fry grows to 200 to 300 kg during a cultivating period that is usually 3 to 4 months, and about 300 to 500 kg of fish feeds are consumed in this period. Generally three times of cultivation are carried out in a year (Tables G.4.13 and G.4.14).

(3) Fish Feed

Generally the fishermen use pellet feed for fish cultivation, but some fishermen use Mollusk (a kind of shell fish) from the Lake for carp cultivation. Most of pellet feed come from Surabaya, and recently a small feed manufacturer, whose production capacity is only 1 ton/per day in average, has been established at Tondano. They produce pellet feed according to the recommendation of District Fisheries Service. Ingredients of pellet feed are rice bran, fish powder, soybean, by product of coconut oil, noodles powder, maize, cassava, vitamins and minerals (Table G.4.15).

Fish cultivation size varies widely depend on the households. It ranges from minimum 5 net cages to maximum 300 net cages. Total number of net cages in the lake is shown in Table G.4.10. Since 1999, the number of net cages is still not determined, but it can be estimated at 5,000-6,000 cages, 10-12 cages per household. According to following assumption, the feeds consumption becomes to considerable amount.

Number of fishermen: 480
Average number of net cages: 10 cages
Amount of feeds per cage per period: 350 kg

Yearly feed consumption per cage : 350 kg x 3 times=1,050 kg = 1ton
Total feed consumption : 480 x 10 x 1=4,800 tons

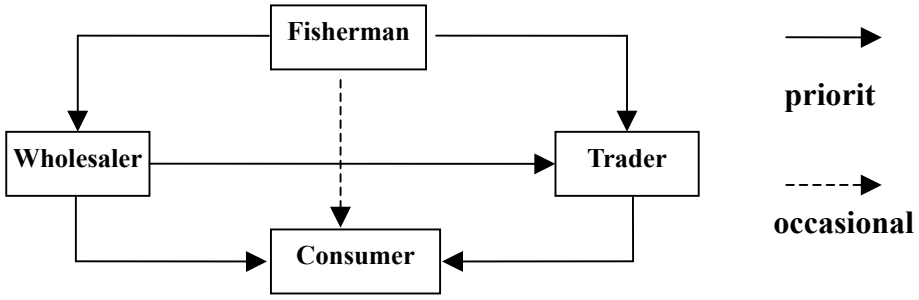
Supposed that 20% of feeds become to residuals and feces, about 1,000 tons of organic materials will be discharged into the lake. Incidentally, according to a research report for aquaculture, it is reported that nitrogen retention rate in fish body to total supplied nitrogen is only about 35%, and remaining nitrogen is lost as gill excretion, feces and uneaten feed.

(4) Present Socio-Economic Situation of Fish Cultivator

There are no cooperative specialized to fish cultivation activity, but 18 fishermen groups with 20-30 members in average, have been established mainly to get information from extension workers who are stationed at lake side of Sub-districts. Accordingly all of fish cultivator themselves are running individually. They procure fish seeds partly from the provincial and private hatcheries and partly from the Lake, and get most of fish feeds as a pellet type from feed manufactures.

The unit price of cultivated fish is about Rp. 7,400/kg. Average production value per household in one cultivation period is about Rp.1.77 million and production cost is some Rp. 1.17 million which is composed of Rp. 220,000 of seed and Rp.950,000 of feed. The average income is estimated at some Rp. 600,000 per household. Supposed that a fisherman has 10 net cages and cultivate 3 times per year, he will be able to get Rp.18 million in a year, though initial cost and replacement cost of net cages are not included (Table G.4.16). Initial investment cost at some Rp. 4 million will be required for 10 net cages cultivation (bamboo fence, small cottage, construction cost, net cages, etc.). The cost of a net cage is about Rp.175,000 and it must be replaced with supporting bamboo fences once a 3-5 years. Usually daily management is carried out by family labours.

Traders or wholesalers visit fishermen to purchase cultivated fishes. Marketing system is shown as following figure. Fisherman asks trader to sell his cultivated fishes and trader pays money to the fisherman after selling fishes. Wholesalers directly buy cultivated fishes from fisherman.



The major constraints of fishermen are capital deficits for fish cultivation, low price of products against high feed cost and increasing water hyacinth in the lake that affect to cultivation management. From the experiences in 1995-96, they fear some damages caused by sudden change of water color of the lake. According to heads of village, they think fish cultivation should be develop as the important business in future and some of them considered water deterioration by fish cultivation must be little. Some fishermen also recognize that fish cultivation may affect to the water quality of the lake, while some deny it.

(5) Government View

1) Provincial Fishery Service Office

Development programmes of Provincial Fishery Service Office for inland fishery development in Lake Tondano are summarized as follows:

1) to increase the production of fish cultivation and fish stock
2) to introduce grass carps into the lake for biological control of aquatic weeds,
3) to provide reservation area of restocking fish, and to improve the structure of net cages and feed efficiency for conservation of water quality.

The Office recognizes water quality deterioration of the lake, but understands that it is not so serious for fish cultivation at present. If it is necessary for controlling water quality, the District Fishery Service Office should be responsible for the control of fish cultivation.

2) District Fishery Service Office

The development programmes of District Fishery Service Office for fish cultivation in Lake Tondano is summarized as follows:

1) Increase of number of cages for increase of production of fish cultivation
2) Upgrading of fishermen's skill
3) Expansion of marketing of the products
4) Arrangement of fish cultivation area for more efficient production
5) Introduction of grass carp for control of aquatic weeds

(6) Regulation of Fish Cultivation

There is no regulation on the basis of government law to carry out fish cultivation in Lake Tondano. The fisherman who wants to begin fish cultivation contact with Head of village and neighbors and after getting their agreements (in most cases he will be permitted), he can start his fish cultivation. Besides the fish cultivation running by

local fishermen, there are some fish-restaurants located at lakeside, serving cultivated fishes from their net cages. These restaurants are also not regulated. Heads of village consider government if necessary should do the control of fish cultivation, but they also think lakeshore conservation and control of domestic wastes are rather important for the lake.

