REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

THE FEASIBILITY STUDY ON THE NIAS ISLAND IRRIGATION AGRICULTURAL DEVELOPMENT PROJECT

Volume II

AGRICULTURAL DEVELOPMENT PLAN IN THE NIAS ISLAND

OCTOBER 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

THE FEASIBILITY STUDY ON THE NIAS ISLAND IRRIGATION AGRICULTURAL DEVELOPMENT PROJECT Vol. II Agricultural Development Plan in the Nias Island

REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

THE FEASIBILITY STUDY ON THE NIAS ISLAND IRRIGATION AGRICULTURAL DEVELOPMENT PROJECT

Volume II

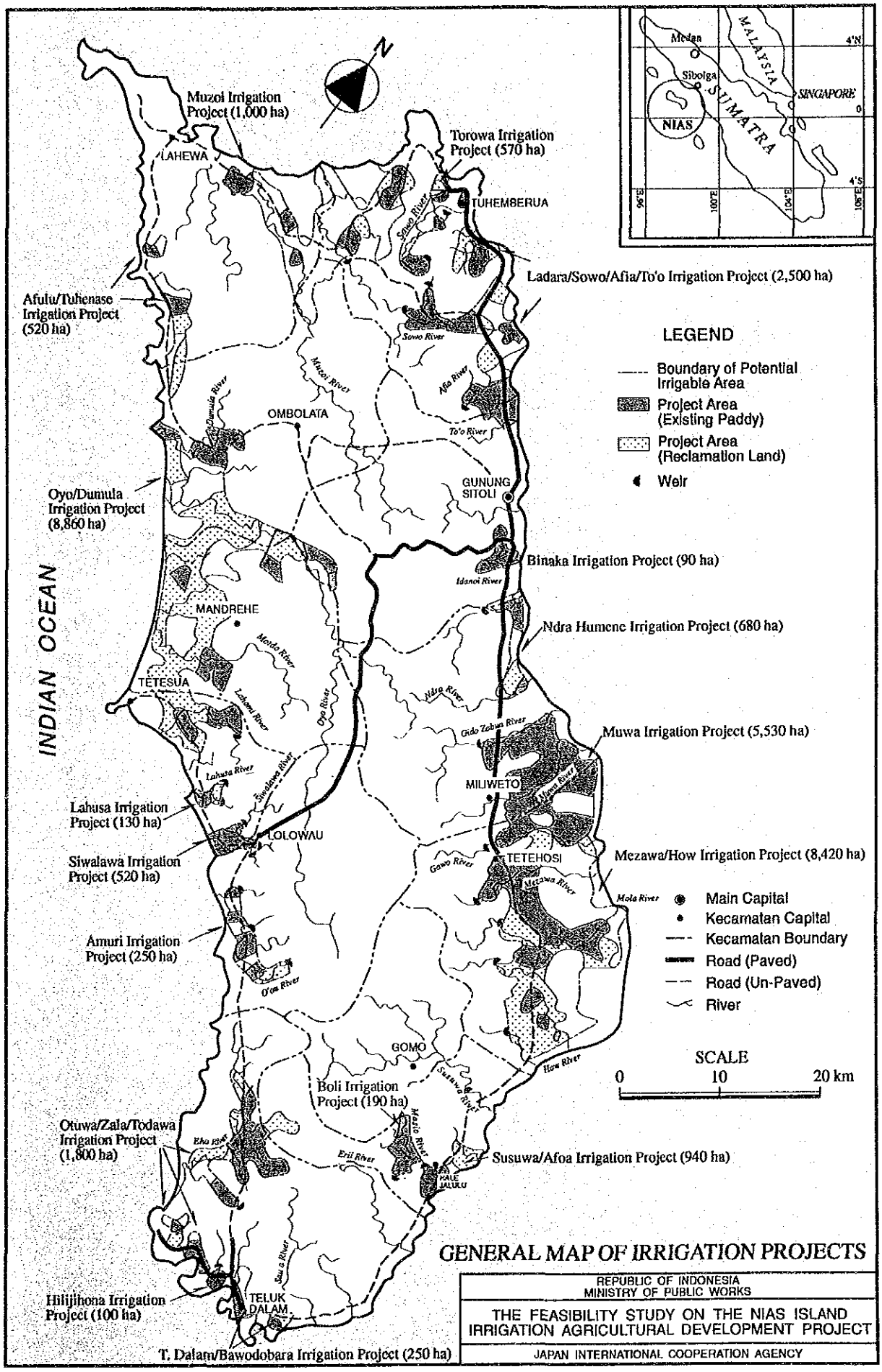
AGRICULTURAL DEVELOPMENT PLAN IN THE NIAS ISLAND

OCTOBER 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

LIST OF REPORTS

Volume I	**Main Report**
Volume II	**Agricultural Development Plan in the Nias Island**
Volume III	**Feasibility Study for the Mezawa/How Irrigation Development Project**



GENERAL MAP OF IRRIGATION PROJECTS

REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS

THE FEASIBILITY STUDY ON THE NIAS ISLAND IRRIGATION AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

THE FEASIBILITY STUDY
ON
THE NIAS ISLAND IRRIGATION
AGRICULTURAL DEVELOPMENT PROJECT

VOLUME II

AGRICULTURAL DEVELOPMENT PLAN IN THE NIAS ISLAND

CONTENTS

TABLES

FIGURES

GLOSSARY OF TERMS AND ABBREVIATIONS

ADB	- Asian Development Bank
AGRARIAN	- Badan Pertanahan Nasional
BAPPEDA	- Badan Perencana Pembangunan Daerah (Provincial Development Planning Board)
BAPPENAS	- Badan Perencanaan Pembangunan Nasional (National Development Planning Board)
BIMAS	- Bimbingan Massal
Bina Marga	- Directorate General of Highways
BPP	- Balai Penyuluhan Pertanian (agricultural extension center)
BRI	- Bank Rakyat Indonesia (People's Bank of Indonesia)
BRIUD	- Bank Rakyat Indonesia Unit Desa (village branch of BRI)
BULOG	- Badan Urusan Logistik
Bupati	- District Chief, Head of Kabupaten
Cabang Dinas	- PU Seksi, (Administrative area for Irrigation with the PU-Wilayah)
Camat	- Sub-district Chief, Head of Kecamatan
CRIFC	- Central Research Institute for Food Crops
CS	- Construction supervision
Desa	- Village or group of small villages
DGFCA	- Directorate General of Food Crops Agriculture, Ministry of Agriculture
DGWRD	- Directorate General of Water Resources Development, Ministry of Public Works
DIP	- Project Implementation Budget
DOI	- Directorate of Irrigation
Dolog	- Depot Logistik
DPT	- Dinas Pertanian Tanaman Pangan
DPU	- Direktorat Pekerjaan Umum Ministry of Public Works
FC	- Foreign currency
E/S	- Engineering services
FY	- Fiscal year (April 1 to March 31)

GDP	- Gross Domestic Product
GOI	- Government of Indonesia
Golongan	- Division of an irrigation area in order to phase planting and reduce peak water demand
Gotong royong	- Mutual assistance system
HYV	- High yielding variety
IACC	- Irrigation Agricultural Coordination Center
IBRD	- International Bank for Reconstruction and Development (World Bank)
ICB	- International competitive bidding
IGGI	- Inter-governmental Group on Indonesia
INMAS	- Intensifikasi Massal (massive intensification for self sufficiency in food)
INMUM	- Intensifikasi Umum
INSUS	- Intensifikasi Khusus (Special intensification program)
ISSP	- Irrigation Sub-Sector Project
JICA	- Japan International Cooperation Agency
Julu	- Official responsible for the day-to-day operation of an irrigation area, generally no greater than 1,000 ha
Kabupaten	- District (sub-division of province)
Kecamatan	- Sub-district within the Kabupaten
KUD	- Koperasi Unit Desa (Village unit co-operative)
KUPEDES	- Kredit Umum Pedesaan (general rural credit program)
KUT	- Kredit Usaha Tani
LC	- Local currency
LCB	- Local competitive bidding
LPT Bogor	- Lembaga Penelitian Tanah Bogor (Soil Classification System of Bogor)
LP3ES	- Lembaga Penelitian Pendidikan dan Penuangan, Ekonomi dan Social (Institute of Research, Education & Information for Social & Economy)
LS	- Lump sum
M & E	- Monitoring and evaluation

MCM	- million cubic meter (1000,000 m3)
MOPE	- Ministry of Population and Environment
M/M	- Man-months
OECF	- the Overseas Economic Cooperation Fund, Japan
O&M	- Operation and maintenance
PBME	- Project benefit monitoring and evaluation
PDAM	- Perusahaan Daerah Air Minum (Ministry of Drinking Water)
Pelita	- Five Year Development Plan
Pengamat	- Water distribution supervisor
PLN	- Perusahaan Listrik Negara
PMF	- Probable maximum flood
PMP	- Probable maximum precipitation
Polowijo	- All annual crops other than rice, sugar or vegetables grown on wet paddy land
PPA	- Penjaga Pintu Air (Gate operator)
PPK	- Penyuluhan Pertanian Kecamatan (Extension workers on Camat Level)
PPL	- Penyuluhan Pertanian Lapangan (Field extension worker)
PPM	- Penyuluh Pertanian Madya (agricultural extension supervisor)
PPS	- Penyuluh Pertanian Spesialis (agricultural extension specialist)
PPUP	- Penyuluh Pertanian Utama Pratama (subject-sector supervisor)
PRPTE	- Program for the rehabilitation and expansion of export crops, Ministry of Agriculture
PT	- Dinas Pertanian Tanaman Pangan (agricultural service)
PUSRI	- Pupuk Sriwijaya
P2AT	- Proyek Pengembangan Air Tanah (Groundwater Development Project)
P3A	- Perkumpulan Petani Pemakai Air (Water Users Association)

P3SA	- Proyek Pengembangan dan Penyelidikan Sumber- sumber Air (Water Resources Development and Planning Project)
RMG	- Rheinische Missiongesellschaft
Rp.	- Indonesian Rupiah
Sawah	- Wet rice field
SCF	- Standard conversion factor
SHS	- Sang Hyang Seri Seed Company
SUPRA INSUS	- Super Intensifikasi Khusus
S/W	- Scope of Work
TA	- Technical Assistance
TOR	- Terms of reference
TSP	- Triple Super Phosphate
T & V	- Training and Visiting
Ulu-ulu	- an employee of the P3A responsible for O&M of tertiary unit
UNDP	- United Nations Development Program
USDA	- United States Department Agriculture
VOC	- Dutch East Indies Company
Waker	- Assistant to the Juru stationed at the main river offtake
WKBPP	- Wilayah Kerja Balai Penyuluh Pertanian
WKPP	- Wilayah Kerja Penyuluh Pertanian (working area of field extension worker)
WUA	- Water User Association
WUAO	- Water User Association Organizer

CONVERSION FACTORS

	Metric to Imperial		Imperial to Metric	
Length	1 cm	= 0.394 inch	1 inch	= 2.54 cm
	1 m	= 3.48 feet	1 feet	= 30.48 cm
	1 km	= 0.621 mile	1 mile	= 1.609 km
Area	1 sq.m	= 10.76 sq.ft	1 sq.ft	= 0.0929 sq.m
	1 ha	= 2,471 acres	1 acre	= 0.4047 ha
	1 sq.km	= 0.386 sq.mile	1 sq.mile	= 2.59 sq.km
Volume	1 lit	= 0.22 gal (imp)	1 cu.ft	= 28.33 lit
	1 cu.m	= 35.3 cu.ft	1 gal (imp)	= 4.55 lit
	1 mil. cu.m	= 811 acre-ft	1 acre-ft	= 1,233.5 cu.m
Weight	1 kg	= 2.20 lb	1 lb	= 0.4536 kg
	1 ton	= 0.984 long ton	1 long ton	= 1.016 ton
Derived	1 cu.m/s	= 35.3 cusec	1 cusec	= 0.0283 cu.m/s
Measures	1 ton/ha	= 891 lb/acre	1 lb/acre	= 1.12 kg/ha
	1 cu.m/s	= 19.0 mgd	1 mgd	= 0.0526 cu.m/s
Temperature	°C	= (°F-32) x 5/9	°F	= 1.8 x °C + 32

CURRENCY EQUIVALENT
(as of end 1990)

US$ 1.0 = Rp. 1,850

1. INTRODUCTION

This is the Final Report for the Feasibility Study on the Nias Island Irrigation Agricultural Development Project prepared in accordance with the scope of work agreed upon between the Directorate General of water Resources Development, Ministry of Public Works (DGWRD) and the Japan International Cooperation Agency (JICA) on November 23, 1989.

This report presents (1) an assessment of land and water resources development potential in the whole Nias island, (2) setting up basic direction of the agricultural development in the Nias island, (3) identification and formulation of the irrigation development project in the Nias island and (4) determination of the project sequence.

2. AGRICULTURAL BACKGROUND

The Government has made every endeavor to increase foodstuff, especially paddy production, since the First Five Year Development Plan (Pelita I). In 1985 self-sufficiency in rice for the whole Indonesia was attained. Since then, there has been, however, no substantial increase in annual paddy production in Indonesia. Further, rice demand increases due to increase of population and per capita consumption. Thus, domestic paddy demand has gradually gained upon domestic production.

The Pelita V started from April, 1989. In this plan, the Government economic development strategy places strong emphasis on rural and regional development, one of the key factors of which is the agricultural sector. The agricultural sector aims at enhancing food production, especially rice, to meet increasing domestic demand, to provide rural employment, and to achieve balanced regional development. Besides the development of the main outer-islands, that of the medium scale islands (remote islands), which usually remain economically depressed at present, is one of the highest priority subjects to be performed by the Government.

