THE REPUBLIC OF THE PHILIPPINES
NATIONAL IRRIGATION
ADMINISTRATION (NIA)

JAPAN INTERNATIONAL
COOPERATION AGENCY
(JICA)

FEASIBILITY STUDY ON THE UPLAND IRRIGATION AND RURAL DEVELOPMENT PROJECT IN SOUTHERN LUZON

VOLUME I
MAIN REPORT

March, 1995

NIPPON GIKEN INC.
TOKYO, JAPAN

NIPPON KOEI, CO., LTD.
TOKYO, JAPAN

JAPAN INTERNATIONAL COOPERATION AGENCY
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PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a Feasibility Study on the Upland Irrigation and Rural Development Project in Southern Luzon and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team headed by Mr. Katsuhiko Kimura, Nippon Giken Inc., three times in the period from January 1994 to December 1994.

The team exchanged views with the officials concerned of the Government of the Philippines and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the Project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Philippines for their close cooperation extended to the team.

March 1995

Kimio Fujita
President
Japan International Cooperation Agency

March 1995

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the Feasibility Study Report on the Upland Irrigation and Rural Development Project in Southern Luzon in the Republic of the Philippines. The report contains the appropriate formulation of the above mentioned Project deliberating on the advice and suggestions of the authorities concerned of the Government of Japan and your Agency. The report also incorporated comments made by the agencies concerned of the Government of the Philippines during technical discussions of the draft report which were held in the Philippines.

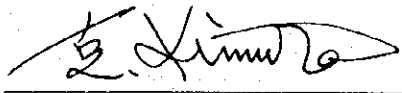
This report presents an irrigated horticulture and rural development plan, and at the same time an environmental conservation plan on the footslope of Mts. Banahaw and San Cristobal in the Study area. The development plan consists of 1) irrigation development, 2) improvement of marketing activities, 3) agricultural training and extension, 4) soil conservation, and 5) rehabilitation of rural water supply systems. Because of the blessed site location close to biggest consumer city, Metro Manila and favorable climate suitable for vegetable production, the integrated agricultural and rural development plan in the Study area will activate rural economy, living conditions, and eventually contribute to prevention of further environmental destruction of the National park contiguous to the Study area. The Project is formulated as economically, technically and institutionally feasible in the local condition.

In view of the urgency of forest protection in and around the Study area and of the increase of vegetable production in the Philippines, we highly recommend that the Government of the Philippines implements the Project as a higher priority.