(7) Fish Cultivation as a Water Pollutant

It is difficult to judge whether the present situation of fish cultivation in Lake Tondano is critical or not for water conservation of the lake. Because there are still few data of load of pollutants come from other sources such as domestic wastes, agricultural drainage (including fertilizers and animal wastes) and natural flows from the whole watershed area, so as to know the contribution rate of fish cultivation in total pollutant load pouring to the Lake.

Therefore, before control of the fish cultivation, accumulation of these data is essential and in addition, hydrological analysis of replacement of the lake water (inflows, outflows, convection mechanism, etc.) should be more studied. Furthermore, from viewpoints of environment and socio-economy it is important to discuss what kind of water quality standard should be applied for the lake water. However it is considered that the load of organic pollutants causing by fish cultivation should not be neglected taking into consideration about its huge feed consumption, as the water quality of the Lake has already deteriorated in recent years.

(8) "Air Lewo" Phenomenon

Air Lewo means bad water. This phenomenon occurs usually in the beginning of rainy season when strong south wind lasts and large mass of water flows into the lake, and it is believed that this raises up-welling of organic deposits from the lake bottom. These deposits consume much amount of oxygen and produce hydro-sulfide, methane and ammonia, and make water color brownish. Fishermen are afraid of it very much. This phenomenon had occurred during the period from 1995 to 1998, especially in 1995 and 1996. In the studying of water quality in Lake Tondano, analysis of this mechanism is important because it must be affect water quality of the lake.

4.1.11 Agricultural Extension Service

Agricultural extension service is carried out by Agricultural Information and Extension Service (BIPP) and forestry extension service by District Forestry Service. BIPP has 17 specialists and 234 extension workers (PPL) for food crop and

horticultural crop sub-sector, 2 specialists and 114 PPLs for estate crop sub-sector, 5 specialist and 63 extension workers for animal husbandry sub-sector, 4 specialists and 68 extension workers for fishery sub-sector, but there is no specialist and limited number of PPL for agroforestry (See Table G.4.17). District Forestry Service has 2 specialist (soil conservation and forest) and 64 extension workers but only few extension workers for agroforestry development. These officials covers whole Minahasa District. However, farmers always complain that they have some difficulties to contact to PPL. PPL visit farmers only once a month or sometimes once a year due to shortage of budget for activities of PPL. Since agroforestry has been recognized in early 1980's as an important area of scientific inquiry, education and training in agroforestry lags far behind other agricultural and forestry disciplines, leaving a definite shortage of experienced, qualified trainers in agroforestry. Only limited number of officials in District Forestry Service guide farmers technically as a side job. Only BRLKT has established demonstration farm of agroforestry at Remboken Sub-district.

4.1.12 Current Problems on Agriculture and Agroforestry System in the Intensive Area

There is two categories of problems on agriculture production, one is production side and the other is marketing. The biggest problem for production is relatively low level of cultural practices, biological disasters, high production cost and poor extension service, while constraints for marketing is quality control of commodities, low price of commodities and fluctuation of price. Biological disasters and quality control of commodities could be controlled by strengthening extension activity.

No farmers in the Intensive Area have raised complain against the existing agroforestry system in spite of the productivity being not so high. It could be explained that the agroforestry system in the area has short history, and farmers can not adequately understand agroforestry system. When the farmers can get knowledge on agroforestry system, problems would come to the surface. By field observation, following problems can be pointed out.

1) Improper agricultural land use due to lack of information on soil conservation
2) Still using rudimentary agroforestry system
3) Poor maintenance for tree crops and herbaceous crops
4) The activities of agricultural and forestry extension service have declined
5) There is no extension activity for agroforestry system.

4.2 Improvement Plan of Agriculture and Agrofrestry

4.2.1 Needs of Watershed Conservation from the Viewpoint of Agriculture and Agroforestry

Some 80% of the Intensive Area are presently used for agricultural activities. Out of them, about 80% are located at undulated and sloped area gradient more than 8%. Such topographic conditions require the more careful land use to keep sound soil conservation and soil fertility. In fact, the interviews with farmers concerned revealed that improper farming practice on clove cultivation would cause tremendous surface soil erosion in 1980s.

A well-designed agroforestry system is one of the most effective system for soil conservation and increase of soil fertility, which farmers could participate in. In the Intensive Area, some 80% of agricultural upland are already covered with agroforestry system. But it is mostly at rudimentary level judging from its random plant spacing of trees, and thus it is essential to improve the present agricultural system, to realize the watershed conservation functions mentioned above.

On the other hand, the fuel wood consumption is significant in the Intensive Area. About 40 kg/household of fuel woods would be consumed in a week on average. Farmers get it from their fields and bush and/or purchase it from other farmers at present. Agroforestry including hedgerow cropping also highly contributes to supply of fuel woods without disturbing environment.

Dissemination of well-designed agroforestry system needs intensive extension services. However, there is poor extension system for agroforestry development in the Intensive Area. It is urgently necessary to establish the extension system for agroforestry development. Since agroforestry has been only recently recognized as an important field for soil fertility increase in the tropics, education and training in agroforestry lag far behind other agricultural disciplines leaving a definite shortage of experienced and qualified trainers. Therefore, training for specialist, extension workers and farmers are urgently required.

4.2.2 Strategy for Agiculture and Agroforestry Development

Based on the principles and objective of WACSLU, **Strategy 3, Reduction of potential critical land,** could be proposed for agricultural development. As a larger part of the Intensive Area is undulated and sloped area, soil conservation practices is one of the key factors for agricultural development. Agroforestry system is one of the most effective farming systems for soil conservation and increase of soil fertility and productivity. However there is poor extension system for agroforestry development. Under this condition, key components of agriculture and agroforestry development as

follows.