The Nias island is one of the remote islands, located about 130 km west of the Sumatra island. It has an area of about 4,000 km^2 with population of 560,000. Agriculture is the main industry in the island. About 80% of the total population of the island are engaged in agriculture and its related activities. There are about 26,000 ha of paddy field. Out of them, about 10% are irrigated. However, these irrigation systems are under the categories of semi-technical and/or simple irrigation system. In spite of abundant land and water resources, development of irrigation in the Nias island has not yet performed because investment for irrigation sector has been concentrated in the main islands such as Java, Sumatra, Kalimantan and Sulawesi. Under such situation cropping intensity in the paddy field and yield of rice are low. Up to the present, self-sufficiency in

rice has not been obtained in the island. Rice movement to the island has gradually increased and reached 24,000 tons of rice in 1989.

In addition to the paddy field, tree crops such as coconut and rubber have been cultivated and played an important role in agricultural income sources. However, the international market price of these crops has been stagnant.

The Gross Domestic Product per capita in the island in 1988 is so low as either 43% of that of North Sumatra Province or 39% of the average GDP of whole Indonesia. The GDP per capita in the Nias island varies according to locations, ranging from Rp.414,000 (or US$230) in Kecamatan Gunung Sitoli to Rp.86,000 (or US$50) in Kecamatan Gomo as shown in Table 2.1.

3. THE STUDY AREA

3.1 Historical Background

The precise origin of the Nias people is not known, but accepted theory places them as having migrated to the island from mainland Southeast Asia between 2500 and 1500 BC. These emigrants, known as the Proto-Malays, were the first inhabitants of the Indonesian Archipelago. As indicated by their almond-shaped eyes and light complexion, it is likely that the early emigrants settling on Nias were of Mongolian descent. It is believed that the early Nias people have a common origin with the other Proto-Malay peoples of Indonesia such as the Dayaks of Kalimantan and the Toraja of central Sulawesi.

The oldest historical references to Nias come from Arab (851) and Persian (1154) sources but provide little information about the island and its inhabitants. The island was reported to be inhabited by cannibals and headhunters with trade between Nias and Sumatra being primarily coconuts and gold. Further historical record of Nias did not appear until the 17th century when Portuguese and Dutch explorers arrived in search of gold and spices.

The inhabitants of Nias refer to themselves as " Ono Niha " (children of the ancestors) and their island as " Tano Niha " (land of the ancestors). According to the myths of origin, the first divine ancestors came down to earth in the Gomo River region from which the people spread north and south over the whole island and eventually to the Batu Islands to the south of Nias. Although four recognizable groups of Nias people developed in the south, west, central and north regions of the island, none emerged as distinct kingdoms or political units. Likewise for the island as a whole, no central authority or kingdom developed. This political weakness led to Nias Island being dominated by outside powers.

Up to the middle of the 19th century Nias Island was dominated by the Achenese Kingdom of northern Sumatra. During this period the Achenese and Dutch bought slaves and coconuts from Nias, paying for them with gold. Nias slaves were sold on main land Sumatra and in Singapore. In 1756 the English visited Nias which led to the Dutch feeling obliged to make a settlement to defend their rights in the region. A trading post was established in Gunung Sitoli but it was abandoned after a few years.

On the pretension of suppressing slavery and protecting the people of Nias from the Achenese, Great Britain under Lieutenant-Governor Sir Thomas Stamford Raffles took possession of Nias in 1822. In 1825 the British Government ordered Raffles to withdraw from Nias so as not to provoke a conflict with the Dutch. But it was not until fifteen years later that the Dutch established a permanent presence on the island.

The Dutch East Indies Company (VOC) built a military fort in Gunung Sitoli in 1840. Military expeditions were undertaken in 1847, 1855, 1856, 1857 and 1863 to establish Dutch control of Nias Island. Throughout the period of British and early Dutch occupation of Nias, the slave trade continued despite its official abolition. Only in 1864 were the islands off the west coast of Sumatra, including Nias, officially placed under Dutch authority.

In 1865 the first Protestant Christian missionaries arrived on Nias from the Rheinische Missiongesellschaft (RMG) of Barmen, Germany. The Lutheran Society began missionary activities on the Batu Islands in 1889. Acceptance of Christianity by the people of Nias was slow up to 1915, but between 1915 and 1930 the number of converts grew fivefold reaching 85,000. After Indonesian independence the Catholic Church became established on Nias, growing to include 17% of the present population of Nias. Spirit worship and the erection of megalithic monuments continued in more remote mountains regions up to the second world war. Since Indonesian independence the ancient belief system of Nias has

disappeared as the most isolated communities have accepted Christianity.

Dutch military expeditions were again conducted for a year in 1900-1901 and for one month in 1908 in southern Nias. The first expedition was to protect the Dutch trade mission and the second to put down a local insurrection. Dutch colonial rule continued until 1942 when the Japanese took control of Nias. Japanese colonial control ended with the ending of the war and Indonesia's proclamation of Independence in August 1945.

During the colonial period Nias was governed from Padang as part of the West Sumatra Regency. After independence Nias was put under the government of North Sumatra province. Hence since 1945 political administration of Nias has come from Medan as capital of the province. The Nias Regency (Kabupaten Nias) was established including Nias Island and the southern islands known as Pulau-Pulau Batu. Present administration divides Kabupaten Nias into 13 sub-districts (Kecamatan), with 12 Kecamatans on Nias Island and 1 Kecamatan encompassing all of the southern island of Pulau-Pulau Batu.

3.2 Administration

The Nias Island is located about 130 km southwest of the Sumatra island. The area of the island is about 4,000 km^2. Administratively, the Nias island is under jurisdiction of Kabupaten Nias, North Sumatra Province. The Nias island consists of 12 Kecamatans, 651 villages and 6 urban sub-districts.

3.3 Population

The basic Socio-data of the Nias Island are shown in Tables 3.1 to 3.5.

The total population of the Nias Island as of 1989 is estimated at 559,000 consisting of 95,000 households. The average population density in the island is estimated at 140 persons/km^2, ranging from a minimum of 560 in Kecamatan Lahusa to a maximum of 2,600 in Kecamatan Gunung Sitoli. The average family is estimated at 6.

The distribution by sex and age class for Nias as a whole is normal with a slight predominance of female children (below age 15) and female adults. The Kabupaten child-adult ratio is 1 : 1.22 (or 1 : 1.21 without Kecamatan Pulau-Pulau Batu), which is similar to that found elsewhere in Indonesia.

Among the Kecamatan there is a wide range of child-adult ratios and median ages. The child-adult ratios are highest in Kecamatan Idano Gawo (1 : 1.97) and Kecamatan Lahewa (1 : 1.75) where the median age is 21 years. The lowest child-adult ratio is 1 : 0.87 in Kecamatan Teluk Dalam where the median age is only 13 years. These variation in age composition of individual Kecamatan can be clearly seen in the graphic representations of the population pyramids prepared for each Kecamatan.

It appears that a large percentage of adult males and females, especially in the age classes from 15 to 30 years, leave Kecamatan Teluk Dalam to find work elsewhere. Assuming that they are moving to, and finding work in, Kecamatan Idano Gawo and Kecamatan Lahewa this also may account for the larger number of young adults in these two Kecamatans and subsequently an older median age. These inequities in median age and age structure have implications on the availability of labor for these Kecamatan.

The native inhabitants of Nias Island are all of a single tribe/ethnic group known as the Suku Nias, or " Nias People ". Among the Nias people there are 169 margas, or clans, whose membership is based upon blood relations. Non-Nias people living on the island include ethnic Chinese (2,188 people or 4% of the total population) and an unknown number of other Indonesians. The other Indonesians on Nias island are predominantly from nearby areas of mainland

Sumatra such as the north Tapanuli area of North Sumatra Province, Ache Province, and the Padang area of West Sumatra Province. No statistical information is available on the number of non-Nias people, but it is estimated that they constitute less than 10% of the total population of Nias Island.

The inhabitants of Nias are predominantly Christian (77% Protestant and 17% Catholic), with approximately 6% being Islamic. Buddhists constitute less than 1% of the population and are exclusively ethnic Chinese. In addition there is a small number of Hindus (67 people).

Over 81% of the population of Nias list their primary occupation as farming. Fishing is not distinguished as a separate category in this data source. The second largest occupation category is that of government service (7.5 %). The only other significant occupation category is that of traders who constitute 6% of the total population of Nias.

3.4 Climate

At present, there are 6 rainfall stations including 4 meteorological stations in the Nias island (Fig. 3.1). The climatic data in these stations are available for 7 to 11 years. Tables 3.6 to 3.15 show the details of climatic features of the Nias island.

The climate of the Nias island is characterized by the monsoons. An annual rainfall averages 3,000 mm. There is a considerable year to year variation in rainfall, ranging from 2,200 mm to 3,500 mm. The wettest season is from September to December.

The annual average temperature is about 26° C with very little seasonal variation throughout the year. The mean daily temperature varies from 30° C at maximum to 21° C at minimum. The relative humidity averages about 90% with very little seasonal variation throughout the year. The annual mean sunshine duration is 49%

ranging from 38% in September to 61% in June. Mean wind velocity is about 0.4 m/sec.

Probability analysis of the rainfall has been done using the data of the Gunung Sitoli station which provides the most reliable data with a long observation period. The annual rainfall with 5-year return period is estimated at about 2,600 mm (Table 3.16). In spite of relatively high annual rainfall, long consecutive rainless spells sometimes occur through the year as shown in Table 3.17. The consecutive rainless spell with 5-year return period is estimated at 17 days. The average rainfall distribution in Gunung Sitoli is illustrated in Fig. 3.2. The relation between the mean monthly evapotranspiration and the rainfall is shown in Fig. 3.3.

3.5 Rivers and Run-off

3.5.1 River system

There are about 30 rivers in the Nias island. These rivers have a small catchment area of less than 200 km^2 except the Muzoi, the Susuwa, the Oyo and the Eho. The stream gradient of these rivers is very steep. The gradient is from 1/40 to 1/170 in the upper stream and 1/550 to 1/750 in the downstream. The location, conditions of these rivers and the cross section of these rivers are shown in Figs. 3.4 to 3.6 and summarized in Tables 3.18 and 3.19.

3.5.2 River run-off

(a) The gauging stations

At present there are 3 gauging stations in the Nias island that are installed on the Mezawa, the Oyo and the Eho. The water level records in these rivers are available for 4 to 7 years, however the rating curve for these rivers is not yet prepared. The location and features of these gauging stations are illustrated in Fig. 3.7 and shown in Table 3.20.

(b) River run-off percentage

Since there are few available and reliable data on run-off, the river run-off percentage of the rivers in the Study area is examined and estimated by three methods; (1) direct measuring of river discharge at the main rivers, (2) estimation using the present water level records by preparing the rating curve and (3) estimate using the rational water balance formula.

Direct measuring of river discharge:

During the survey period of Phase-I, river discharge of the Mezawa, the Gawo, the Mola and the Muzoi was measured. The observation points of river discharge are shown in Fig. 3.7. Especially the river discharge observed on August 25, 1990 is the drought discharge when the 10 consecutive rainless days occurred in the catchment area. The results are shown in Table 3.21. The results indicate that specific run-off of the these rivers is about 1 to 2 $m^3/s/100km^2$ or 315 to 630 mm/year. It is considered that about 10 to 20% of the annual average rainfall (3,000 mm) contributes to the basic flow.

River run-off from water level records:

The rough rating curve is prepared based on the results of cross section survey and discharge measurement at the Mezawa and the Oyo. The run-off percentages of these rivers are estimated as follows; (Since there is no rainfall record in the catchment area of two rivers, rainfall data at the Gunung Sitoli station is used.)

The Mezawa river

Year	Rainfall (mm)	Run-off depth (mm)	Run-off percentage (%)
1984	2,418	1,262	52
1985	2,675	1,432	54
1986	2,376	125	53
1987	1,666	854	51
1888	-	-	-
1989	1491	678	45

The Oyo river

Year	Rainfall (mm)	Run-off depth (mm)	Run-off percentage (%)
1984	613	240	39
1985	2,849	1,356	48
1986	2,844	1,331	47
1987	1,666	926	56

River run-off estimated by the water balance formula:

Generally, the relation among rainfall, areal evapotranspiration and surface run-off within the large area during a long hydrological cycle is presented by the following formula.

$$R=(ETa + Qo) \quad \text{----------} \quad (a)$$

in which R : rainfall
ETa : evapotranspiration
Qo : surface run-off

Further, there seems to be a relation among the aerial evapotranspiration, evapotranspiration estimated by the Penman's method which is applicable in the humid climate region, and the potential evaporation as shown in the following formula.

$$ETa + ETpen = 2ETpt \quad \text{----------} \quad (b)$$

$$ETpt = 1.26 \times \Delta \times Rn / (\Delta + r) \quad \text{----------} \quad (c)$$

in which ETpen : evapotranspiration estimated by the Penman's method

ETpt : potential evaporation

Δ : rate of change of the saturation vapour pressure with temperature

r : psychrometric constant

Rn : net radiation in equivalent evaporation in mm/day

Based on the above formula, ETa, ETpen and ETpt in the Study area are calculated as shown in Table 3.22. Accordingly the following formula is obtained;

$$ETa = 0.58\ ETpen$$

A coefficient of 0.58 falls within a range of 0.5 to 0.8 which is considered to be reasonable in the humid climate region. It is considered that the value of ETa is almost constant unless the drought period continues abnormally for a long time. Therefore run-off percentage increases in proportion to rainfall like the following example;

R (mm/year)	ETa (mm/year)	Qo (mm/year)	r (%)
2,400	1,190	1,210	50
2,600	1,190	1,410	54
2,800	1,190	1,610	58
3,000	1,190	1,810	60
3,200	1,190	2,010	63
3,400	1,190	2,210	65

It may be concluded that the run-off coefficient calculated by using water balance formulae is more applicable than that estimated by water level record. Because (i) the rating curves

prepared for the rivers are uncertain because of low level of precision of data and short period of data, (ii) the river section at the gauging stations is liable to change whenever floods come, and (iii) since rainfall record at the Gunung Sitoli station used in this study is not in the catchment area of the Oyo and the Mezawa rivers, relation between rainfall and discharge is uncertain. Furthermore the run-off coefficient calculated considerably accords with the value obtained by the direct measurement of the rivers.