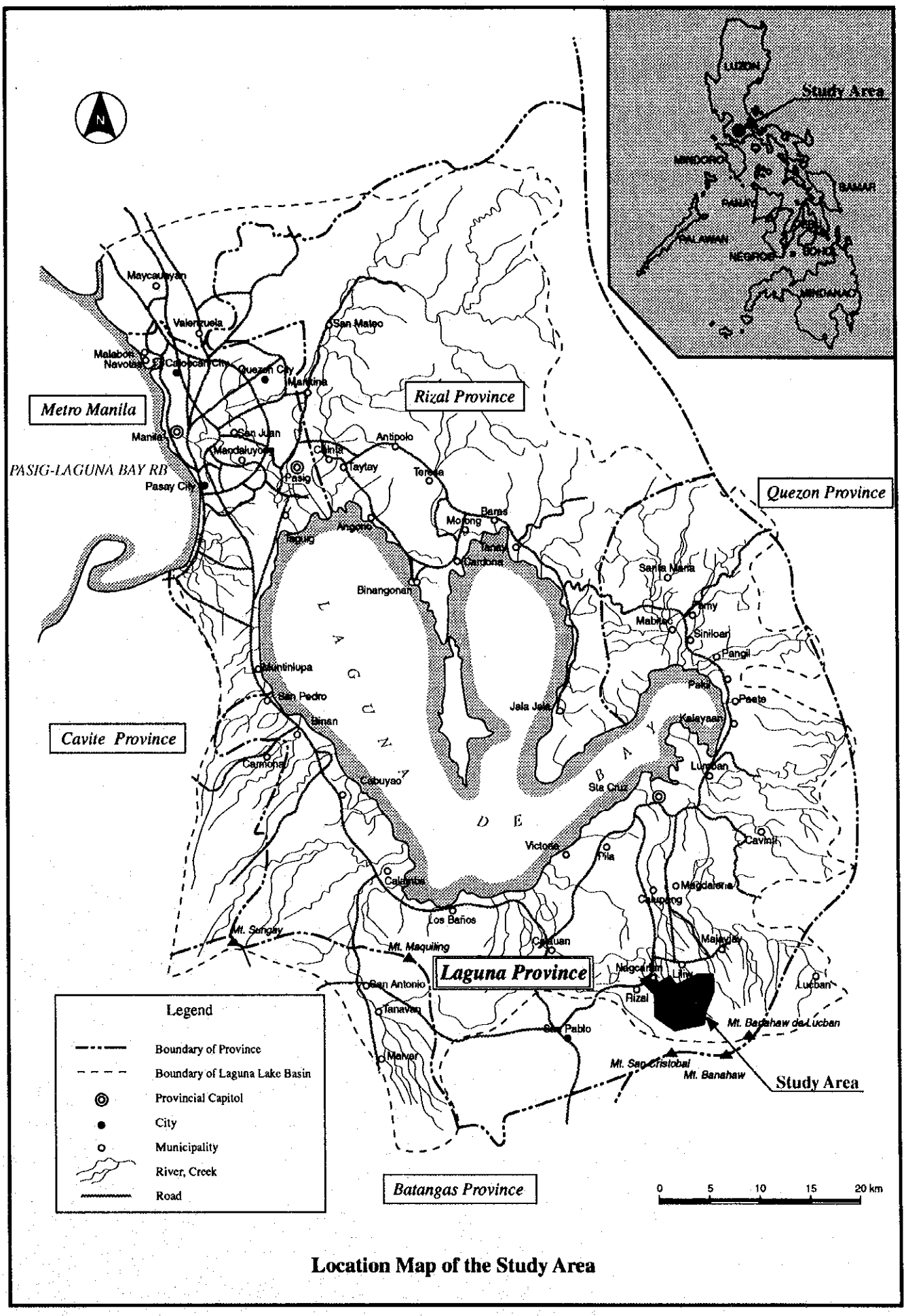
We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, and the Ministry of Agriculture, Forestry and Fisheries. We would also like to express our gratitude to the officials concerned of the National Irrigation Administration and other authorities concerned of the Government of the Philippines, the JICA Philippine office and the Embassy of Japan in the Philippines for the close cooperation and assistance throughout field investigation and study.

Finally, we hope that this report will contribute to further promotion of the Project.

Very truly yours,



Katsuhiko Kimura
Team Leader,
Feasibility Study on the Upland Irrigation
and Rural Development Project
in Southern Luzon



Location Map of the Study Area

Ibabang Sungi - Ilayang Sungi L=4.4 km

Novaliches - Luquin L=5.7 km

Pangil - Bukal L=4.3 km

Sinipian - Silangan Lazaan L=6.0 km

Soil Conservation Extension Center

San Francisco - Bukal L=6.6 km

Malinao - Kanlurang Lazaan L=1.7 km

Kanlurang Lazaan - Bukal L=2.1 km

Upland Horticulture and Irrigation Technology Center

Majayjay

Nagcarlan

Liliw

Mt. San Cristobal

Mt. Banahaw

SAN ROQUE

BALIMBING

OPLIS

NOVALICHES

BUKAL

SILANGANG NAPAPATID

SAN FRANCISCO

MALINAO

ABO

KANLURANG LAZAAN

SILANGAN LAZAAN

Bancal River

Maimpis River

Ila River

Nagcarlan River

Liliw River

Oples River

San Diego River

300 400 500 600 700 800 900 1,000 1,100 1,200 1,300

Legend

- Boundary of Municipality
- Contour in Meter
- Rivers
- Road Improvement
- Boundary of Public Forest Lands
- Boundary of the National Park
- Wet Paddy Fields
- Vegetable Cropped Fields
- Intake Weirs
- Farm Ponds
- Pipe Lines
- Trading Posts
- Soil Conservation Demo Fields
- Rehabilitation Works on Rural Water Supply Systems