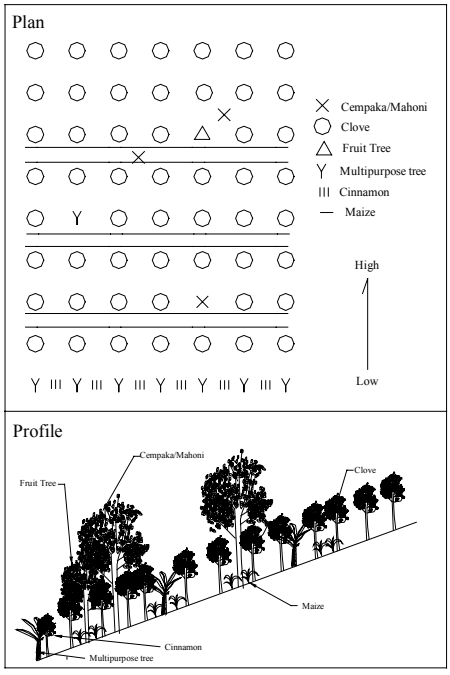
- No drastic change in agricultural land use system and farming practices
- Suitable farming category and agroforestry system for each Zone should be selected by considering characteristics of agroforestry system and physical and social condition.
- Suitable tree species and crop should be selected by considering present cropping pattern, requirement of solar radiation, marketing and demand supply balance, transportation of commodities, price of commodities and requirement of farmers and community.
- Spacing of trees and tree crops should be determined by requirement of solar radiation by crops, crop management and crop yield.
- Introduction of multipurpose trees should be employed for not only soil conservation but also fuel wood supply
- Fruit trees, rapid growth multipurpose trees and some estate crops should be introduced for water front green belt
- To establish extension system for agroforestry and strengthen agriculture and forestry extension system.
- Strengthen of training for specialists extension workers and farmers.

4.2.3 Improvement of Agroforestry System and Cultural Practices

Improvement plan of each type of present agroforestry system is explained below:

(1) AGF-I (type I-2)/IM

AGF-I (typeI-2) / IM



Clove should be planted regularly at replanting time and spacing of clove and/or other trees should be gradually reformed by replanting and removing of trees. For reforming of spacing of trees, firstly clove seedlings should be planted at he designed spacing and secondly old trees would be cut down when seedlings become production trees. The plant density of clove is proposed at 200-300 plants per ha. For the completion of reforming plant spacing it would take some 5-10 years.

AGF-I (Type I-2)/IM will consist of some fruit trees such as durian, mango, langsat

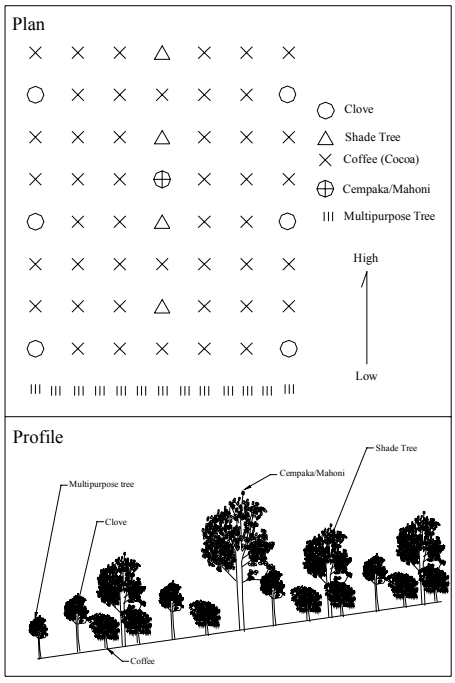
avogado, banana, etc., and timber trees such as *Cempaka (Elmerilla spp.)* and mahogani (*Swietenia spp.*) with a low plant density (less than 20 plants per ha). Hedge trees such as cinnamon and multipurpose tree like *Gliricidia* and *Calliandra* are proposed at 1.5m for cinnamon and at 0.5-1.5m for multipurpose trees (Figure G.4.1). Herbaceous crops like maize and pulses are cultivated under trees by row cultivation at the row width 70cm. Planting area of herbaceous crops would decrease with a growth of trees. For herbaceous crop cultivation, it is required to apply soil conservation technique such as contour ridge cultivation, mulching and no-tillage methodss.

(2) AGF-I (Type I-4)/IM

This system would be applied only for steep-sloped area. The present land use should be mostly left as it is from he view point of well maintenance of bio-diversity and prevention ofsoil erosion. In the area where tree plant density is relatively low, tree/tree crops should be planted and high density of trees should be kept. In this connection, it is recommended hat existing indigenous species such as *Kayu Sirih* (*Piper aduncum*) and *Ficus spp*. should be kept as much as possible.

(3) AGF-I (Type I-5)

AGF-I (Type I-5) / IM



Proposed combination of tree crops are clove and coffee or cocoa with shade trees, fruit trees such as durian, mango, langsat avogado, banana, etc.,timber trees like *cempaka* and mahogani and hedge treessuch as cinnamon, Gliricidia and Calliandra (Fig G.4.2). In the case of clove-coffee (cocoa) garden, plant density of clove and coffee (cocoa) is proposed 100 trees/ha and 800 (400) trees/ha respectively. Spacing of clove could be proposed at 20 x 5 m., for coffee at 3 x 3 m. Proposed plant density of fruit trees and timber trees are less than 20 trees/ha, and spacing of hedge trees areplanted at 0.5-1.5 m. Distance between hedge rows is proposed at some 50 m (Figure G.4.2).