Flood discharge:

In order to estimate flood discharge, flood mark survey of Mola, Mezawa, Gawo and Muzoi rivers was carried out. Annual flood discharges at the observation points are estimated as shown in Table 3.23.

3.5.3 Water quality

Quality of the river waters and ground waters in the Nias island has been analyzed to use for irrigation water and drinking water. The analysis has been carried out by the quick test method for the items of pH, EC, iron, zinc, ammonium and colon bacillus. A total of 12 samples have been taken : 4 from the rivers and 8 from the existing wells. The locations are shown in Fig. 3.8. The results of the analysis are shown in Table 3.24.

3.6 Geology

The geology of the Nias island (see Fig. 3.9) consists mainly of Neogene and Paleogene Tertiary; widely scattered in the whole island. This material is composed of mudstone, shale, sandstone and some gravels. Around the margin of the whole island, uplifted coral limestone is widely observed. The lifted height is estimated at about 30 to 50 m above the sea level.

Alluvial plains are located in some part of the island and some areas consist of deep alluvial soft layers having clayey soils with partly peats.

Palegone is located in the middle center of the island and widely stripped along lineation of the island.

Geological structure of the Nias island is composed with folded and faulted bed rocks. Generally, bed rocks folding has the same direction with its length (northwest-southeast). Also its bed rocks faulting has same direction and some of faultings cross the southern part of the island (southwest-northeast). Generally the faults from northwestward to southeastward are uplift faultings and they are characterized by a wide and heavy erosion zone.

The geology of the prospective dam site upstream of the Mezawa area (Idano Mezawa) consists of Tertiary mudstone and coral limestone. The foundation rock of mudstone is weathered and coral limestone, laid on mudstone is fragile and very porous. Therefore it is important to settle an adequate method when dams are constructed. Considering the foundation mudstone, this rock is generally massive, impermeable. Some part is very porous and the directions of permeable water pass are very at random. A big problem might occur if the dams are constructed on this porous coral limestone.

3.7 Soils and Land Capability

3.7.1 Soils

According to the Indonesian National Soil Classification Systems, LPT Bogor (Lembaga Penelitian Tanah Bogor, 1971), soils in the study area have been classified into 13 great soil groups. They are,

I. Soils formed on coastal plain ;

including (1) Peat Soils, (2) Marine Swamp Soils and (3) Regosols,

II. Soils formed on alluvial plain ;

including (4) Alluvial Soils, (5) Gray Hydromorphic Soils,

III. Soils formed on Terraces ;

including (6) Latosol, (7) Renzina, (8) Red Yellow Mediterranean Soils,

IV. Soils formed on Undulating hill ;

including (9) Red Yellow Podzolic Soils, (10) Red Podzolic Soils,

V. Soils formed on Steep mountainous area ;

including (11) Brown Podzolic Soils (12) Yellowish Brown Podzolic Soils and (13) Lithosols

Distribution of these soils is illustrated in Fig. 3.10 and the extents by soil groups and their characteristics are shown in Table 3.25. They are summarized as follows:

Land Form/Great Soil Group	Area (ha)	Area (%)
I. Coastal Plain		
(1) Peat Soils	5,200	1.3
(2) Marine Swamp Soils	3,200	0.8
(3) Regosols	18,500	4.6
Sub-Total	26,900	6.7
II. Alluvial Plain		
(4) Alluvial Soils	20,900	5.2
(5) Gray Hydromorphic Soils	45,900	11.4
Sub-Total	66,800	16.6
III. Terraces		
(6) Latosols	10,500	2.6
(7) Renzina	11,700	2.9
(8) Red Yellow Mediterranean Soils	66,700	16.6
Sub-Total	88,900	22.1
IV. Undulating Hill		
(9) Red Yellow Podzolic Soils	118,000	29.3
(10) Red Podzolic Soils	3,600	0.9
Sub-Total	121,600	30.2
V. Mountainous Area		
(11) Brown Podzolic Soils	4,800	1.2
(12) Yellowish Brown Podzolic Soils	15,300	3.8
(13) Lithosol	78,100	19.4
Sub-Total	98,200	24.4
Total	**402,400**	**100.0**

Soil of (1) is distributed on the swampy lowland along the coastal line with slope less than 2%. Soil of (1) is mainly formed from swamp forest, the peat deposited is well decomposed and the depth of peat layer measured during Phase-I field survey period is in range of 0.3 to 0.6 m. The soil (1) is rich in nitrogen contents, poorly to

very poorly drained, acid and black to olive black colored soil. Distribution of the soil (2) is limited to the lower part of Muzoi river basin and sowo area; the soil is affected by sea water, the natrium contents are generally high, and the soil reaction is slightly alkaline. The soil (2) is formed from marine sediments and very poorly drained. Present vegetation of the soils (1) and (2) is swamp forest and these soils could be developed for tree crop production if the drainage condition is improved. According to USDA taxonomy, the soils (1) and (2) are classified as Tropofibrists/Tropohemists and Sulfaquents, respectively.

The soil (3) is narrowly distributed along coastal line with slope of less than 3% and is mainly used as coconut plantation. The soil is coarse textured, strongly acid, light olive to olive gray colored. The drainability of this soil group depends on micro-topography and varies widely. The fertility of this soil is generally low. The soil of this group is formed from marine sand and sand dunes, and effective soil depth ranges from 30-90 cm. According to USDA taxonomy, soil of this group is classified as Tropopsamments or Tropaquents and is only suitable for coconut plantation under proper management.

Both of the soils (4) and (5) are formed on alluvial plain with slope of less than 3%. They have a moderately fine texture, are poorly to moderately well drained and slightly to very strongly acid with effective soil depth ranging from 60-90 cm. Parent material of these soils is alluvial deposits. The soil (4) is olive gray colored and moderately fertile and classified as Fluvaquents or Tropofluents. The soil (5) is light olive gray colored with iron mottle and classified as Hydroquents. The lands covered with these soils are partly used for rice production and coconut plantation. The soils of these groups are highly suitable for rice farming under proper irrigation development. Due to poor drainability of the soil (5), drainage improvement of this soil group is required.

The soils (6), (7) and (8) develop on terraces with slope ranging from 8-25% and are well drained. Both of the soils (7) and (8) are derived from limestone or marlaceous rocks and the soil (6) is formed

from dacient rocks. Effective soil depth of (6) and (7) is in range of 60-90 cm and that of (8) is 30-60 cm. These soils are extensively used as rubber plantation. Their soil reaction is slightly to strongly acid: (6), neutral to slightly alkaline: (7) and (8). Due to high gravel contents, the soil (7) is not suitable for intensified farming without any amelioration. These soils are characterized as red to brown-dark red colored:f (6), dark red colored: (7) and bright yellowish brown colored: (8). The soils of these groups are moderately fertile have and fine texture. The soils (6) and (7) are suitable both for upland and tree crop cultivation. According to USDA taxonomy, the soils (6), (7) and (8) are classified as Haplorthox, Rendolls and Tropudults/ Tropudalf, respectively.

The soils (9) and (10) are distributed on hilly/undulating land with slope ranging from 25 to 40%. Parent materials of these soils are acid rocks or rhyolite and present vegetation is bush, secondary forest or rubber plantation. They are well drained, strongly to very strongly acid and low fertility soils. The soil (9) has fine texture and (10) has moderately fine texture. Effective soil depth of these soils is in a range of 60-90 cm. Colors of the soil (9) and (10) are bright yellowish brown and bright reddish brown, respectively. According to USDA taxonomy, the soils (9) and (10) are classified as Tropudults or Tropudalf. Both of the soils are suitable for rubber or clove plantation.

The soils (11) and (12) are developed on mountainous area with slope ranging from 25% to 40%, and derived from acid rocks. These soils are well drained, have moderately fine texture, with moderately effective soil depth (60-90 cm) and moderate fertility. The soils of these groups are partly developed for rubber cultivation or shifting cultivation and the natural vegetation is bush or secondary forests. According to USDA taxonomy, both of these soils are classified as Eutropepts or Humitropepts. The soils of these groups are suitable for tree crop cultivation.

The soil (13) is found on steep mountainous area with slope of more than 40% and has been suffering from erosion hazards. The soil is excessively well drained, very acid, light colored, and has

moderately coarse texture and low fertility. Due to residual condition, effective soil depth is as shallow as less than 10-30 cm. Present vegetation of this soil is bush or rock out crops. From the viewpoint of land conservation, the soil (13) should be reserved for reforestation. According to USDA taxonomy, the soil (13) is classified as Troporthents.

3.7.2 Land Capability

To assess the potentiality of agricultural development from the viewpoint of land resources, the land capability classification on paddy, upland and tree crop cultivation for the Nias island was made. Considering the end of this assessment and available data and information on soils of whole Nias island, it is conceived that the land suitability criteria prepared by DGFCA, Department of Agriculture and North Sumatra University can be applied to this study. The factors of criteria include (1) slope, (2) effective soil depth, (2) drainage condition, (3) soil texture, (4) soil reaction and (5) ground water quality. Their specifications for rice, upland crops (annual) and tree crops (perennial) are shown in Table 3.26. Three land classes are applied; S(suitable), M(marginally suitable) and N(not suitable). The distribution of area is illustrated in Figs. 3.11 to 3.13 and proportional extents by class are shown below:

Land Class	Land Suitability					
	Rice Farming		Upland Crop		Tree Crops	
	(ha)	(%)	(ha)	(%)	(ha)	(%)
S (Suitable)	66,800	17	98,100	24	258,300	64
M (Marginally suitable)	0	0	30,200	8	62,800	16
N (Not suitable)	335,600 *	83	274,100	68	81,300	20
Total	402,400	100	402,400	100	402,400	100

Note; * including 3,200 ha of marine swamp, and peat 5,200 ha of sediments.

3.8 Land Use

Present land use condition in the Nias island is investigated based on analysis of the existing land use map prepared by agrarian office, landsat images taken 23 July 1989 and ground verification conducted by JICA team in 1990. The present land use condition in the Nias island is illustrated in Fig. 3.14 and summarized as follows:

Land Use Categories	Area (ha)	Percentage (%)
1. Agricultural Land		
1.1 Paddy Fields	26,200	6.5
1.2 Upland Crop Fields	11,100	2.8
1.3 Coconut Estates	25,200	6.3
1.4 Rubber Estates	47,100	11.7
1.5 Other Tree Crop Estates*1	1,200	0.3
Sub-Total	110,800	27.6
2. Unused Land		
2.1 Forests	28,600	7.1
2.2 Swamp (Forest)	8,400	2.1
2.3 Bush/Shrub	243,900	60.5
Sub-Total	280,900	69.7
3. Settlement Land	9,500	2.4
4. Others	1,200	0.3
Total	**402,400**	**100.0**

Note;*1:include clove, coffee, etc.

The paddy fields occupy 26,200 ha or 7% of the total land area and are found on alluvial plain (24,600 ha or 94% of total paddy field) and valley bottoms (1,600 ha or 6% of total paddy field) in hilly/mountainous area. Out of 26,200 ha, 2,800 ha or 9% of the total area of paddy fields are irrigated and the rest are rainfed. Cultivated upland, which occupy 3% of the whole, scattered in terraces and hilly area on a small scale and are mostly planted with cassava and sweet potato and "nilam" (Pogostemon cabin).

Coconut estates occupy about 6% of the Nias island and are mostly distributed along the coastal line and low lying area. However

coconut trees found in coastal area are mostly aged, and the quality of maintenance is low.

Rubber estates extend at north-eastern part of Nias island and are mostly found on hilly, gently sloped mountainous lands and terraces. They occupy 12% of the total land area.

Small areas are devoted to other kind of tree crops, such as coffee, clove, cacao, and durian, but not on a scale at which they can be classified on 1:50,000 maps.

There are 280,900 ha of unused land, consisting of swamp forest (2%), dry land forest (7%) and bush/shrub (61%). Interpretation of landsat images shows that shifting cultivation has destroyed virtually all original forests except for a few scattered either in peat swamps or on the most remote and limestone peaks and has extended over steep slopes of the study area.

3.9 Land Tenure and Land Holding

Historically no central kingdom existed on Nias but in the past it was common for large areas of Nias to be referred to as tanah marga, or clan land. Some more isolated areas are still referred to as tanah marga today, but some misunderstanding of this term exists. Tanah marga only refers to the region occupied by members of a certain marga (clan) and does not indicate either communal ownership or communal use of land. All land in Nias is owned by individuals and is cultivated by households.

Originally ownership of land was obtained by being the first person to put a parcel of land under cultivation. Clearing the primary forest and establishing a slash and burn garden (ladang) constituted indisputable rights henceforth to that parcel of land. In the case of conversion to sawah fields, tree crop gardens, and other forms of permanent annual cultivation, the boundaries of such parcels have become clearly delineated, often being marked by planted trees if not

by natural boundaries such as rivers or rock outcroppings. Except for some of the islands of Kecamatan Pulau-Pulau Batu and a few small pockets on Nias Island, primary forest no longer exists in Kabupaten Nias. Thus nearly all land in Nias can be said to be owned by someone or at least to have a claimant.

Nias society is strongly patrilineal (male dominant) and land of any type can only be owned by men. No ethnic Nias women own land although it is possible that among the small ethnic Minangkabau community, who have moved to Nias Island from West Sumatra, women may own some land. This may have occurred since Minangkabau society is strongly matrilineal (female dominant) with a tradition of land only being owned by women. Other non-Nias people living on the island (Achenese, Batak, Chinese) also are patrilineal so for all intensive purposes it can be said that land in Nias is owned only by men.

Upon his death all of a man's property is inherited by his sons. In addition to land this includes the family house, money and heirloom property. A surviving wife will be taken care of by her sons, as will be any unmarried female children regardless of age. Although a daughter can not inherit land, she and her husband may be granted temporary use of her brothers' land if her husband's family is short of land. Likewise a widow with young children will be allowed to continue to use her husband's land as caretaker of his estate until the sons came of age and can work the land themselves.