0 200 400 600 800 1,000 m

GENERAL PLAN OF THE PROJECT

Project Descriptions
Upland Irrigation and Rural Development Project in Southern Luzon

Project Title	Upland Irrigation and Rural Development Project in Southern Luzon		
Country Name	Republic of the Philippines	**Province**	Laguna
		Municipality	Nagcarlan, Liliw, Majayjay

Objectives of the Project

Excessive logging has reduced primary virgin forests to 36% within Public Forest lands which occupies half the land in the Philippines.
Immigrating farmers created by general impoverishment employ extensive and subsistence farming manner, mostly shifting cultivation, resulting in the devastation of natural forests.
Mts. Banahaw - San Cristobal National Park and Public Forest lands lie in the southern part of the Study area, so that the Project area is identified as one of the front area under the situation stated above.
Fundamental issue that general poorness of the farmers causes such problems should be solved.
The Project provides various infrastructures such as irrigation facilities and farm-to-market roads for raising the farmers' incomes and hence the livelihood. Ancillary works and services for supporting the farmers to realize the improved farming and marketing are also executed by the Project.
In order to eliminate further destruction of environment and natural resources in the area and preserve or even enhance the quality of those, the project is expected to be urgently implemented.
At the same time, Mts. Banahaw and San Cristobal watersheds being a part of the Laguna lake basins, have contributed to mitigate the contamination of the Laguna Lake, of which environmental preservation will be assured by the Project.

		Vegetable Fields		Coconuts / tree crops	Forest / scrub	Others	Total Study area
		Irrigation area	Rainfed area				
Land Use (net area)	Present (ha)	0	760 (720)	1,220	750	270	3,000
	with Project (ha)	340 (320)	1,050 (1,000)	590	750	270	3,000

Benefited Area:	1,250 ha (Road influence area: 1,250 ha, Irrigation area: 320 ha)				
Beneficiaries:	Direct beneficiaries	8,100	Benefited farmers	6,300	Farmers' household	1,340
	Total beneficiaries	15,000 (One-third of population in related Municipalities are benefited)			

Major Features of the Project

Irrigation facilities

Intake works	2	sites	Water source; Bukal spring, Luquin spring
Farm ponds	10	sites	Concrete structure (V=360cum)
Conduit pipeline	12.55	km	Steel pipe φ4"-10"
Distribution pipeline	37.20	km	Steel pipe φ3"- 6"
Common hydrants	173	nos	

Farm-to-market roads

Concrete pavement	18.54	km	W=4.0m : L=15.41km, W=5.0m : L= 3.13km, with L-shape gutter
L-shape gutter	12.29	km	
Bridges	4	brdgs	Box culvert type
Trading posts	15	bldgs	Working space=100sq.m, office

Upland Horticulture and Irrigation Technology Center

Demonstration farm	1.0	ha	Green house, on-farm irrigation instrument
Center building			
Main building	264	sq.m	Seminar room, laboratory, accommodation, office
Garage/storage	56	sq.m	

Soil conservation

Demonstration fields	12.1	ha	(9 sites)
Soil Conservation Extension Center			
Tree nursery	2,000	sq.m	
Main building	156	sq.m	
Garage/storage	56	sq.m	

Rural water supply system

Rehabilitation works	2	sites

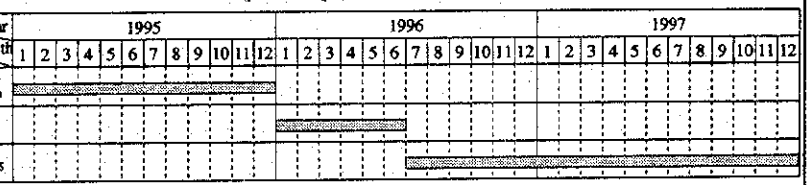
Machinery/equipment : Vehicles, agricultural machinery, office tools, meteorological observation equipment, etc.