(4) AGF-I (Type I-6)/IM

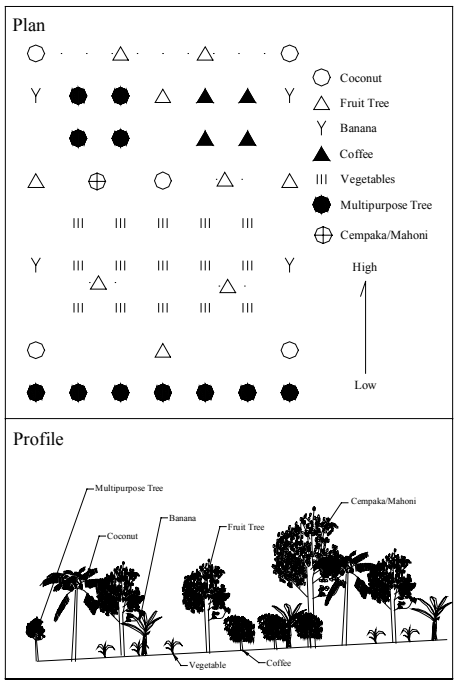
It is necessary to pay attention to prevention of soil erosion for home garden situated at the waterfront of Lake Tondano. To plant hedge trees on the border of the field is one

of possible measures.

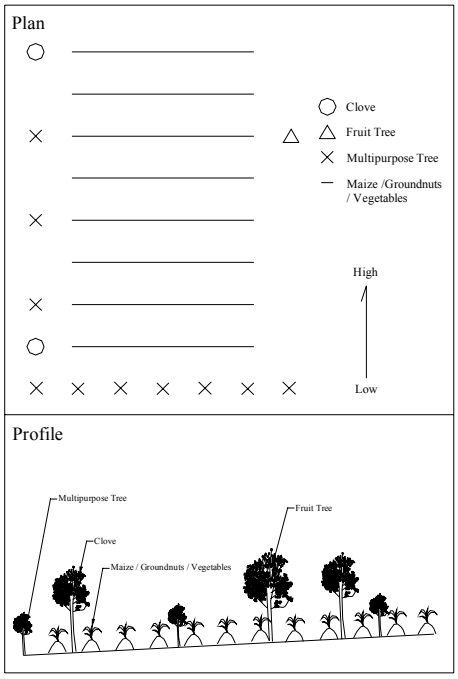
(5) AGF-II (Type II-2)/IM

Clove and other tree crops/trees should be rearranged. Clove should be planted near the border of field at the low plant density (30-50 plant/ha), and other trees such as fruit trees, coconut, cempaka should be planted at the border of field with hedge trees (Figure G.4.3). As there is some soil erosion potential in this system, it is required to provide soil conservation technique for annual crop cultivation. The proposed soil conservation technique are employ contour ridge cultivation, mulching and no-tillage cultivation. Since the plant density of trees is low compared with other agroforestry system, supply of organic matter becomes low. Therefore, Leguminosae hedge trees such as *Gliricidia* and *Calliandra* are effective for organic matter supply and increase of soil fertility by ayomospheric nitrogen fixation. These will also contribute to fuel wood supply. The spacing of hedge trees is recommended at 0.5-1.5 m.

AGF-I (Type I-6) /IM



AGF-II (Type II-2) /IM



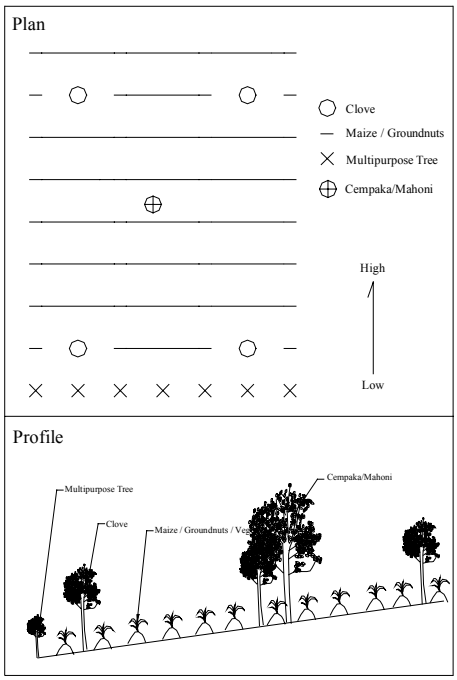
Considering soil conservation, farmers' requirement (based on RRA survey) and increase of soil fertility, it is also proposed to employ crop rotation system such as cereals- pulses-vegetables-cereals under this system. Area ratio of these crops could be recommended at 80% for cereals, 15% for pulses and 5% for vegetables from the view point of present farming pattern, home consumption, marketing, labour requirement and price of commodities.

(6) AGF-III (Type III-2)/IM

Clove would be regularly planted at wide row and narrow distance considering

herbaceous crop cultivation. Spacing of clove would be ordinary some 6 x 6 to 7 x 7 m (plant density at some 200-300 plants/ha). In this type the proposed spacing of clove would be 14 x 5 m (plant density at 140 plants/ha) considering working efficiency and distribution of solar radiation (Figure G 4.4). Herbaceous crops such as maize and pulses would be cultivated between clove rows, at the row width at 70cm for maize, 70cm to 150cm for pulses. In this system, total production value would become 130%-150% of mono-culture of clove. Fruit trees and timber trees are proposed to be planted in the field at low plant density (less than 20 plant/ha). As there is still some soil erosion potential even in this system, it is required to provide soil conservation technique for herbaceous crop cultivation. The proposed soil conservation technique is to apply hedgerow cultivation, mulching, contour ridge cultivation, no-tillage cultivation for herbaceous crop cultivation. The spacing of hedge trees is recommended 0.5 to 1.5 m.