Division of land is at the bequest of the father to his sons and does not necessarily have to be equal. Prior to his death a father will make it known among the family and members of the village how be wishes to divide his property. It is common for the father to divide his property evenly among his sons, although he may give a larger share to his eldest son since he is expected to have greater responsibility in caring for his mother if still alive and any unmarried sisters. Since a man is not bound by adat to divide his land equally among his sons, he is free to base his bequest on other considerations. If, for example, two of five sons have left Nias to live elsewhere he may

chose to only divide his land among the three sons remaining on Nias. Similarly if one son has a reputation as being lazy or a troublemaker, the father may decide to give this son only a small share of his land or none at all.

Should a man die before making his wishes known with regard to the division of his property, the ketua adat in consensus with the members of the family will resolve the matter. A man having no son may choose to adopt the son of a brother to became his heir. Such a course of action is an expensive proposition since an adat ceremony, presided over by the ketua adat, must be held with pigs slaughtered as part of the feast to which all members of the village are invited. A son thus adopted subsequently can inherit the land and other property of his adoptive father.

While division of land is at the bequest of the deceased father, at the time of actual division of the land a formal meeting is convened. In attendance are the members of the family, the ketua adat and the male elders of the village. This group discusses the details of the deceased's bequest and provide witness to the formal inheritance procedure.

Adat with regard to the sale of land does not appear to be consistent across Nias. Some villages report that land cannot be sold to an outsider, that is someone who does not live in the village or is not a direct relative of a village resident. Other villages state that an outsider can purchase land if there is consensus among members of the family selling the land as well as the village as a whole. Yet other communities state that anyone could purchase village land. The degree of openness in who can own land parallels the degree of adherence to tradition (adat). The stronger adat is in a village, the less likely there is to be non-resident ownership of land. In general the upland communities tend to be more conservative and the lowland/coastal village more open in this respect.

Rather than sell land or trees an individual may choose to give it to another person in the form of a free grant (hibah). All types of

productive trees, except rubber, can be given as a hibah. Hibah is used exclusively as a mechanism for a father to give a favored daughter land or productive trees, since according to adat only his sons can inherit land. The actual transaction is a transfer of property not to the daughter but from a father to his son-in-law. In the case of a hibah of trees, the grant is given for the productive life of the trees. Both in the case of land and of trees, the receiver of such hibah property is given full ownership and as such is free to sell it. Likewise property received through a grant can be passed on to the receiver's sons as part of their inheritance.

The right to use (hak pakai) a parcel of land for a set period of time may be given for one of several reasons. In sawah areas, such as Mezawa in Kecamatan Idano Gawo, use rights to a specific parcel of land are given with the expectation that the user will fulfill certain requirements. During the time he is allowed to use the sawah land the user is expected to clear the land of weeds, build bunds to hold in the sawah water and dig irrigation channels. Thus at the end of the use contract period the owner gets back his land in an improved state.

Sometimes hak pakai to land is given to another person for reasons of debt. The debtor gives his land to a person to whom he owes money. This person is allowed to use this parcel of land until the owner of the land has fully repaid his debt. In such cases the land in question acts as a form of collateral held by the lender as assurance that he will be repaid and not as payment for the debt.

A third reason for giving use rights to land to another person is to help a relative. An individual who is short of land may borrow the use of land from a relative who has more than he presently needs. Hak pakai to such land is freely given to relatives without expectation of any payment or share of the harvest.

In all forms of hak pakai, ownership of land is never transferred. After a fixed period of using a land the individual who has been using it must return it to the owner. The actual terms of hak pakai are

flexible and entirely up to the owner, although in the case of sawah land on which the owner expects the borrower to make improvements, the term of use is generally for five years.

Land can be rented either on the basis of a cash payment or, more commonly, as a fixed payment in kind. When a land rental contract is for cash, partial payment is usually made at the time of signing the agreement with the balance being paid later as stipulated in the contract. If goods are to be paid for rental of land, such as payment of a pig, these goods are given to the land owner at the time of making the rental agreement. The most common land rental agreement calls for payment in the form of paddy (unhusked rice). Rice payments are made to the land owner at the time of harvest at a pre-agreed rate. In South and West Nias a typical agreement for rental of one gorongan (approx. 15m x 15m) of land is one joe (approx. 30 liter) of paddy (unhusked rice). In North and Central Nias rental payment in paddy is generally calculated by weight in terms of pikul (approximately 60.5 kg) rather than in joe which is a volume measure.

Share harvesting is a common method of renting land or productive trees. The actual share division of agricultural yield varies from one area to another and even sometimes within a single village. Share harvesting of sawah in Kecamatan Tuhemberua is reportedly a divide-into-four system with the owner of the land getting 1/4 of the harvest and the cultivator 3/4. In the Mezawa area of Kecamatan Idano Gawo the owner gets 1/3 and the cultivator 2/3 of the rice harvest with the cultivator being responsible for providing the seed and all agricultural inputs. If the land owner provides seed and other agricultural inputs such as fertilizer and pesticides, then the owner and the cultivator share the harvest yield evenly.

Rubber, coconut and other trees also may be share harvested. In the case of coconut and fruit trees the harvest is sometimes sold on the basis of one season's harvest or the harvest for a year.

3.10 Social Structure

3.10.1 Nias island

Although of a single ethnic group, or suku, and having a single language the Nias people are divided into 169 marga, or clans. Each marga is an extended family grouping whose members are all descendants of a common ancestor or, in the case of wives, married to a descendant of the common ancestor. When taking a wife a man must either choose a woman from another marga or, if from his own marga, a woman whose family has been separated from his immediate family for at least ten generations. Among non-Nias people living on the island, such as those whose ancestors came from North or West Sumatra or are Chinese, families also are divided into marga (clans).

Originally each Nias marga lived in a specific region of the island, hence what was known as "marga land". The marga as an entity did not actually own such land nor was such land ever used communally. Even during early times land that was used for cultivation was owned by individual families. Thus the household has always been the most important social unit. Today members of various marga are scattered throughout the island with individual villages often composed of families from several different marga.

Traditionally, Nias is nominally divided into four general geographical regions. South Nias includes Kecamatan Teluk Dalam, Kecamatan Pulau-Pulau Batu, part of Kecamatan Lolowa'u and part of Kecamatan Gomo. West Nias covers Kecamatan Sirombu, Kecamatan Mandrehe, and part of Kecamatan Alasa. Central Nias includes Kecamatan Gunung Sitoli, Kecamatan Gido, Kecamatan Idano Gawo, part of Kecamatan Lolowa'u and part of Kecamatan Gomo. North Nias covers Kecamatan Lahewa, Kecamatan Tuhemberua and part of Kecamatan Alasa. Culturally, only South Nias is different from West, Central and North Nias which have similar culture.

3.10.2 Village

The settlement pattern of most Nias farm communities is dispersed. Some families build their houses clustered together along the main road or village lane, while other families build their houses in their individual fields. Only in South Nias, especially Kecamatan Teluk Dalam, are the villages constructed as tightly clustered houses. Among the South Nias people a village was traditionally constructed around a central square which was paved with stone. Typically such villages were built on a hilltop for defensive reasons.

Village industry and other forms of rural off-farm employment barely exist on Nias. Those that do exist are primarily related to the processing of agricultural commodities, such as the production of coconut and patchouli oils or foodstuffs like tahu, tempe and fish crackers. Except for one or two small shops or in the front room of villagers' houses, most Nias villages are exclusively agricultural.

Traditionally the leader of a Nias village is the ketua adat, or the senior leader of customary tradition. This is an inherited position held by a single man in each village. It is a lifelong position which upon the death of the man passes to his eldest son. The ketua adat is responsible for adjucating any disputes which arise among villagers, for maintaining the oral histories of the community as well as all of its members, and advising the community on any matters dealing with adat (customary tradition). Since nearly all land on Nias Island is still held under adat and has never been surveyed, it is the ketua adat to whom villagers first turn when disputes occur regarding land and when a villager wishes to sell or rent his land. Likewise, when a member of the village needs to know someone's ancestor, such as that of a perspective bride, he turns to the ketua adat for the information.

The other important village leader is the kepala desa, or village head. This individual is elected by the villagers for a fixed term of office and is responsible for all matters pertaining to official Indonesian government laws and regulations. Although legally this person may be male or female, only one female kepala desa is

reported in the 657 villages of Kabupaten Nias, and that is from a village in the southern islands of Kecamatan Pulau-Pulau Batu. Clearly the male dominance of patrilineal Nias society does not except the authority of a female. Since the position of kepala desa is a political one rather than a traditional position, seniority does not prevail. Preference is given to an individual with formal education, if possible a high school graduate.

The roles of the ketua adat and the kepala desa vary from village to village depending on the composition of the village and the degree to which its members still adhere to adat. Among upland villages which tend to be more traditional as well as more homogeneous (being composed of only one, two or three marga), the position of the ketua adat is still strong. It is the ketua adat to whom villagers first turn for advice or adjucation of disputes. Villagers go to the kepala desa primarily for government related matters or to officially reaffirm the ketua adat's decisions.

Among villages which are less strongly tied to Nias adat, especially those which contain Moslem and non-Nias people, the position of the ketua adat is weaker. Such communities are typically located along the coastal regions and in or near urbanized areas and larger villages which are more heterogeneous (being composed of a mix of people from a number of marga, both Nias and non-Nias). In these communities the position of the kepala desa is dominant. It is also among these villages that farmers are more likely to posses some sort of official papers for their land. Although not surveyed or issued with an official Ownership Certificate (Sertifikat Hak Milik), an official letter from the post office (old system) or the Camat's office (new system) may have been issued to verify land ownership. Thus recognition of Indonesian government authority, and hence recognition of the role of the kepala desa, in these villages is greater than among more traditional communities.

Religious leaders (Protestant, Catholic or Moslem) are respected in the village and they may play a role in village affairs, but generally this role is subservient to those of the ketua adat and the

kepala desa. Generally it appears that religious leaders tend to stay out of disputes among villagers and issues of adjucation. This is particularly more so in villages whose members belong to more than one religion or church sect.

Both in villages with strong ties to adat and those where adat is weaker, village consensus is an important facet of Nias social structure. An initial decision may be made by either a ketua adat or a kepala desa on matters such as disputes between villagers or selling land, but final settlement is done by consensus of all of the members of the village. Only after there is a consensus of the whole village, whatever the issue, will the matter be accepted as being resolved. In reality rarely does village consensus go against an earlier decision by a ketua adat or kepala desa but is merely the public witnessing of an agreed upon resolution.

3.10.3 Family

The average household size is 6 people (5 in Kecamatan Pulau-Pulau Batu) with the norm being a husband, wife and their children. Extended family households including an aged parent or other relative also are common. Residence and household are not always the same since it is not unusual for two or more nuclear families to share a single dwelling. Throughout Nias great variability occurs with respect to residence. In some cases two, or even three, families may share a single house but each will have a separate kitchen. Other cases occur where the house contains a single kitchen but each family cooks separately, and there are yet other families sharing a house who also share food and cook together. Multiple family houses most often are inhabited by the families of brothers who have yet to divide the family lands, possibly since their mother is still living. No single pattern could be identified as dominant where multiple family residence of a single house occurred, but in all areas of the island single family residence was considered the desirable norm.

3.11 Agriculture

3.11.1 Agricultural crops and cropping pattern

The main staple food crops in the Nias island are rice, followed by upland rice, cassava, sweet potato and maize. The main tree crops are rubber, followed by coconut, clove and coffee. In addition, polowijo crops such as groundnuts, green beans, soybeans, chili, some vegetables, patchouli (nilam) and so forth are cultivated on a small scale. And cacao and vanilla have been introduced in recent years, being practiced on a small scale.

The present cropping pattern prevailing in the paddy area is illustrated on Fig. 3.15. Generally a double cropping of paddy per year is common in the irrigated land and a single cropping of paddy in the rainfed paddy field.

The wet season paddy is planted on the onset of the monsoon, generally in September and harvested in January. The dry season paddy is planted in March and harvested in July. Polowijo crops after wet season paddy is not practised in the rainfed paddy field like in Java island.

In the upland area, cultivation of upland crops such as upland rice, sweet potatoes, maize is commenced on the onset of the monsoon. As mentioned in section 3.4 ," climate ", a long consecutive rainless spell sometimes occurs. And such cultivation of upland crops are forced to gamble on yield of crops.

3.11.2 Farming practice and farm inputs

Paddy is cultivated by intensive manpower from sowing to harvesting.

Land preparation and levelling are done twice by hoe without draft animal and mechanical power. Wet nursery is prevailing. Transplanting with a random planting is common. Weeding is done

once or twice. Harvesting is carried out by sickle or ani-ani. It is estimated that about 65% of the farmers use ani-ani. Threshing is mostly done by method of feet trampling. The total labour requirement for paddy cultivation per ha is estimated to be about 140 man-days.

With respect to rice varieties used in the study area, high yielding varieties as well as local varieties are used. The growing period of these varieties is 110 to 150 days. Among the high yielding varieties, IR-42 and IR-36 are common. The amount of seeds is estimated at about 35 Kg/ha. Application of fertilizer and agricultural chemicals is practiced over the study area. Except KCl, over 60% of the farmers use fertilizers. The average dosage of fertilizers per ha is estimated to be 63 Kg of Urea, 36 Kg of TSP, and 8 Kg of KCl. Agricultural chemicals such as insecticide, fungicide and rodenticide are applied at an estimated average dosage of 3.6 lit/ha.

Cultivation of upland crops is also carried out by intensive manpower from sowing to harvesting. Local varieties of crop seeds are used. No fertilizers nor agricultural chemicals are used.

With respect to rubber and coconut, most of these tree crops are of local varieties. The age of these tree crops is beyond the economic period. All farming activities are also done by manpower. Application of fertilizers and agricultural chemicals is seldom.

3.11.3 Yield of crops and production

Unit yield of crops is estimated by examining the results of the farm economic survey and statistical data prepared by the statistic office in Kabupaten Nias.

According to the statistical data, the average unit yields of major crops are shown below. Details are presented in Tables 3.27 to 3.29.