Project Implementation : National Irrigation Administration (NIA)

Project Steering Committee (PSC)

Leading agency: NIA Region IV Office
Participating agencies: NEDA Region IV Office
DBM
DA Region IV Office
DENR Region IV Office (PENRO, CENRO)
DAR Region IV Office
Provincial government of Laguna
Municipal governments

Proposed Implementation Schedule



Project Cost: ₱ 347.3 million (F/C: ₱ 179.0 million, L/C: ₱ 168.3 million)

	('000 pesos)		('000 pesos)
1. Detail design	15,223	3. O & M machinery/equipment	12,231
2. Construction works	214,598	4. Administration cost	2,942
Irrigation construction works	75,290	5. Engineering cost	25,530
Road improvement works	113,131	6. Land acquisition	2,065
Trading posts construction	11,953	7. Physical contingency	27,258
Horticulture / Irrigation Center	8,495	8.Price contingency	47,433
Soil conservation works	3,836		
Rehabilitation works for rural water supply systems	1,896		
		Total	347,280

Project Justification (unit: ₱ '000)

Net incremental benefits : 88,258 (Irrigation: 59,370, Road: 28,888)
Economic project cost : 274,710 Economic Internal Rate of Return: 18.5%

Operation and Maintenance Plan

Proposed components	Responsible agencies for O&M	Supporting agencies/personnel
Irrigation	Irrigators' Association (IAs) (Nagcarlan, Liliw IAs)	NIA Region IV (Irrigation Development Officer) Municipal governments
Farm to market roads	Provincial government (responsible for Provincial roads) Municipal governments (responsible for Barangay roads)	Provincial government
Trading posts	Marketing cooperatives (O&M) Municipal governments	Cooperative Development Authority Municipal Cooperative Board Municipal Agricultural Officer
Upland Horticulture and Irrigation Technology Center	Department of Agriculture (DA) Region IV cooperated by Municipal governments	NIA Region IV, University of the Philippines (UPLB)
Soil Conservation Extension Center	PENRO Laguna, (CENRO)	Municipal governments
Demonstration fields	Farmers	PENRO Laguna, (CENRO)
Rural water supply system	Existing each Barangay Water Works and Sanitation Associations (BWSAs); Abo in Nagcarlan and Gawanan in Liliw	Nagcarlan and Liliw Municipalities for each BWSA

Operation & Maintenance Committee (OMC)

Leading agency: NIA (Region IV Office)
Participating agencies: DA Region IV Office
DENR Region IV Office (PENRO)
PGL
Municipal governments

Environmental Evaluation Unit (EEU)

Leading agency: Municipal governments
Participating agencies: PENRO (DENR)

Annual O&M Cost

₱ 6.0 million

Relative Projects

Master Plan Study on the Project CALABARZON, 1991, JICA
Diversified Crops Irrigation Engineering Project (DCIEP) 1987 - 1998, JICA

BASIC DATA OF THE PHILIPPINES

Land and People (1994)

Land Area	278,568 sq.km
Population	67,038,000
- rural	36,935,000 (55%)
- urban	30,103,000 (45%)
Population density	241 persons/sq.km
Nos. of household	11,975,000
Average household size	5.60
Annual population growth (1985 - 1990)	2.11%