AGF-III (Type III-2) / IM

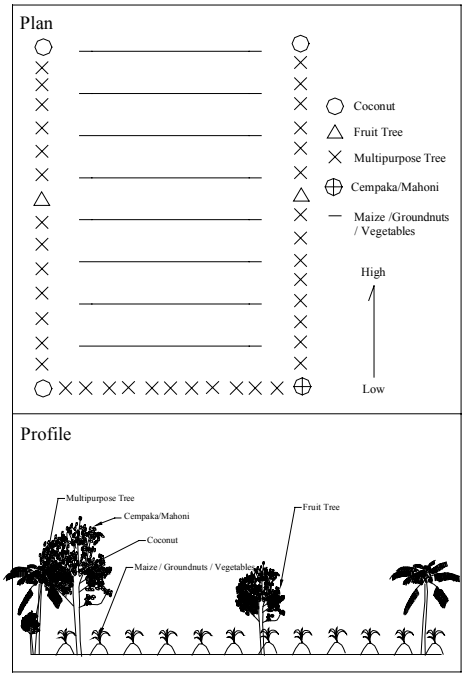


(7) UF/IM

Increase of hedgerow cultivation area and multipurpose tree density in the hedgerow is proposed in this system. Hedgerow cultivation would heighten organic matter supply to soil and soil fertility by atomospheric nitrogen fixation, and also could increase in supply of fuel woods to farmers. In UF/IM in F zone, it is proposed to introduce Leguminisae trees such as Gliricidia and Calliandra as a hedge tree, for soil conservation and keeping soil fertility, to supplement low organic matter supply (Figure G.4.5).

Considering soil conservation, farmers'

UF/IM



requirement (based on RRA survey) and increase of soil fertility, it is also proposed to employ crop rotation system such as cereals- pulses-vegetables-cereals under UF/IM. Area ratio of these crops could be recommended at 70% for cereals, 20% for pulses and 10% for vegetables from the view point of present farming pattern, home consumption, marketing, labour requirement and price of commodities. Major vegetables would be tomato, leaf onion, ginger, chili, long beans Pumpkins and cucumber. Cropping intensity of these crops could be recommended at 1.5 to 1.6, considering 1.3 to 1.5 of present cropping intensity and grazing cattle at fallow field.

4.2.4 Application of Suitable Agroforestry System by Area

In accordance with Section 4.2.1 the suitable agroforestry system for each zone has been selected through evaluation of each component as shown in Tables G.3.17, G.3.18 and G.3.1.9. The summary of application of suitable type of agroforestry system for each zone is shown below (Details are shown in Table G.4.18).

Application of Suitable Type of Agroforestry

Proposed Type	Area (ha)	Recommended Zone
AGF-I (Type I-2)/IM	1,900	Bm1 and Bm3 Zone
AGF-I (Type I-4)/IM	860	Bm1 and Bw Zone
AGF-I (Type I-5)/IM	100	Bm1, Bm2 and Bm3 Zone
AGF-I (Type I-6)	10	Bm1, Bm2 Bm3 and Bw Zone
AGF-II (Type II-2)/IM	1,760	Bm2, Bm3 and F Zone
AGF-III(Type III-2)/IM	1,970	Bm2 and Bm3 Zone
UF/IM	1,680	Bm3 and F Zone

4.2.5 Improvement Plan of Each Zone

(1) P Zone

Among the East Area, South Area and West Area, the encroached area of South Area is only discussed here, because there is no application of agroforestry system for the remaining two areas.

Proposed agroforestry system for the encroached area of some 30 ha, which will be treated as community forestry, are discussed at every three parts of upper part, middle part and lower part.

Upper part

In the upper part, more than 70% of the area is remained as rotational fallow land. It is therefore recommended tat upper part should become tree plantation with pine and multipurpose trees including fruit trees such as *Albizia, Gliricidia, Calliandra*, durian mangostin, mango, etc. Since the land utilisation of the area is very extensive, there is not much problem if farmers discontinue cultivation of annual crops. Therefore, it

could be proposed to start planting trees immediately after agreement between head of district (Bupati) and community.

Middle part

In the middle part, land is presently utilized more effectively than upper part. It is recommended that the middle part should be fruit tree dominant agroforestry system. The proposed species are durian, mangostin, mango, avogado, langsat, jackfruit, *Albizia*, *Gliricidia* and C*alliandra*. A larger part of the area is now under cultivated land. Planting of these trees would be completed during 20 years.

Lower part

In the lower part, an intensive agriculture is concentrated at present. Thus, there would be big problem for encroachers, if they would be forced to discontinue annual crop cultivation. It is recommended that the land use of lower part should be gradually changed by application of "Tumpansary" system within twenty years considering encroachers livings. The application rate of "Tumpansary" system could be proposed at 0.5 ha per year. Fruit trees such as durian, mangostin, mango, avogado, langsat, jackfruit and cempaka and mahogani are proposed in this system. Tree density at production stage would be 150-200 plants/ha. During the younger stage of trees some food crops and vegetables could be cultivated under trees. Maize, pulses, tomato chili and cucumber are recommended as annual crops, and taro/talas (*Colocasia esculenta*) and ginger are recommendable as annual crops during later stage.

Details for these proposed agroforestry system are mentioned in Sub-section 4.2.3.

(2) Bm1 Zone

Agricultural area of Bm1 Zone is estimated at 1,850 ha, out of which 1,620 ha are distributed in the East Area. Bm1 Zone is largely divided into steep sloped area and sloped area in terms of steep gradient.

Steep sloped area (more than or equal 40% in slope gradient: about 720 ha)

In this area, AGF-I (type I-4)/IM is proposed. For the limited area of some 20 ha, where improper farming practice are presently conducted, it is proposed to corrective measures such as ridge cultivation, no-tillage cultivation, mulching, terracing and hedgerow, to avoid further deterioration.

Sloped area (less than 40% in slope gradient: about 1,130 ha)

AGF-I (Type I-2)/IM and AGF-I (Type I-5)/IM are proposed in this area from a view point of soil conservation and production. AGF-I (Type I-2)/IM would be applied for larger part of this area (Some 1,100 ha in total; 810 ha for the East Area and 290 ha for

West and South Areas). AGF-I (TypeI-5) could be proposed for about 100 ha in this zone.

Details for these proposed agroforestry system are mentioned in Sub-section 4.2.3.