Crop	ton/ha
paddy	3.1
upland paddy	1.6
maize	0.9
cassava	10.4
sweet potato	7.8
rubber	0.55
copra	0.94
coffee	0.68
clove	0.26
nilam	0.23

Table 3.27 shows the unit yield of paddy between 1985 and 1989 at Kecamatan level that is prepared by the statistic office. Table 3.30 indicates the unit yield of paddy which is obtained through the farm economic surveys. The values obtained from the statistic data are significantly higher than those from the economic surveys. The statistic values are obtained from the crop cutting survey for area of 2.5 m x 2.5 m in the selected field. In this survey, the paddy field having been severely damaged by drought, rats, pests and diseases was discarded. On the other hand, the values obtained from the economic survey are estimated from total paddy production and total planted area of the sampled farmers, including the paddy fields seriously damaged by drought, rats, pests and diseases. It is considered that these causes bring about such difference in the paddy yields. It is estimated on the basis that 80% of the statistic values seems to be real present paddy yield. In general, the yield of crops in the study area is significantly low. The causes of low yield of paddy are considered to be (i) damages accrued from rats, pests and diseases, (ii) damages due to occurrence of drought and weeds which are brought about by insufficiency of irrigation water, (iii) low level of dosage of farm inputs and improper farming practices, (iv) insufficient extension services for the paddy farmers and, (v) improper water management of the existing irrigation systems due to lack of operation/maintenance fund and deterioration of the systems and (vi) so forth.

The low yield of upland crops results from (i) damages from uneven distribution of rainfall, pests and diseases, (ii) low level of

dosages of farm inputs, (iii) use of local varieties, (iv) others. As to the yield of tree crops the constraints are considered to be (i) damages by pests and diseases and (ii) use of non-hybrid variety and low level of dosage of farm inputs.

With respect to the yield of crops such as tree crops, upland crops, and so forth, the values from the statistic data are as same as those obtained in the farm economic survey.

The total production of the crops in the study area is summarized below:

Crops	Harvested area (ha)	Total production (ton)
paddy	28,500	88,300
upland rice	5,300	8,300
maize	2,800	2,600
cassava	10,400	109,000
sweet potato	8,800	68,800
rubber	34,000	18,800
coconut(copra)	29,900	28,200
coffee	959	650
clove	1,200	300
nilam	700	160

3.11.4 Livestock

Livestock raising is practiced in homestead yards of the farmers. The number of livestock in the Nias island is shown in Table 3.31.

3.12 Existing Irrigation and Drainage Systems

3.12.1 Irrigation projects

At present there are 28 existing irrigation projects in the Nias island in total. The total potential area of these systems is about 5,200 ha, out of them 2,400 ha (46% of the total potential area or

10% of the total existing paddy field in the Nias island) are irrigated. The features of these systems are mentioned in Tables 3.32 and 3.33. 60% of these systems are located in two Kecamatans such as Teluk Dalam and Tuhemberua as illustrated on Fig. 3.16. Out of these, 9 systems having an area of 3,900 ha are managed by DPU and the remainders by the Agricultural Service (PT), (Dinas Pertanian Tanaman Pangan). DPU manages the large scaled systems and PT manages the small scaled systems averaging 40 ha in size.

3.12.2 Condition of the facilities

The intake weirs in the irrigation systems are constructed at the tributary rivers with smaller catchment area except the Afia and Gido Zebua systems. Due to unsteady water supply, inadequate design of the weir structures and destruction of the weir facilities, most of the systems cannot realize the full exploitation of the potential area covered by the systems.

Generally, main canals in the systems are lined and in good condition. The canal density is very low. There is no farm road in the systems. The plot-to-plot irrigation is practiced at present.

3.12.3 Drainage

There is no drainage canal except the natural rivers in the systems. Though there are some cases that a inundation continues for a few days and damages the paddy, drainage improvement project has not been considered until now.

3.13 Existing Socio-rural Infrastructures

The existing socio-rural infrastructures such as road, sea port, airport, communication systems, electricity supply system and drinking water supply system on Nias island are shown in Fig. 3.17 and summarized in Table 3.34.

3.13.1 Road

The road network on the Nias island is not well maintained. The length and present conditions of the existing roads are shown in Table 3.35. The present asphalted roads are from Gunung Sitoli to Lolowa'u, Gunung Sitoli to Tetehosi, Gunung Sitoli to Tuhemberua and several city parts. The densities of provincial road and asphalt-paved roads are estimated at 0.092 km/km^2 and 0.044 km/km^2, respectively.

Since the existing asphalt-paved roads are of low standard, road surface is deteriorated due to increasing traffic and monsoon climate. In addition, many bridges in Gunung Sitoli - Tuhemberua section and Gunung Sitoli - Tetehosi section have collapsed and many villages are unreachable by car.

The present road situation of important sections is shown below:

Section	Length (km)	Length to be repaired (km)	Pavement
Gunung Sitoli-Lahewa	87	66	Asphalt/Earth
Gunung Sitoli-Idano Gawo -Teluk Dalam	120	53	Asphalt/Stone
Gunung Sitoli-Tetehosi -Teluk Dalam	108	70	Asphalt/Earth

Roads and bridges will require extensive rehabilitation and upgrading to provide access to isolated villages currently unreachable by land transportation. The present poor condition of roads and bridges restricts the movement of goods and equipment. At present, many Kecamatan capital cannot be reached from Gunung Sitoli by road. The distances from Gunung Sitoli to each Kecamatan capital are shown in Table 3.36.

Improvement works of existing the provincial roads (widening and repairing of road including rehabilitation of bridges between Gunung Sitoli - Idano Gawo section) are being carried out by Bina Marga with financing by the World Bank and OECF (Overseas Economic Cooperation Fund). The improvement works are:

Location	Length (km)	Pavement	Financed by
Gunung Sitoli - Tetehosi	37	Asphalt	OECF
Gunung Sitoli - Sawo	35	Asphalt	IBRD
Migo - Lolowa'u	59	Asphalt	IBRD
Lolowa'u - Teluk Dalam	55	Asphalt	OECF

3.13.2 Communication

Present communication facilities are limited. Available communication facilities on Nias island are telegram, telephone, post office and tele-communication. The tele-communication network is available in all Kecamatan capitals. Full service post offices exist in only seven Kecamatan capitals. Telephone is available in Gunung Sitoli and can connect to big cities in Indonesia.

The available communication facilities are summarized as follows:

Kecamatan	Telegram	Post office	Telephone
Gunung Sitoli	Available	Available	Available
Tuhemberua	-	Available	-
Lahewa	Available	Available	-
Ombolata	-	-	-
Mandrehe	-	-	-
Hiliweto	-	Available	-
Tetehosi	-	Available	-
Lolowa'u	-	-	-
Tetesua	-	Available	-
Gomo	-	-	-
Helezalulu	-	-	-
Teluk Dalam	Available	Available	-

3.13.3 Port

There are four (4) sea ports on Nias island, i.e. Gunung Sitoli, Lahewa, Sirombu and Teluk Dalam. Ships can enter these ports. Among these, Gunung Sitoli is the biggest port. Communication with Sibolga, North Sumatra, can be executed by ferry and sea vessels. The frequency and cost of passenger transportation are:

	Frequency	Time required	Fair (Rp.)
Ferry	1 time/ 2 day	9 hours	8,000-22,000
Sea vessel	3 times/ day	12 hours	3,000 - 6,000

The total passengers at above four (4) ports in 1984 and 1989 are tabulated below:

		Gunung Sitoli	Lahewa	Sirombu	Teluk Dalam
Passenger					
Arriving	1984	29,638	537	2,284	1,023
	1989	13,973	372	4,747	179
Leaving	1984	29,744	863	1,453	1,138
	1989	55,663	559	5,138	388
Cargo					
In	1984(kg)	44,614	23,821	6,852	3,977
	1989(kg)	55,663	2,599	8,836	7,542
Out	1984(kg)	20,670	5,121	1,889	2,966
	1989(kg)	27,737	6,835	2,926	2,834

3.13.4 Airport

Since 1976, an airport has been opened at Binaka, about 20 km south of Gunung Sitoli. Air flight by PT. SMAC is available once a day between G.Sitoli and Medan and once a week between G.Sitoli and Padang.

The total passengers who arrive at and leave Binaka Airport in 1989 were 4,448 and 4,524, respectively. The annual total passengers from 1984 to 1989 were:

Unit : persons

Year	Passengers	
	Arriving	Leaving
1984	3,872	4,108
1985	3,983	4,293
1986	4,288	5,100
1987	4,567	4,659
1988	4,637	4,724
1989	4,448	4,524

The government intends to commence the design of a new airport at Teluk Dalam, southern part of Nias island, in 1991.

3.13.5 Electric power supply system

PLN has responsibilities for planning, designing, constructing and maintaining electric power supply systems. As of August 1990, Nias island has 10 existing PLN diesel stations in nine (9) Kecamatan capitals with a total installed capacity of 3,675 kW.

Location	Kecamatan	Installed capacity (kW)
Gunung Sitoli	Gunung Sitoli	2,860
Teluk Dalam	Teluk Dalam	375
Lahewa	Lahewa	100
Hiliweto Gido	Hiliweto	40
Mandrehe	Mandrehe	20
Bawomataluo	Teluk Dalam	40
Lolowa'u	Lolowa'u	20
Tuhemberua	Tuhemberua	20
Sirombu	Sirombu	100
Pulau Tello	Pulau Tello	100
Total		3,675

Gunung Sitoli, the largest town of the Nias island, the largest load center. The total production at Gunung Sitoli in 1989 was 4,071,490 kWh.

Besides PLN station, electricity is also produced by private households for their own use, mainly for lighting.

3.13.6 Water supply system

The Ministry of Drinking Water (PDAM, Persahaan Daerah Air Minum) is responsible for supplying drinking water. There are three (3) existing water supply systems operated by PDAM on Nias island.

Location	Kecamatan	Water source	Capacity (lit/s)	Demand (lit/s)
Gunung Sitoli	Gunung Sitoli	Well	35	20
Lahewa	Lahewa	Well	35	5
Teluk Dalam	Teluk Dalam	Well	3.2	3.2
Lagundi	Teluk Dalam	(Under study)		
Moale	Lolowa'u	(Under study)		

In the above cities, drinking water is distributed to the houses from wells through pipe distribution network.

Generally drink water is taken from wells or springs. At present, there is sufficient water for drinking water supply.

3.13.7 Health

Health facilities in the Nias island are shown in Table 3.37.

Infant mortality for Kabupaten Nias in 1989 was 57 per 1,000 (60 per 1,000 when Kecamatan Pulau-Pulau Batu is excluded) which is within the norm for Indonesia as a whole. The range of infant mortality among Kecamatan was quite extreme, from 0 in Kecamatan Tuhemberua and 14 per 1,000 in Kecamatan Lahewa to 127 and 121 deaths per 1,000 in Kecamatan Alasa and Kecamatan Sirombu.

Among the cases of illness reported during 1989, the incidence of malaria and waterborne infections was high. Almost 9% of the population contracted malaria during 1989 while over 8% reported contracting some variety of waterborne infections. Given that these statistics are only those officially recorded, the seriousness of malaria and waterborne diseases is probably actually greater. Both of these health problems indicate problems with stagnant dirty water throughout the island.

The reported incidence of other diseases does not appear to be outside of the norms found elsewhere in rural areas of Indonesia. Still, overall improvements in health care throughout Nias are warranted.

3.13.8 Medical services

The medical facilities are shown in Table 3.38. There are only two hospitals on Nias Island, one in Gunung Sitoli and the other in Teluk Dalam. Only the hospital in Gunung Sitoli has full facilities including specialist doctors. Each of other Kecamatan has at least one public health center and all but three Kecamatan (Gomo, Lahusa and Pulau-Pulau Batu) have at least one doctor. Three or more public health sub-centers are found in each Kecamatan, as well as at least one family planning clinic. Most Kecamatan (except Kecamatan Tuhemberua and Sirombu) also have at least one mother and child clinic. Most numerous are simple village clinic with between 30 and 169 beds in each Kecamatan, thus virtually all of the population are within easy access to medical services.

Each Kecamatan on Nias Island has a minimum of three nurses and all but Kecamatan Mandrehe have at least one midwife. All have trained lay midwives to attend births either in clinics or at home. Although no statistics are available, many births are still attended by untrained lay midwives. Despite this the infant mortality rate for Nias in 1989 was only 60 per thousand, a rate comparable to that of Indonesia as a whole.

3.14 Marketing and Processing

3.14.1 Internal trade of main agricultural commodities

There are four main harbors in the Nias island, namely (1) Gunung Sitoli, (2) Lahewa, (3) T. Dalam and (4) Sirombu. Internal trade of the main commodities is handled by these habors. Export and import of these commodities from 1988 to 1990 are shown in Table 3.40.

Main import commodities are rice, sugar, wheat, tobacco, cement and fertilizer. The annual amounts of these commodities are about 22,000 tons of rice, 1,500 to 1900 tons of sugar, 600 tons of wheat, 500 tons of tobacco and 500 tons of salted fishes.

Main export commodities are rubber (silab), coffee, copra, cooking oil, nilam oil, clove and cake of pressed peanuts. The annual amounts of these commodities are 25,000 to 27,000 tons of rubber, 1,600 tons of copra, 3,000 to 4,500 tons of cooking oil, about 200 tons of nilam oil, about 300 tons of coffee, 140 tons of clove and 900 to 1,800 tons of cake of pressed peanuts.

3.14.2 Marketing and prices

The government interventions in the market of agricultural products have concentrated on rice through the National Logistics Agency (BULOG) at the national level and the Regional Logistics Depot (DOLOG) at the provincial level. BULOG has been able to defend the floor price procuring up to about 10% of the total production through the village cooperatives (KUDs).

North Sumatra province is the region suffering from rice shortage. Rice has been imported from other provinces such as East Java province. The Nias island also suffers from rice shortage. The Nias island has imported rice from Sumatra island. The imported amount of rice has been gradually increasing and reached about 24,000 tons in 1989 as shown in Table 3.40. These amounts of rice

have been handled by Sub-DOLOG in North Sumatra province and by private sector. About 90% of the imported rice has been handled by the private sector. The Sub-DOLOG has played the role of distribution of rice to the government employees and military pensioners. The rice amount handled by DOLOG branch is only 200 to 500 tons annually as shown in Table 3.41. Distribution of imported rice to the people within the island is undertaken by the private sector.