Macro-Economic Indicators	1988	1989	1990	1991	1992
GDP at current price (₱ billion)	799.2	925.4	1,073.1	1,244.7	1,338.4
GDP at constant 1985 price (₱ billion)	658.6	699.5	718.1	712.3	710.4
Real GDP growth (%)	6.8	6.2	2.6	-0.8	-0.3
Consumer price index (1988=100)	100.0	112.2	128.0	157.8	170.6
Inflation Rate (%)	8.9	12.2	14.2	18.7	8.9
Population (million)	58.7	60.1	61.5	62.9	64.2
Export fob (US$ million)	7,074	7,821	8,186	8,839	9,824
Import cif (US$ million)	8,159	10,418	12,206	12,051	14,158
Balance of trade (US$ million)	-1,085	-2,597	-4,020	-3,212	-4,194
Current account (US$ million)	-390	-1,465	-2,688	-1,033	-999
Exchange rate (₱ per US$)	21.74	24.31	27.76	25.61	25.61
Government Revenue (₱ billion)	112.8	142.1	180.9	340.7	409.8
Current operating expenditure (₱ billion)	255.8	284.1	177.9	291.9	341.9
Net budgetary surplus (₱ billion)	-24.2	-14.5	-37.2	-17.5	-17.4
Debt service (₱ billion)	71.3	56.9	71.1	120.5	119.3

Origin of GDP for 1992

Agriculture	22.5%
Manufacturing	25.3%
Construction	5.1%
Trade	14.7%
Transport & Communication	5.9%
Public Administration	5.1%
Other services	21.4%
Total (GDP at current price)	100.0%

Components of GDP for 1992

Private consumption	76.0%
Public consumption	7.7%
Gross capital formation	22.5%
Export	29.0%
Less : Import	-33.7%
Less : Statistical discrepancy	-1.5%
Total (GDP at current price)	100.0%

Principal Agricultural Exports for 1991

	(US$ million)
Total exports	8,839
Agricultural exports	1,845 (20.9%)
Coconut products	440
Fruit and Vegetables	497
Forest products	225
Sugar products	146

Principal Agricultural Import for 1991

	(US$ million)
Total import	12,051
Agricultural imports	1,259 (10.5%)
Cereals	226
Fertilizers	131
Dairy products	210
Feeds	153

Source: (1) 1993 Philippine Statistical Yearbook, October 1993, National Statistical Coordination Board
(2) Selected Statistics on Agriculture, June 1993, Bureau of Agricultural Statistics
(3) National Handbook on Land and Other Physical resources, July, 1992, NEDA

SUMMARY

INTRODUCTION

(1) This is the "Final Report" on the "Feasibility Study for the Upland Irrigation and Rural Development Project in Southern Luzon".

(2) The Implementing Arrangement on the Technical Cooperation for the Study was agreed upon between the National Irrigation Administration and the Japan International Cooperation Agency on February 3, 1993. The Study was carried out from January to November, 1994 in conformity with I/A.

(3) The objective of the Study is to formulate the irrigation and rural development in the area along the foot of Mt. Banahaw in the Province of Laguna, aiming at the improvement of agricultural productivity and rural welfare. The Study also aims to undertake transfer of technology to the Philippines counterpart personnel concerned in the course of the Study.

(4) The Study area covers an area of 3,000 ha along the foot of Mt. Banahaw in Municipalities of Nagcarlan, Liliw and Majayjay in the Province of Laguna.

BACKGROUND

(5) A total of approximately 15.5 million ha of uplands in the Philippines is equivalent to 52 % of the total land area. The uplands was thought to be unsuitable for farming partly because soil erosion starts to become excessive when lands above 18 % slope are cultivated, and to be suitable only for forests and pasture. Contrary to Alienable & Disposable lands that constitutes public lands with less than 18 % slope, the uplands are classified into the Public Forest lands and reserved for perpetual public ownership. The utilization, therefore, is restricted under the national law, although many upland farmers have used the lands without permissions for decades. Due to limited arable land in lowland and population pressure, a large tract of the uplands in the Philippines are now put under cultivation. It is estimated that use of uplands for cultivation amounts to 2.0 million ha or 13 % of the total uplands, and 8-10 million of the population are farming there.

(6) The socio-economic conditions in the upland are worse than those in the lowland. The agricultural production depends on rainfall. Cost of farm inputs is high due to poor accessibility. Infrastructures are very limited and basic social services are difficult to

receive. The Government has implemented the Integrated Social Forestry program since 1983 in order to improve the socio-economic condition of the upland farmers as well as to preserve the natural environment. In turn to the agricultural supports in the program, the farmers applied to the ISF program are prohibited to expand their farmlands in the Public Forest lands and obliged to protect the environment.