(3) Bm2 Zone

Agricultural area of Bm2 Zone is 3,630 ha. Some 2,600 ha of total are distributed in the West Area followed by the East Area (520 ha) and there is a small area of Bm2 Zone in the South Area (510 ha). The proposed agroforestry systems are as follows:

- AGF-III (Type III-2)/IM is basically proposed for 1,700 ha of the relatively low potential of soil erosion area
- AGF-I (Type I-2)/IM and AGF-I (TypeI-4)/IM are proposed for 1,080 ha and 90 ha of relatively high potential of soil erosion area, respectively.
- AGF-II (Type II-2)/IM is proposed for 690 ha of the low potential of soil erosion area.
- UF/IM is proposed for 70 ha of the low potential of soil erosion area.

Details for these proposed agroforestry system are mentioned in Sub-section 4.2.3.

(4) Bm3 Zone

Agricultural area of Bm3 Zone is about 1,500 ha consist of 1,110 ha in the West Area and 390 ha in the South Area. UF/IM, AGF-II (Type II-2)/IM and AGF-III (Type III-2)/IM are proposed in this zone, and occupy 770 ha, 640 ha and 90 ha, respectively.

Details for these proposed agroforestry system are mentioned in Sub-section 4.2.3.

(5) Bw Zone

Agricultural area of Bw Zone is 94 ha. It distributes in the east and west sides of Lake Tondano. Fifty percent of the area are dwelling area, which are surrounded by home garden, and 40% are lowland where paddy plant is cultivate throughout the year. Remaining 10% are upland covered with tree dominant agroforestry system and grass fallow.

For keeping the waterfront in good condition, it is proposed to make green belt along the lakeshore. In Bw Zone of the Intensive Area, followings are proposed for environment conservation.

1) AGF-I (Type I-4)/IM is proposed for steep-sloped area along the road. High tree density should be kept to mitigate soil erosion.
2) AGF-III (Type III-2)/IM for foot of steep-sloped area. In the area, herbaceous crop cultivation should be applied as soil conservation technique such as ridge row

cultivation, mulching and hedgerow etc.

3) Upland of grass fallow could be proposed to be changed into lowland field (flat and lower area) or into fruit tree dominant tree complex (undulated area).
4) In AGF-I (Type I-6)/IM (home garden), it is necessary to pay attention for soil erosion. To plant hedge trees on the border is one of possible measures.
5) Since the area is close to the lake, ground water level would be high, therefore, proposed trees should be resistant to high ground water level. Bamboo, *Ficus spp., Albizia Gliricidia* durian, avogado langsat, coconut sugar palm and sago palm, which are observed, are proposed to plant in water front.

Details for these proposed agroforestry system are mentioned in Sub-section 4.2.3.

(6) F Zone

Agricultural area of F Zone is 1,940 ha consisting of 620 ha of lowland and 1,320 ha of upland. Some 1,080 ha or 75% of upland distributes in the South Area.

UF/IM and AGF-II (Type II-2)/IM are proposed for this zone and occupy 910 ha and 410 ha, respectivly. Average weekly consumption of fuel wood per household is some 40 kg. Framers collect fuel woods from their field or bush. As F Zone is close to dwelling area, farmers can save labour force to collect fuel woods, if they can get fuel woods from the neighbouring area. Considering the fuel wood consumption and maintaining soil fertility, application of Leguminisae hedgerow is useful.

Details for these proposed agroforestry system are mentioned in Sub-section 4.2.3.

4.2.6 Anticipated Crop Production

The proposed planting area of each crops is shown in Table G.4.19, and summarized below. Since there is no big change in land utilization, the planted area of each crops would be slightly changed by improvement of agroforestry system and crop rotation. The planted area of tree crops would be increased, while that of field crops would slightly increased for pulses and vegetables, but decreased for maize.

Although present yield of food crops in the Intensive Area is relatively high comparing with the average yield of North Sulawesi Province and Indonesia, there is some space for yield increase by improving farming practices. The yield of these crops could be increased by application of improved cultural practices and by more intensive agricultural extension service. The yield of estate crops could be also increased by employing improved agroforestry system and by more intensive extension service.

By application of the project, crop production would increase. The production would

increase year by year and attain the anticipated production ten years for tree crops and five years for herbaceous crops after start of project.

Trend of yield of Tree Crops

Year	1	2	3	4	5	6	7	8	9	10
Increment (%)*	0	0	0	0	0	10	30	70	90	100

Trend of yield of Herbaceous Crops

Year	1	2	3	4	5	6	7	8	9	10
Increment (%)	0	30	60	80	100	100	100	100	100	100

**: shows the percentage of increased production to anticipated increased production*

The yields of major crops under "with project condition" could be estimated on the basis of present technology level, research outcomes on the yield potential, strengthening of agricultural extension service. The yields of the major crops under "without project condition" are estimated at the present yield level by considering on the yield level by considering on the yield trends of recent few years and the technology level of farmers. The anticipated crop yields thus estimated for the "without project" and "with project" conditions are shown below.

Anticipated yield and production

Crop	Area (ha)		Yield (kg/ha)		Production (t)	
	without	with	without	with	without	with
Paddy	1,020	1,020	4,800	5040	4,900	5,140
Maize	5,343	4,955	2,900	3,050	15,500	15,110
Ground nut	320	600	1,080	1,130	350	680
Cowpea	130	360	900	950	120	340
Vegetables	340	485	7,000	7,350	2,390	3,570
Clove	1,470	2,570	200	215	295	550
Coffee	190	270	950	1,000	180	270
Coconut	190	80	1,200	1,250	240	100
Other estate crops	110	160				
Other trees	2,203	981				

Future crop production after completion of the project could be estimated on the basis of the proposed land use, cropping pattern and anticipated yield of crops. The anticipated production in the Intensive Area is given in above table (Details are presented in Table G.4.20).

4.2.7 Crop Budget, Farm Budget and Farm Economy

Crop budget have been prepared based on estimated "without project" and "with project" conditions. The results of financial crop budget for each crop under future "without project" and "with project" conditions are summarized in following table (Details are shown in Table G 4.21). Under with project condition, net return of whole

crops would be increased for all the crops.