The results of the farmer's economic survey indicate that since total production of rice per farmer is very low, the volume of marketed rice seems very small. About 100% of the respondent farmers reported that they buy rice several months during the year. 45% of the respondent farmers reported they buy rice for less than 3 months in a year, 42% for 3-9 months and 13% for over 9 months.

With respect to distribution of fertilizers such as urea, ammonium sulfate, TSP and KCl, PUSRI distributes fertilizers to KUDs. The main channel of distribution from KUDs consists of (1) direct to farmers, (2) KIOSKs managed by KUDs, (3) KIOSKs managed by farmer's groups and (4) private KIOSKs. The retail price to farmers is Rp.185 for urea and Rp.210 for TSP and KCl. The price structure from PUSRI to farmers is shown in Fig. 3.19. The distribution of seeds and agricultural chemicals is handled by 3 private dealers in the Nias island, namely Usaha Gumarang, Usaha Timur and Tanisubur. The retail prices of these materials in 1990 at G.Sitoli city were Rp.10,000 to 11,000 /lit. for insecticide, Rp.2,200 to 14,000/lit. for herbicide, Rp.3,500 /kg for rodenticide and Rp.850/kg for IR-64 variety seed.

The retail price of rices and other major crops are shown in Table 3.42. The government support price of rice in 1990 is Rp.556/kg.

3.14.3 Processing and storage facilities

There are 134 rice mills in the Nias island as shown in Table 3.43. All of the mills are managed by private sector and Sub-DOLOG

has no rice mills. Supposing that the average milling capacity of the mill is 700 tons/year, the total milling capacity of the existing mills is 94,000 tons/year in the Nias island. Such total milling capacity is considered sufficient for the present output in 1989.

There is no warehouse having a big capacity except two warehouses in the Nias island. One is the warehouse having 1,360 m^2 managed by the Port Authority in G. Sitoli, the other 1,200 m^2 managed by Sub-DOLOG in G. Sitoli city.

3.15 Agricultural Support Systems

The present overall organization structure of agricultural development is illustrated on Fig. 3.20, containing the government organizations and farmer's organizations.

3.15.1 Mass guidance of agricultural intensification program

BIMAS Program is one of the strongest administrative supporting services for agricultural development in Indonesia. The present BIMAS Program implemented in North Sumatra province is INMUM, INSUS and SUPRA INSUS. For the successful implementation, BIMAS Committee chaired by Governor and BIMAS Daily Executive Committee chaired by chief of Regional Agriculture Office are organized at provincial level. At each Kabupaten, Kecamatan and village a BIMAS coordination committee chaired by Bupati, Camat and Lurah, respectively is also organized with strong support of implementation of the BIMAS program.

In the Nias island, SUPRA INSUS program is not yet introduced. The area under INSUS and INMUM from 1987/88 to 1989/90 is shown below.

Unit : ha

Program	Year 1987/88	1988/89	1989/90
INSUS	4,216	4,751	3,722
INMUM	7,037	4,424	4,225
Total	11,253	9,175	7,947

3.15.2 Agricultural extension services

One of the strongest supporting arms for implementation of BIMAS Program is agricultural services.

Agricultural extension staff consists of three kinds, subject-matter specialist (PPS), subject-sector supervisor (PPUP) and field extension worker (PPL). In Kabupaten Nias, there are four PPS and 59 PPL. There are three Rural Extension Centers (BPP) in Nias island, namely Wa'ai BPP, Hiliweto BPP and Hilimaenamolo BPP as shown in Table 3.44. One PPL covers about 10 villages, about 1,000 farm households and about 400 ha of paddy fields on an average.

Each BPP is equipped with similar office building with a leader's room, a large office room and a meeting room with furnitures. The Inventory of each BPP is listed in Table 3.45. All extension workers have a motor-cycle provided by the Government, but other extension facilities are not yet provided.

3.15.3 Seed multiplication and distribution

Total certified paddy seed production in North Sumatra was about 1,500 tons in 1989 of which more than 95% were produced by North Sumatra Branch of Sang Hyang Seri seed company (SHS).

By the end of 1987, about 3.4 tons of certified paddy seed have been produced by two seed centers located in Hiliweto Gido and Soliga. However, these seed centers do not function at present. All certified paddy seeds are distributed through 3 dealers : (1) Usaha

Gumarang in G. Sitoli, (2) Usaha Timur in G.Sitoli and (3) Tanisubur in Tuhemberua.

3.15.4 Agricultural credit

Limited agricultural credit has been available to farmers in Nias Island through the national bank, Bank Rakyat Indonesia (BRI). The Bank is authorized to provide BIMAS credit and special small scaled credits to qualified farmers with soft loan condition (monthly interest rate of 1 %).

The total amount of credit provided by BRI to all cooperatives in the Nias island from 1986 to 1989 was about Rp. 216 million as shown in Table 3.46. The credit allocated to KUD (for paddy cultivation farmers) amounted to Rp. 217 million for 6,441 farmers. The credit for fisheries cooperatives was Rp. 6 million for 359 fisheries farmers. The credit for tree crop cooperatives was Rp. 15 million for 761 tree crop farmers. It is estimated that the credit service from BRI is available for about 10% of the total number of farmers in the Nias island. Presently rice farmers who can't receive the credit from BRI must rely on private moneylenders to obtain fund for their required agricultural inputs. The farmers report that they must pay 12% interest per month on fund obtained from such moneylenders.

The Department of Agriculture has a program of rehabilitation and expansion of export crops (PRPTE) which includes smallholder (up to 2 ha) rubber and coconut on Nias, but the program has yet to be turned over to BRI for conversion into farmers' loans. One of the problems is that these lands have not been officially surveyed and ownership certificates issued. BRI requires ownership certificates before loans can be made for smallholder cash crops.

3.15.5 Farmers' organization

(a) KUD (Cooperative)

In the Nias island, there are 27 KUDs. These KUDs were established in 1986 or 1987. The total membership of these KUDs is about 11,000 or 14% of the total number of farmers in the Nias island. The average membership per KUD ranges from 74 in the smallest KUD to 1,642 in the largest one, averaging 400.

The main function of KUD is to undertake such economic activities as supply of farm inputs, farm credit, processing and marketing of farm products. Also KUD has principally key facilities such as storage, small shop, dry yards and rice mill. The condition of the KUDs is summarized in Table 3.47. This table indicates that activities of the KUDs in the Nias island are not yet so active. Out of 27, 13 KUDs are relatively active.

(b) Water users' association (P3A)

In North Sumatra province, water users' associations (P3A) were once organized in every village in early 1970, although irrigation facilities did not cover all the villages. At present there are 30 P3As in the Nias island covering an area of about 2,600 ha. According to data from the Agricultural Service, only 4 P3A are active. Table 3.48 shows information of these P3As in the island.

3.16 Farmer's Expectation for Agricultural Development

To grasp the farmer's expectation for the future agricultural development, a farmer's interview survey has been carried out in the agro-economic survey by the staff of University of North Sumatra.

Sixteen items of expectation for the future agricultural development have been checked. Degree of expectation is classified into four for each item, 1) greatest, 2) great, 3) a little and 4) no need. The information on expectation of the farmers has been compiled according to the types of farmers such as 1) paddy farmers cultivating double cropping of paddy in the technical-irrigation system, 2) paddy farmers cultivating double cropping paddy in simple irrigation systems, 3) paddy farmers cultivating double cropping of paddy in the rainfed area, 4) paddy farmers cultivating single cropping of paddy in the rainfed area, 5) rubber farmers and 6) coconut farmers.

The results of the survey are shown in Table 3.49. The results suggest that most of the paddy farmer respondents feel the following need and expectation.

1) expansion of cultivation land
2) rehabilitation and new installation of irrigation system
3) installation of drainage system
4) development of village road, and
5) provision of technical extension services

With regard to the expectation of the rubber farmers, special requirement was not obtained.

With regard to the expectation of the coconut farmers, the following are strongly requested.

1) expansion of cultivation area
2) development of village road
3) agricultural mechanization
4) introduction of hybrid variety
5) financial and credit services
6) improvement of marketing system and
7) provision of technical extension services

3.17 Tourism in Nias Island

There are many kinds of tourism resources in the Nias island. These are (1) traditional house areas, (2) megalithic stone areas, (3) caves, (4) surfing areas and (4) other resources. Tourism development for the Nias island has not been fully carried out. Recently, however, the Government of Indonesia made every endeavour to promote tourism development in the southern part of the Nias island, paying emphasis on the area around Lagundri, Simaetno, Bw.Mataluo and Sirombu.

The number of foreign tourists during the period from 1980 to 1989 ranged from 1,000 to 3,800 as shown in Table 3.50. It cannot be said from the past 10-year statistical trend that the number of tourists will increase in the future, but this number can be expected to increase, taking into consideration the Government policy of tourism development promotion

4. BASIC DIRECTION OF AGRICULTURAL DEVELOPMENT AND DEVELOPMENT POTENTIAL

4.1 Basic Direction of Agricultural Development in Nias Island

The basic direction of agricultural development in the Nias Island has been formulated based on the following condition and necessity, recognizing the present situation in the island and constraints for the development.

(1) Economic growth in Kabupaten Nias is much more stagnant than the provincial/national average. Per capita GRDP was Rp.316,380 in 1988, which is only 43% of that in North Sumatra Province and 39% of that in whole Indonesia. The Nias Island is a much less developed area and has been economically left behind from other areas in the main islands. In the isolated remote area of Nias Island, therefore, it is essential to raise the living standards of inhabitants and attain economic self-sufficiency through enhancement of regional economy, in order to overcome the geographical disadvantage and to solve the poverty.

(2) Agriculture plays a dominant role in the economic activity of the Nias Island. About 80% of the total population of the island (560,000) are engaged in agriculture and its related activities. Most of the production and income of the island come from this sector. Enhancement of agricultural sector, therefore, plays a most important role for raising the family income level and attaining economic self-sufficiency in the island.

(3) Agricultural activities in the island mainly consist of cultivation of food/feed crops for domestic supply such as rice, cassava, maize, potatoes, etc., plantation of estate crops as major income sources from out of the island, such as rubber, coconuts, coffee, cloves, etc. and livestock and fishery for domestic consumption. Though cultivation of food crops, fishing and feeding of livestock

animals have been generally active in the island, their production are supposed to be insufficient for local consumption since increase of foodstuffs imported from out of the island is remarkable. Insufficiency of staple crops has depressed the economic self-sufficiency of the island.

(4) Development potential of the mining sector is very low since mineral and fossil resources are scanty in the island. Development of tourism would be promising in the island and can be expected to contribute to the uplift of regional economy to the level of economic self-sufficiency in the island.

Considering the situation mentioned above and physical/social resources in the Nias Island, the most promising and applicable development sector would be agriculture and its related activities. The basic direction of agricultural development in the Nias Island has been formulated as follows:

4.1.1 Paddy production enhancement plan

Most of the paddy fields in the island are under rainfed condition and the use of water resources has been left below their maximum potential. Since increase in rice production has not been attained to meet the demand of the growing population and increasing per capita consumption, rice movement into the island has gradually increased. Reduction of the amount of rice imported from out of the island is a pressing need. It is, therefore, necessary to increase paddy production through development of agricultural infrastructure to achieve self-sufficiency in rice and as a result to raise income level of the farmers. Furthermore, in order to increase job opportunities in rural area, intensified rice farming system will be introduced. As shown in Fig. 3.11, there is an area of 66,800 ha suitable for paddy cultivation in the Nias Island. Through development of irrigation facilities for all of the suitable lands for paddy cultivation, it is expected to sell rice surplus to out of the island, in the future. However, due to the investment made for paddy development in the Sumatra island, the surplus of rice has a possibility to conflict with

that from paddy in the Sumatra island. Therefore, programmed investment for the purpose of achieving self-sufficiency in rice should be proceeded for these potential irrigation areas in the island.

4.1.2 Tree crop cultivation

Tree crops, such as rubber and coconuts are widely cultivated in coastal plain, terraces and hills in the island. These crops have been introduced in the period of Dutch rule of this country. Tree crops have been managed by small holder system. However, improvement or rehabilitation activities has been seldom made for these crops. The quality and productivity have been generally low. Due to lack of funds of farmers and stagnant international prices of crops, the tree crops have not been replaced, even though they have been over their economic useful age.

From the viewpoint of land resources, there still remain vast unused lands suitable for tree crops on the hills and terraces (Fig. 3.13). If international market prices of these tree crops improve, it is expected that production of these crops can be expanded with introduction of modern farming including hybrid through improvement of the existing tree land and expansion of cultivated land.

The tree crop products have been sold as agro-processing materials to the advanced factories outside the island. In the future, with the enhancement of tree crop production, it is expected that agro-based industries will be installed in the island and contribute to economic growth of the Nias island.

Furthermore, from the viewpoint of land capability and climate condition, oil palm, a promising export crop, is also possible to be developed in the island by the private sector. It is expected that promotion of the tree crop cultivation will bring an economic growth to the island in the 21st century.

4.1.3 Fruit plantation

The main fruit production in the island consists of banana, duku, durian and pineapple. They have been cultivated mainly for home consumption and partly as cash income sources. From the viewpoint of climate and soil condition, development potential of fruit plantation including expansion of holding size is high in the island. However, due to far access to the big market in the Sumatra island, promotion programme of these crops is supposed to be disadvantageous without any marketing facilities.

It is expected that these products in the island can be supplied in the future to the tourists through up-grading of cultivation technology, improvement of quality, introduction of new variety and increase in production.

4.1.4 Upland crop

Main upland crops of the island consist of upland rice, maize, cassava and sweet potato which are cultivated in mountainous hills and homeyards mainly for home consumption. Due to poor farming and unstable climatic condition, the yield of these crops is low and unstable. Further demand of these crops is low at present. Then the farmers in the island have no intention to cultivate these crops more intensively.