(7) Agricultural sector still remains as a major pillar of the Philippine economy. It accounts for about 23 % of GDP, more than 21 % of export earnings and about 50 % of the total employment. However, majority of the rural residents, especially small farmers, remain at poverty level. In view of these conditions, Philippine Agricultural Development Plan (1991-1995) has been programmed to increase the agricultural GVA by an average rate of 4.3 % per annum in real terms. In consonance with the Medium-Term Philippine Development Plan (1993-1998), the Department of Agriculture emphasizes to increase the productivity and real income of small farmers, especially in upland, coastal areas and other poverty-stricken areas.

(8) In 1992, vegetables inclusive of beans and root crops, accounted for 11 % of GVA in agriculture, contributing 2.4 % of GDP and 0.3 % of total exports. In 1992, DA set forth the "Fruit and Vegetable Development Plan for 1992-1995" to achieve the increased vegetable production in the medium term. The Plan is directed towards the following targets.

- Categorization of vegetable producing areas and formulation of proper technical guidelines for location-specific technologies
- Provision of agricultural infrastructures, such as irrigation and roads, and supporting services for agricultural sector
- Development and promotion of superior varieties
- Provision of post-harvest facilities at the farm level
- Improvement of marketing and distribution systems
- Strengthening of research, training and extension efforts
- Strengthening of institutional linkage among the government offices concerned

(9) The Study area has been acknowledged as follows by various agencies suitable for production of sub-tropical vegetables:

1) The Study area was identified as one of the highest priority areas for highland horticultural development by the JICA master plan study for the project "CALABARZON" in 1991.
2) The Study area was selected by ADB/BPI horticulture sector project in 1991 as the most promising alternative area of Baguio for the production of sub-tropical vegetables.
3) University of the Philippines, Los Baños has operated a pilot demonstration farm since 1988 in the Study area for research and demonstration on new vegetable production.

(10) In such circumstance, the Study area is situated in a marginal upland area, where natural resources are degrading by farming activities. At the same time, the Study area is recognized as a highly potential area for high-valued vegetable production. Therefore, the Project aims a sustainable and intensive irrigated horticulture development accompanied with a proper conservation of the rich natural resources.

PRESENT CONDITIONS OF THE STUDY AREA

(11) The Study area is located approximately 70 km southeast of Manila, the northeast foot of Mts. Banahaw and San Cristobal. Its elevation ranges from El. 300 m to El. 1,300 m, characterized by an undulating topography. Several rivers originated from Mt. Banahaw flow down to northwest direction, and flow down to the Laguna de Bay. Their major tributaries in the Study area are the Nagcarlan, the Liliw, the Maimpis and the Olla rivers. There are several springs in various size along the rivers.

(12) Population of Municipalities of Nagcarlan, Liliw and Majayjay were 37,679, 21,911, and 15,875, respectively in 1990. Major source of income in these Municipalities is agriculture. Small cottage industries and tourism also contribute to the income. The Study area can be divided into 15 Barangays in which 8 are in Nagcarlan, 4 in Liliw and 3 in Majayjay. The Farmers' Household Survey conducted in 1994 shows that total population and households are 8,044 and 1,727 respectively, and 1,340 households are farm households.

(13) Climate of the Study area characterized by pronounced two seasons of the dry season from November to April and the wet season in the rest of the year. Annual rainfall in the Study area is about 2,350 to 2,400 mm at the Municipality of Liliw. Mean monthly temperature ranges from a minimum of 16 °C to a maximum of 30 °C at the elevation of 700 m in the Study area. The coldest months are from December to February while the warmest are April and May.