Crop Budget of Major Crops

Unit Rp. 000/ha

	Without project			With project			
	Gross Value	Production cost	Net Return	Gross Value	Production cost	Net Return	Increase from w/o
Paddy	4,800	3,304	1496	5,040	3,372	1,668	172
Maize	2,900	2,547	353	3,050	2578	472	119
Groundnut	4,320	3,140	1,180	4,520	3,272	1,248	68
Cowpea	4,098	2,868	1,230	4,323	2,969	1,355	125
Vegetables	12,000	8,084	3,916	12,600	8,295	4,305	389
Clove	6,000	4,315	1,685	6,450	4,675	1,775	90
Coffee	5,700	3,060	2,640	6,120	3,398	2722	82
Coconut	1,200	1,130	70	1,250	1,130	120	50

Farm budget have been prepared based on estimated crop budget and the planted area of each crops under "without project" and "with project" conditions. The results of financial farm budget for each crop under future "without project" and "with project" conditions are summarized in following table (Details are shown in Table G 4.22).

Farm budget

Unit: Rp million

East		South		West		Whole Area	
Without	With	Without	With	Without	With	Without	With
2,931	3,679	2,105	3,145	3,585	6,188	8,622	13,012

Under future "with project condition", incremental benefit would increase year by year and reached at Rp 4.4 billion in ten years after start of project.

Under the "with project condition, farm economy could be improved. The farm economy of average farmer under "with project" and "without project" condition of each Area could be estimated. The results is shown in Tables G.4.9 and G.4.23 and summarized below. Net benefit of average farm household under "with project" condition would be increased at some Rp five hundred thousand compared with that of "without project" condition.

Farm Economy of Average Farm Household

Unit: Rp 000

	East Area		South Area		West Area		Intensive Area	
	Without	With	Without	With	Without	With	Without	With
Income	11,404	12,221	9,382	10,205	9,779	10,534	10,188	10,986
Expenditure	10,957	11,254	8,958	9,245	9,409	9,617	9,775	10,039
Balance	447	967	424	960	370	917	414	948

4.2.8 Strengthen of Agricultural and Forestry Extension Service

(1) Extension system

Agricultural extension service has a long history and the extension system has been completed. According to RRA survey, farmers complain poor agricultural extension service (visiting service is very poor, once per month or two month) due to shortage of fund, especially in transportation cost. Therefore, project would provide transportation facility by supplying motor cycles and bicycle for strengthen agricultural extension service.

At present, extension system for agroforestry development under both District Forestry Service office and under Agricultural Information and Extension Service (BIPP) is very poor. These offices cover whole Minahasa District. There is no agroforestry specialist and few extention worker (PPL) in both District Forestry Service office and BIPP. It is urgently required to establish the extension service system for agroforestry under the District Forestry Service office. For intensive extension of agroforestry, three agroforestry specialist (soil conservation and soil fertility, crop management and forestry) and 60 extension workers (one extension worker for one village) would be required as a special programme. This special programme would be employed at least five years. Although some organizations have trained staff whose jobs are to train farmers, it may make sense for institutions to work with farmers as trainer in order to increase the efficiency of their staff and help more relevant to farmer needs. Under this condition, District Forestry Service, which handles agroforestry extension work, should closely cooperate with BIPP.

Since there are not enough extension services for intensive agricultural extension service required by farmers, it is necessary to employ more effective extension method. Followings are examples of effective agricultural extension service;

1) to collaborate with other related institutions such as universities and NGOs,
2) to adopt group guidance method by organizing farmers group and establishing demonstration plot,
3) to provide the chance of farmers training programme.

(2) Training programme

While agroforestry, as a land use practice, has existed for a long time, it has only recently recognized as an important area for crop production, soil conservation and increasing soil fertility, especially in the tropics. As a result, education and training in agroforestry lags far behind other agricultural disciplines, leaving a definite shortage of experienced, qualified trainers in agroforestry. Therefore, the training for planners,

specialist, extension workers and farmers is urgently required for agroforestry development. The training programme varies with each category of group. It could be proposed training programme on agroforestry under special programme which continue for five years. Following plan could be proposed.

1) Training for policy planners and specialist

The success of agroforestry development will depends in part on the firms conviction of policy makers, specialists and farmers who plan and implement it. Existing land-tenure policies, forest produce transit rules, forest laws and regulation which limit the practice of agroforestry should be reviewed and modified to enable to choose the species of their own choice and to market them as they see fit. Policy makers and specialist often need to be adequate trained to see the promise of agroforestry and constraints to successful implementation of the agroforestry development.

The training of planners and specialists aims:

- to strengthen their capabilities to develop policies and plans to increase production of commodities from agroforestry,
- to enable them to better support research and extension programmes for improving agroforestry systems to produce more commodities,
- to better understanding the market needs of farmers, processors and end users, and
- to organize training programmes in agroforestry within their own organizations.

To realize above mentioned, following curriculum would be proposed.

- agroforestry production and market study.
- soil and water conservation, seed and nursery management.
- information service and data base.
- technology verification (Field visit).

One week training course for planner and specialist would open three times per five years. Proposed trainer would be teaching staff of universities, researchers of research institute, government officers and NGO staff.

2) Extension worker training

Training topics for extension worker are mainly designed using a top-down approach and many prove appropriate to meet farmer's needs and problems. Thus extension workers need training in assessing farmers' needs. This may

include methods such as diagnosis and design, sketch mapping, rapid rural appraisal, problem census analysis.

Since a thorough understanding of agroforestry requires exposure to various disciplines, the extension worker needs to have some background in the subjects other than his own area of training.

Training courses, which add specific area of technical agroforestry knowledge, can be extremely valuable to extentionist who are generalist.