Demand for these crops, however, will be gradually increased due to growing population and the raising of income level in the future. In order to meet the future demands for these crops, it is necessary to achieve the intensification and diversification of upland crop production. To this end, institutional supporting services, such as extension services, qualified seed supply, steady supply of farm inputs through enhancement of KUD and BPP, shall be reinforced.

At present, cassava and sweet potato have been harvested as main forage crops for livestock raising. In the future, however, it is

recommended to utilize by-products of paddy production, such as rice bran and rice stems for livestock feeding.

4.1.5 Livestock

Main livestock in the island consist of swines and poultry, however, these are raised on a small scale. The livestock products are the main sources of protein and cash income of farmers in the island.

The farmers' technical levels are generally low and some forest residents in southern part of the island have still acquire their foods by hunting.

On the other hand, piggery and poultry will have possibility to develop the commercial base of farming owing to increase in by-products of paddy. Furthermore, through the introduction of animal power for rice production enhancement, extension of the technology for animal feeding (water buffalo) will be needed.

4.1.6 Fishery

Fishery has played a significant role in regional economy of the island. Fish catch from sea is far superior to that from inland or fresh water. Marine products have also been one of the main sources of protein and farmer's cash income. The island is surrounded with rich fishery resources, particularly it is very close to tuna fishing ground. Therefore, development potential for fishery is conceived to be high. Furthermore, supply of marine products for growing tourists through development of tourism in the Nias island is also expected to contribute to up-grading of regional economy. Therefore, it is recommended to develop fishery facilities in a long-term plan aimed at increasing farm income.

Out of the said basic directions for agricultural development in the island, the first priority for agricultural development shall be given to paddy production in view of i) self-sufficiency in rice as well as ii) higher profitability of rice double cropping, compared with that of

other crops, iii) higher socio-economic impacts through development of irrigation facilities, which will bring increase in farm income and dissolve poverty, compared with those of other agricultural activities, and iv) up-grading of regional economy through reduction of the amount of rice imported from out of the island.

The second priority shall be put on the promotion of export crops, including rubber, coconuts, cloves and oil palm plantation. It has been recognized that the promotion of these crops is promising as a long-term development plan in the island.

Due to the expansion of shifting cultivation and deforestation in the mountainous areas in the central part of the island, the vegetation of this area is degenerated. Therefore, it is recommended to pursue re-forestation for the entire mountainous areas from the viewpoint of soil and land conservation. Furthermore, agricultural development mentioned above should be realized without reclamation of the swampy forest in the coastal lands. These forest lands should remain as they are for tropical forest reserve and for wild animals.

4.2 Development Potential of Land Resources

Land resources in the Nias island with a surface area of 402,400 ha were assessed from the viewpoint of soil/land physical condition based on the land capability criteria prepared by DGFCA, Department of Agriculture and North Sumatra University. The land capability classification of the potential areas for agricultural development was made for paddy, upland and tree crop cultivation. Criteria for land classification applied to this assessment are shown in Table 3.26. Three land classes were applied; S(suitable); M(marginally suitable) and N(not suitable). Furthermore, from the viewpoint of development efficiency, minimum potential unit classified as suitable for paddy land was limited to more than 100 ha. As mentioned in section 3.7, the distribution of area and proportional extents by class are shown below:

Land Class	Paddy Farming Area(ha)	%	Upland Farming Area(ha)	%	Tree Crops Area(ha)	%
S (Suitable)	66,800	17	98,100	24	258,300	64
M (Marginally suitable)	-		30,200	8	62,800	16
N (Not suitable)	335,600	*83	274,100	68	81,300	20
Total	402,400	100	402,400	100	402,400	100

Note; * including 3,200 ha of marine swamp and 5,200 ha of peat sediments.

Possible area for upland field was estimated at 127,500 ha within the study area, which is distributed on moderately well drained alluvial plain, terraces and gently sloped hilly area. Out of them, 20,100 ha distributed along major rivers are suitable either for paddy or upland cultivation.

Suitable area for tree crop cultivation would amount to 80% of the total land area, which was assessed excluding steep mountainous area with slope of more than 40% and marine tidal-swampy area.

From the viewpoint of land resource and land utilization in Nias island, the recommended land use pattern is illustrated in Fig. 4.1.

4.3 Development Potential of Water Resources

4.3.1 Available river discharge

The available river discharge at the proposed intake weir site was estimated on the basis of the following formula for assessment of the water resources in irrigation plans. Run-off percentage was adopted as conservative value.

$$Q = 1/3.6 \times F1 \times F2 \times r \times A$$

in which Q : possible intake discharge (m^3/s)
F1 : run-off percentage (=0.5)
F2 : intake percentage (=0.8)
r : rainfall intensity (mm/hr)
A : catchment area at intake weir site (km^2)

The rainfall data used in this study are that of the Gunung Sitoli station. The rainfall with a 5-year return period was used for calculation of rainfall intensity. The mean daily rainfall with a 5-year return period was estimated as follows:

unit:mm/day

Month	Rainfall	Month	Rainfall
Jan.	5.5	Jul.	7.1
Feb.	4.9	Aug.	6.1
Mar.	6.3	Sep.	9.1
Apr.	6.4	Oct.	10.9
May	5.7	Nov.	10.3
Jun.	5.4	Dec.	8.1

The river discharge at the intake weirs proposed in the irrigation plans was estimated and the results are presented in Table 4.1. The lowest river discharge during the year occurs in February. The total accumulated river discharge of the proposed intake weir sites would be for about 40 m^3/s in February.

4.3.2 Water potential created by reservoirs

Creation of a reservoir was examined within the purpose of irrigation use. The supplemental irrigation water produced by the reservoirs would be very effective for the expansion of irrigation area because critical irrigation water demand is in a very short period. The scale of reservoir was planned based on the following criteria.

height of dam : minimum 25 m (= contour interval)
crest length : maximum 800 m
capacity : minimum 10,000,000 m^3

Reservoir sites were selected by using the topographic maps (1:50,000) and the geological map (1 : 250,000). As a result, 10 sites were selected. The features of these dams are as shown in Table 4.2 and their locations in Fig. 4.2.

The efficiency of dams varies according to the sites. The effective storage capacity of these dams was estimated to be 900 million m^3 in total.

4.4 Development Potential for Irrigation

4.4.1 General

Based on the results of studies on development potential of land and water resources, the development potential areas for irrigation have been assessed .

Twenty-six (26) individual irrigation projects from the development potential areas were identified as shown in Table 4.3 and Fig. 4.3. Among these, 24 projects will be irrigated by river waters and the remainders will be irrigated by springs. The total potential irrigable area of these projects would be 53,450 ha.

It was planned that double cropping of paddy per year be introduced into the irrigation development projects if irrigation water is available. As a principle, irrigation water will be distributed by gravity. As for the water intake method, four (4) alternatives were considered. These are i) diversion weir on a small tributary, ii) small impounding pond, iii) diversion weir on main river, and iv) regulating dam.

Since reuse of irrigation water is seldom practiced in the Nias island and data to assess return flow are not sufficient, use of return flow in the irrigation plan was not taken into consideration.

Presently, irrigation water is taken by intake weirs constructed on small tributaries except the Gido Zebua irrigation project. Since the development potential for irrigation was evaluated at a master planning level in this study, small scale irrigation projects scattered in mountainous areas, which rely on diversion weir on a small

tributary and small impounding pond, was not incorporated into this study.

In this study, therefore, water intake methods of only items iii) and iv) were examined. Accordingly two alternatives of water intake methods for irrigation development were considered in the assessment of the development potential for irrigation.

Alternative-1	construction of a large intake weir at the main river
Alternative-2	combination of alternative-1 and regulated dam (reservoir)

4.4.2 Water requirement

Although the meteorological conditions in the whole Nias Island are different depending on the location, these differences seem so small that the study for each irrigation project has been done according to the following same conditions.

1) Cropping pattern	:	Double cropping of paddy per year
1st cropping	:	March to July
2nd cropping	:	August to December
2) Meteorological data	:	Gunung Sitoli station
3) Probability of rainfall	:	once in 5 years
4) Method of calculation of water requirement	:	"Guideline for crop water requirements for paddy and other crops (PSA 010)"

Unit irrigation water requirement and diversion water requirement were calculated as shown in Tables 4.4 and 4.5.

4.4.3 Determination of the scale of the irrigable area

The scale of irrigable area in Alternative-1 was determined by the following equation.

$A = Q / q$

in which, A = irrigable area (ha)
Q = available river discharge at the intake weir (m^3/s)
q = unit irrigation water requirement ($m^3/s/ha$)

Table 4.6 shows the area to be irrigated on the semi-monthly basis in case that the irrigable area has a catchment area of 100 km^2 at the intake weir site. The period of late March is the most critical period for irrigation water supply and possible area to be irrigated by Alternative-1 would be 1,944 ha per a catchment area of 100 km^2. The second is early May. The possible area to be irrigated was estimated to be 2,218 ha.

The scale of irrigable area in Alternative-2 was examined. As an example, irrigation of the area of 2,218 ha with water regulated by a reservoir would require an effective reservoir capacity of about 550,000 m^3 as shown in Table 4.6. This table also shows the effective capacity of reservoir required for 2,500 ha and 3,000 ha to be irrigated. For the 2nd cropping season, there is also a critical period for water supply in late August, however the water in the reservoir will be filled by this month.

The possible area to be irrigated by Alternative-1 and Alternative-2 is shown in Table 4.7. The total area to be irrigated by Alternative-1 would be 33,770 ha or 65% of the potential irrigable area. The total area to be irrigated by Alternative-2 would be 38,550 ha or 74% of the potential irrigable area.

5. IRRIGATED AGRICULTURAL DEVELOPMENT PLANS

5.1 Development Needs

The Nias island is one of the remote islands, located about 130 km west of the Sumatra island. Agriculture is the main industry in the island. About 80% of the total population of the island (560,000) are engaged in agriculture and its related activities.

The abundantly available land and water resources in the island have been partially developed because investment for development has been concentrated to the main islands such as Java, Sumatra, Kalimantan and Sulawesi. Up to now about 26,000 ha or about 40% of the suitable land for paddy cultivation (66,800 ha) have been developed as paddy fields in total. And only about 10% of the total paddy field is irrigated. 90% is still under rainfed condition.

Under such situation, paddy production in the Nias island has been left far below its potential mainly due to (i) shortage of irrigation and drainage systems, (ii) shortage of irrigation water, (iii) poor water and farm management. Consequently income level of the farmers in the Nias island is quite low. The gross domestic product per capita in the island is so low as equal to either 43% of that of the North Sumatra province or 39% of the average gross domestic product of whole Indonesia.

The Nias island is a region spelling from rice shortage. At present a considerable amount of rice has to be imported from other provinces as shown in Table 3.40.

The total population in the Nias island was 559,000 as of 1989. The population in 2010, that was assumed as the target year of the agricultural irrigation development in the island, would be about 796,500. Demand of paddy in the target year was forecast to be about 188,000 tons. On the other hand, production of paddy in the target year would be 94,500 tons if new irrigation projects are not

implemented during the period up to the target year. This would leave a shortage of 93,500 tons of paddy (see Table 5.1).

It is, therefore, important to place a development priority on increasing rice production to achieve self-sufficiency in rice in the Nias island and on raising income level of the farmers by increasing paddy production.

5.2 Objectives and Strategy of Development

Reflecting the development needs and the national development policy, the following objectives have been set up for the agricultural irrigation development plan in the Nias island; (i) to raise farmer's income level through enhancement of agriculture, especially rice production, by efficient utilization of the land and water development potential in the Nias island and (ii) to contribute to regional need to increase rice production with the aim of achieving self-sufficiency in rice in the Nias island.

To realize these objectives, the following development strategy is proposed for the formulation of individual plans:

(i) rehabilitation and improvement of the existing irrigation systems

(ii) provision of irrigation and drainage systems for the existing rainfed paddy fields

(iii) development of upland and bush areas to irrigated paddy fields

(iv) raising rice production through increase of unit yield of paddy, increase of annual cropping intensity in the existing paddy fields.

5.3 Agricultural Development Plan

5.3.1 Proposed land use

As mentioned in section 3.7 "Soils and Land Capability", the land suitable for paddy cultivation in the Nias island is 66,800 ha which is the objective area for irrigation development. The future land use was planned for the objective area, taking into consideration the present land use condition and some specific conditions as mentioned below:

(i) The Gido Zebua irrigation project area (1,660 ha) being implemented by the Government under assistance of ADB will be excluded in the study of the future land use plan.

(ii) The forest in the objective area should remain as it is as function as a forest reserve and a reserve for wild animals.

(iii) The upland (780 ha) and the bush land (18,380) ha will be developed the paddy field, judging from their low productivity and farmer's expectation for expansion of cultivated area.

(iv) The coconut field (4,940 ha) and the rubber field (3,500 ha) will remain as they are. The considerable area of coconut field is used for oil production for domestic consumption. Among the rubber field, 1,000 ha are now planned to be rehabilitated.

Under such conditions, irrigation development projects were formulated. Implementation of the irrigation projects will provide perennial irrigation water for increasing the unit yield of paddy and the production. After implementation of these projects, land use in the objective area will change considerably as follows (see Table 5.2):

Unit : ha

Categories of Land Use	Present Condition	With project Condition
irrigated paddy field	2,370	32,350
rainfed paddy field	16,430	0
upland field	780	80
bush and shrub land	18,380	2,130
coconut field	4,940	4,940
rubber field	3,500	3,500
forest and settlement	14,020	14,020
others	4,720	8,120

5.3.2 Proposed cropping pattern

The proposed cropping pattern was formulated taking into consideration (i) climatic condition, (ii) soil condition, (iii) farming practices including control of rats, pests and diseases, (iv) plant physiological features, (v) water balance and (vi) water management .

The proposed pattern is :

(i) to create possible benefits for the farmers and the nation as a whole

(ii) to make optimum utilization of water to be supplied by the project, and

(iii) to conform with the existing social tradition and be acceptable to farmers.

On the basis of the above study, double cropping of paddy per year was formulated as the proposed cropping pattern as illustrated in Fig. 5.1.

In the pattern, high yielding varieties were planned to be introduced in both wet and dry seasons. The staggering period was designed to be 1.5 months. The framework of the cropping calendar was made taking into consideration the following:

(i) The wettest period should be avoided for the harvesting time.

(ii) The period between the end of harvesting of the wet season paddy and the sowing of the dry season paddy is designed to be at least one month to avoid overlapping in the area in order to prevent damages from rats, pests and diseases

(iii) The calendar is designed so as to obtain a sunny weather in the critical growth periods in terms of sunlight requirement as much as possible. The critical period is from 15 days before heading to 25 days after heading.

5.3.3 Proposed farming practices

Proper farming practices are essential for realizing the full exploitation of agricultural potential in the Nias island. It is necessary to introduce high yielding varieties with an appropriate farming practice along with development and strengthening of institutional support.

The proposed farming practices were formulated referring to the farming guidelines prepared by the provincial food crops agriculture service office. The proposed farming practices are shown in Table 5.3.

5.3.4 Anticipated yield and production

The unit yield of paddy was anticipated in case of with and without project. The target yield of paddy without project condition was estimated based on the statistic data, being 2.3 to 3.0 tons/ha depending on location as shown in Table 5.4. The yield of paddy with project condition is estimated based on the yield of the existing well-irrigated land, on information of BIMAS program and proposed farming practices. The yield is anticipated to be 5 tons/ha both in the wet and dry seasons. For attaining the anticipated yield of paddy, an optimum application of farm inputs will be essential along with proper water management.

5.3.5 Marketing and price prospects

The Nias island is short of rice at present. About 22,000 tons of rice have been imported from other provinces in 1990. It is expected that a considerable rice demand will occur in the future due to population increase and per capita consumption of rice. The demand of rice in the Nias island was estimated as follows. Details are shown in Table 5.1.

Unit : tons

Year	Incremental demand of paddy
1990	40,000
1995	52,900
2000	65,800
2005	79,100
2010	93,500
2015	108,000
2020	123,700

It is considered that the amount of rice to be produced in the proposed irrigation projects will be sold in the Nias island.

The prospective prices of farm outputs and inputs were estimated based on the World Bank document on "Price Prospects for Major Primary Commodities, 1988-2000". Prices at the farm gate are shown below. Details are shown in Tables 5.5 and 5.6.

Unit : Rp./ton

Kind of commodity	Price
paddy	298,000
urea	534,000
TSP	607,000
KCl	388,000

5.3.6 Crop budget

On the basis of the estimated production cost and gross income, primary profit of paddy per ha was calculated both on future with and without project conditions as shown in Table 5.7. In the estimation, it was assumed that under the without project condition the production cost will remain constant at the present level as no significant changes in farm inputs were predicted.

5.4 Irrigation and Drainage Development Plan

5.4.1 General

Based on assessment of development potential of the land and water resources in the study area, possible irrigation plans have been formulated in line with the development strategy set up in section 5.2.

To formulate the possible and practical irrigation and drainage projects, the following were considered.

(i) Future land use plan: Land of forests, rubber and coconuts are excluded from the objective area of the projects. Bush and upland crop areas will be the objective area of the projects.

(ii) The Gido Zebua irrigation project that is being performed by the Government is excluded from the objective area of the projects.

(iii) The existing irrigation projects that are now planned by the DPU, North Sumatra province are reflected in the formulation of the projects.

(iv) The irrigation and drainage plans are formulated within the framework of gravity systems without regulating reservoirs.

(v) The areas for each of the irrigation and drainage project is so formulated as to become maximum.

(vi) Unification of the irrigation projects formulated in section 3.4 is planned through a water basin transfer of available water for effective water use.

5.4.2 Water requirement

The water requirement of crop was calculated on the basis of the proposed cropping pattern. The water requirement of paddy was estimated in accordance with the planning guideline prepared by DGWRD. The consumptive use of water was estimated based on the modified Penman method proposed by FAO. The effective rainfall was based on the 5-year return period at the Gunung Sitoli station. The

overall irrigation efficiency was assumed to be 60%. The unit irrigation water requirement is presented in Table 4.5.

5.4.3 Proposed irrigation projects

Formulation of the irrigation and drainage projects in the Nias island was carried out within the framework of the concept mentioned in section 3.4.

Water balance was examined for determination of the scale of the irrigation projects. The result of the study indicates that the unification of irrigation projects through a water basin transfer of river waters would be the best way to use land and water resources effectively. In this study, the following irrigation projects were planned to be unified.

(i) Mezawa and How irrigation projects
(ii) Ladara, Sowo, To'o and Afia irrigation projects
(iii) Susuwa and Afoa irrigation projects
(iv) Otuwa, Idano Zala and Todawa irrigation projects
(v) T.Dalam and Bawodobara irrigation projects, and
(vi) Tuhenase and Afulu irrigation projects.

Based on the result, seventeen (17) irrigation projects were formulated as shown below;

Unit : ha

Name of irrigation project		Development area
(i)	Mezawa/How	8,420
(ii)	Muwa	5,530
(iii)	Ladara/Sowo/To'o/Afia	2,500
(iv)	Susuwa/Afoa	940
(v)	Binaka	90
(vi)	Boli	190
(vii)	Siwalawa	520
(viii)	Amuri	250
(ix)	Lahusa	130
(x)	Ndra Humene	680
(xi)	Otuwa/Id.Zala/Todawa	1,800
(xii)	T.Dalam/Bawodobara	250
(xiii)	Hilijihona	100
(xiv)	Torowa	570
(xv)	Muzoi	1,000
(xvi)	Tuhenase/Afulu	520
(xvii)	Oyo/Dumula	8,860

The proposed 17 irrigation projects are illustrated on Figs. 5.2 to 5.18 and outlined as follows;

(i) Mezawa/How irrigation project

The Mezawa/How irrigation project is located in the alluvial plain along the coastal line of the east coat. The project area belongs to Kecamatan Idano Gawo. The irrigable area is 8,420 ha. The water source is Mezawa river and Mola river for Mezawa area, and Susuwa river and How river for How area. Due to shortage of irrigation water during the dry season, the proposed cropping intensity is 174% of paddy per year. Construction of nine (9) headworks and 159 km of irrigation canal and 3,880 ha of land reclamation is proposed.

(ii) Muwa irrigation project

The Muwa irrigation project is located in the east coast, about 12km south of Gunung Sitoli. Administratively, the project area is overlapping two Kecamatans, Idano Gawo and Gido. The

irrigable area is 5,530 ha. Presently, rainfed paddy planting is practiced. Water source is Muwa, Gido, Sido and Gawo rivers. Proposed cropping intensity is 158% of paddy. Six (6) headworks and about 100 km of irrigation canals will be constructed.

(iii) Ladara/Sowo/To'o/Afia irrigation project

This area is located in the north-east of the island. Administratively, the project area is within Kecamatans Gunung Sitoli and Tuhemberua. The net project area is 2,500 ha. At present, rice is cultivated on 600 ha (24%) under irrigated condition and on 1,350 ha (54%) under rainfed condition. Water source is Sowo river, Afia river and To'o river. The proposed cropping intensity is 200% per year. Construction of seven (7) intake weirs and 90 km of irrigation canals and reclamation of 550 ha of land are required.

(iv) Susuwa/Afoa irrigation project

This area is located in the southeast of the island and belongs to Kecamatan Lahusa. The project area is 940 ha. To introduce double cropping of rice, construction of intake weir on Masio river at about 3 km upstream from river mouth is required. Construction of 30 km of irrigation canals and land reclamation of 670 ha (71%) are also necessary. Prior to the beginning of construction work of irrigation systems in this area, access road shall be constructed. This road will encourage socio-economic development in the project area, however, this is not taken as a direct benefit of the Project.

(v) Binaka irrigation project

Binaka irrigation project is located in east coast about 3 km south of Gunung Sitoli, Capital of Nias island, with a total irrigable area of 90 ha. Presently, rice is cultivated on 90 ha under rainfed condition. Main works of the project are

construction of intake weir on the tributary of the Idanoi river and 8 km of irrigation canals. Proposed cropping intensity is 200% of rice per year.

(vi) Boli irrigation project

Boli irrigation project belongs to Kecamatan Lahusa, southeast of the island. Total irrigable area is 190 ha. Presently 40 ha (21%) are irrigated and remaining 150 ha (79%) are rainfed. Water source is the tributary of Masio river. A cropping intensity of 200% is expected. Two (2) intake weirs and 9 km of irrigation canals will be constructed. Prior to the beginning of construction work of irrigation systems in this area, access road shall be constructed. This road will encourage socio-economic development in the project area, however, this is not taken as a direct benefit of the Project.

(vii) Siwalawa irrigation project

Siwalawa irrigation project belongs two Kecamatans, Lolowa'u and Sirombu, located in the middle of the island. Total irrigable area is 520ha net. Rice is being cultivated on 180 ha (35%) under irrigated condition and on 240 ha (46%) under rainfed condition. Five (5) intake weirs will be constructed on Siwalawa river and its tributaries. Proposed cropping intensity is 200% of rice per year. The construction of irrigation canals (27 km) and land reclamation of 100 ha shall be carried out.

(viii) Amuri irrigation project

Amuri irrigation project belongs to Kecamatan Lolowa'u with total irrigable area of 250 ha. Rice cultivation is practiced under rainfed condition on 180 ha (72%) at present. To introduce double cropping of rice, three (3) intake weirs and 16 km of irrigation canals are to be constructed.

(ix) Lahusa irrigation project

Lahusa irrigation project is located in the western coast of the island. Total irrigable area is 130 ha. Of which, 50 ha (38%) are cultivated by rainfed at present. Proposed works are construction of four (4) intake weirs on small rivers, 8 km of irrigation canals and land reclamation of 80 ha.

(x) Ndra Humene irrigation project

Ndra Humene irrigation project is located in the eastern coast of Kecamatan Gido. Total net irrigable area is 680 ha At present paddy cultivation is practiced on 300 ha (44%) under irrigated condition and on 140 ha (21%) under rainfed condition. Water source is the Ndra river and Idanoi river. Besides the existing intake weir on the Ndra river, a new intake weir is proposed on the Idanoi river. 240 ha of paddy field will be newly developed and irrigation canals with a total length of 21 km are to be constructed. Proposed cropping intensity is 200% of paddy per year.

(xi) Otuwa/Id.Zala/Todawa/Sorake irrigation project

Otuwa/Id.Zala/Todawa/Sorake irrigation project is located in western coast of Kecamatan Teluk Dalam with a net irrigable area of 1,800 ha in total. Presently, 520 ha (29%) are irrigated and 720 ha (40%) are cultivated under rainfed condition. Water source for Otuwa, Id. Zala and Todawa areas is Eho river. Irrigation water for Sorake area is taken from Gomo river. Main project components are four (4) intake weirs and 70 km of irrigation canals and 560 ha of reclaimed land.

(xii) Teluk Dalam/Bawodobara irrigation project

Teluk Dalam/Bawodobara irrigation project is located in southern part of the island and belongs to Kecamatan Teluk Dalam. Total net irrigable area is 250 ha. Irrigation water relies

on small rivers around the project area. At present, paddy is cultivated on 40 ha (16%) under irrigated condition and on 150 ha (60%) under rainfed condition. Construction of a new intake weir and 16 km of irrigation canals and reclamation of 60 ha of land are proposed. Proposed cropping intensity is 200% of rice per year.

(xiii) Hilijihona irrigation project

Hilijihona irrigation project is located in southern part of Kecamatan Teluk Dalam. Total net irrigable area of 100 ha is cultivated by rainfed water. To introduce double cropping of rice, construction of intake weir and 7 km of irrigation canal is proposed.

(xiv) Torowa irrigation project

Torowa irrigation project belongs to Kecamatan Tuhemberua, northern part of the island. Total area is 570 ha in net. Of which, 250 ha (44%) are irrigated and 140 ha (25%) are rainfed at present. Water source is the Sawo river and its tributaries. To introduce double cropping of rice, construction of four (4) intake weirs and 32 km of irrigation canals and reclamation of 180 ha of land are proposed.

(xv) Muzoi irrigation project

Muzoi irrigation project is located in northern part of the island. Administratively, the project area belongs to two (2) Kecamatans, Tuhemberua and Lahewa. Total net area is 1,000 ha. Presently, 250 ha (25%) are irrigated and 380 ha (38%) are rainfed. To introduce double cropping of rice, nine (9) intake weirs and 45 km of irrigation canals are proposed and 370 ha of paddy field are to be newly developed. Prior to the beginning of construction work of irrigation systems in this area, access road shall be constructed. This road will encourage

socio-economic development in the project area, however, this is not taken as a direct benefit of the Project.

(xvi) Tuhenase/Afulu irrigation project

Tuhenase/Afulu irrigation project is located in west coast of Kecamatan Lahewa, northern part of island. Water source is spring water. Out of the total area of 520 ha, 220 ha is presently cultivated by rainfed water. Proposed cropping intensity is 200% of rice per year. Irrigation water is collected by ditch constructed in the mountaneous area and distributed to paddy fields. Total length of the proposed irrigation canal is 13 km. In addition, 300 ha (58 %) are to be newly developed. Prior to the beginning of construction work of irrigation systems in this area, access road shall be constructed. This road will encourage socio-economic development in the project area, however, this is not taken as a direct benefit of the Project.

(xvii) Oyo/Dumula irrigation project

Oyo/Dumula irrigation project is located in western coast of the island. The project area covers three Kecamatans, Alasa, Mandrehe and Sirombu. Total area is 8,860 ha in net. At present rice cultivation is practiced on 190 ha (2%) under irrigated condition and on 2,180 ha (25%) under rainfed condition. Water source is Dumula, Oyo, Morudo and Lahomi rivers. 12 intake weirs are to be newly constructed. Irrigation canal is 134 km in total and 6,490 ha of paddy field are to be newly developed. Proposed cropping pattern is double cropping of paddy. Prior to the beginning of construction work of irrigation systems in this area, access road shall be constructed. This road will encourage socio-economic development in the project area, however, this is not taken as a direct benefit of the Project.