For extension worker who have either substantial field experience or technical training before entering agroforestry extension, participatory training approaches are most appropriate. In participatory training, both trainees and trainers become learners.

In stead of relying on traditional methods (lecture), greater emphasis could be placed is focused on the following method:

- working groups discussion,
- workshops,
- role playing,
- field visits and exercises, and
- case studies and study tours.

The training course for extension workers could be proposed to open once a year with one week duration. The combination of participatory training and traditional method are proposed as training measure for extension workers. Teaching staff of universities, researchers of research institutes, specialists of Provincial and District Forestry Service, government officers and NGO staff would be proposed as trainers.

(3) Training farmers

The training of farmers requires both sensitivity to farmers interests and solid knowledge based on experience. Framers are often interested in more money or increasing their productivity and efficiency. Successful training provides information and skills that help them to realize these gains. Proposed agroforestry training topics that may be of interest to farmers include:

- home nursery development,
- benefit of multipurpose tree and shrubs
- cultural practices of inter-cropping and no tillage
- soil and water conservation techniques
- simple record keeping and information management, and

- market information and marketing mechanism.

Effective training of farmers required thoughtful understanding and sensitivity to their needs, problems and resource constraints. Although some organizations have trained staff whose jobs are to train farmers, it may make sense for institutions to work with farmers as trainer in order to increase the efficiency of their staff and help make training more relevant to farmer needs. The training of farmers by demonstration farmer-trainers on real farms has been proven to be an effective means of encouraging other farmers to consider and adopt new farm practices.

Training for farmers is proposed two steps. At first step, key farmer (200 farmers, who are head of farmers group or leaders of village) would be trained and at second step they would work as farmer trainer. It is proposed that one week training course for key farmers would be open once a year. Specialists of District Forestry Service, extension workers and NGO staff would be proposed as trainer.

4.2.9 Implementation Schedule

Agriculture extension service would be strengthened by supply of transportation facility, from the first year. Agricultural extension activity would be concentrated on crop rotation during the period from the 1st to 3rd year, on cultural practice from the 1st to 5th years, on soil conservation from the 2nd to 4th year and on crop protection the 2nd to 5th year. There is observed rudimentary agroforestry system in a larger part of the Intensive Area. It is urgently required an improvement from the view point of soil erosion and productivity by rearrangement of tree crops. For rearrangement tree crops, it takes five years from the view point of life cycle of tree crops which have four years no production period after planting. For improving of agroforestry system, intensive extension service is required. Implementation schedule is shown below.

Implementation schedule of extension service for agriculture

Item	1st year	2nd year	3rd year	4th year	5th year
Planning					
Recruiting	■				
Extension programme	■				
Recruit					
Equipment	■				
Improvement of practices					
Cultural prctice		■	■	■	■
Soil consrvation		■	■	■	
Crop rotation	■	■	■		
Crop protection		■	■	■	■

Implementation schedule of extension service for agro forestry

Item	1st year	2nd year	3rd year	4th year	5th year
Planning					
Recruiting					
Training and extension					
Recruit					
Staff					
Equipment					
Training					
Specialist					
Extension worker					
Farmer					

Item	6th year	7th year	8th year	9th year	10th year
Improvement of practices					
Replanting tree					
Cutting tree					
Cultural prctice					
Soil consrvation					
Crop rotation					
Crop protection					

Recruiting of staff and equipment would be done in the first year. Training for specialist would be done three times in five years and for PPL and key farmers training course would be opened once a year. Extension activity for replanting of estate crops would be concentrated during the period from 1st to 3rd years, for cutting old trees from 3rd to 5th years, crop maintenance from 1st to 5th years, soil conservation from 2st to 4rd years and nursery technique from 1st to 2nd years.

4.2.10 Project Cost

The cost for special programme of strengthening of extension activity is presented in Tables G.4.24 and G.4.25 and summarized below. Total cost for special programme of strengthening of extension activity is estimated at Rp 4.5 billion.

Cost for Strengthen Extension and Training

Unit: Rp million

Administration	Training	Equipment	O and M	Total
2,417	186	1,592	398	4,593

The cost for planting of trees and cutting of old trees are included in production cost of estate crops.

4.2.11 Project Running Cost

Replacement of equipment would be done every ten years. Annual operation and maintenance cost is Rp 74 million during the period from sixth year to sixtieth year after starting of the project. The equipment would be replaced once in ten years and the cost for replacement of equipment is estimated at Rp 1.59 billion (See Table G.4.25).

4.2.12 Recommendation

(1) As a larger part of the Intensive Area is sloped area, there would be high possibility of soil erosion unless proper farming practice and adequate land use plan would be employed in future. Therefore, it is necessary to establish proper land use system for each category of land classified by zoning.

(2) Agroforestry system is the one of the most effective system for soil conservation and increase of soil fertility and productivity. It is necessary to select suitable agroforestry system to increase production and for more effective soil conservation.

(3) Suitable agroforestry system varies area by area. The suitable agroforestry system could be determined based on the physical condition, required vegetation, soil conservation technology, social condition and the characteristics of each type of agroforestry system. Since a larger part of agroforestry system is still rudimentary, it is necessary to improve agroforestry system and cultural practices. For improving agroforestry system and cultural practices, it is necessary not only to increase production but also to consider soil conservation for sustainable agriculture.

(4) Agroforestry is recently recognized as a important area crop production and soil conservation. As a result, education and training in agroforestry lags far behind other agricultural disciplines, leaving a definite shortage of experienced, qualified trainers in agroforestry. Therefore, the training for planners, specialist, extension workers and farmers is urgently required for agroforestry development.

(5) For inland fishery, it is necessary to be leveled up of fish cultivation technology and conservation of water quality of the Lake by strengthen extension service. Since there is no regulation for inland fishery, it is urgently expected to establish rules and by-law for sustaining inland fishery. For prevention of deterioration of water quality in Lake Tondano, it is recommended to monitouring of water quality of the Lake.