(14) Geologically, the Study area is underlain by Quaternary volcanic products of Mt. Banahaw, which consist of andestic lava flow, tephra deposits, ash flow and lahar deposits. The upper regions of Mt. Banahaw are covered with lava flows and extrusive lava breccias. In steep slopes between El. 800 m and 700 m, pyroclastics and lahar deposits are predominant. Below El. 700 m, ash flow and lahar deposits extend northward to the Laguna de Bay. Most part of the Study area has gentle sloping topography except riverside cliffs, and is covered with pyroclastics such as tephra deposit, ash flow and lahar deposits.

(15) There are seven rivers in the Study area. Among them, the Nagcarlan, the Liliw, the Maimpis and the Olla rivers are perennial. Discharge of 0.23 to 0.25 cum/sec in the Liliw river, and 0.30 to 0.35 cum/sec in the Maimpis river were observed in the dry season. Considerable yield were confirmed at four springs. Yields of the springs measured during the Study and their elevations are as follows. Bukal spring in Nagcarlan yields 0.040 to 0.045 cum/sec at El. 890 m. Two springs, lower Luquin and upper Luquin springs, yield 0.200 cum/sec and 0.070 cum/sec at El. 560 m and El. 610 m, respectively. Maimpis river spring in Majayjay yields as much as 0.200 cum/sec at El. 600 m.

(16) According to the hydrogeological investigation conducted by test well drillings including electric logging and geoelectric survey, the Study area is mainly underlain by andestic lava and surface soil layer. The groundwater level is situated at 50 m below or more from the ground surface. Water bearing formations due to fissure water from the andestic lava are generally thin. The resistivity structure indicated the poor continuity of the aquifer.

(17) Soils of the Study area are formed on a slightly to highly dissected volcanic footslopes. These soils are moderately deep and well drained, and the fertility is generally classified into medium. More than 60 % of lands in the Study area have more than 18 % slope. Suitable area for vegetable production is estimated at about 1,570 ha in the Study area. As present vegetable farming area is approximately 760 ha (net cropped area: 720 ha), the potential area for vegetable production in future is estimated at approximately 800 ha. Most of the Study area are classified into slightly or moderately eroded area.

(18) National road passes the north of the Study area, connecting the central areas of Municipalities of Calauan, Nagcarlan, Liliw and Majayjay. The total length of the road to be improved in the Study area is 30.8 km, out of which 18.5 km is gravel pavement roads and remaining 12.3 km is paved with concrete at present. Present condition of the gravel roads is so poor that only horses are utilized as a effective means for farm products transportation in the wet season. Concrete pavement road has no drainage gutter and therefore it causes soil erosion from both sides of the pavement and road surface of gravel roads by rapid rain water flow.

(19) Rural water supply systems are well maintained in the Study area. Barangay Water Works and Sanitation Associations (BWSAs) are responsible for operation and maintenance of the systems. However, two intake facilities are in need of urgent rehabilitated due to their malfunctions.

(20) Coconut plantation is predominant, occupying 83 % of the total agricultural lands in the concerned Municipalities and 59 % in the Study area. Coconut plantation mostly extends in the lower part of the mountain slopes. Coconut trees there are generally aged. Vegetables are cultivated in a total area of 1,050 ha in the whole concerned Municipalities and 760 ha in the Study area. The farmers generally prefer to cooler climate in mountain side for vegetable cultivation. Vegetables are mostly planted on the mountain slopes between 500 m and 800 m in elevation in the Study area.

(21) The Study area of 3,000 ha is categorized as A&D land of 1,820 ha, Public Forest land of 390 ha and National Park of 790 ha. Most of the A&D land and Public Forest land are still Public land under patent applications by the farmers. However, individual land plots and applicants have already been identified by the municipal government, so that the lands would be re-distributed to the patent applicants. It is estimated that average size farmer cultivates is about 1.5 ha, comprising 0.9 ha of coconuts, 0.5 ha of vegetables and 0.1 ha of other crops.

(22) Major vegetables grown in the Study area are tomato, cabbage, radish, beans, and sweet potato, among which tomato and cabbage are predominant in the dry season. Because of the excessive amount of the rainfall in the wet season from May to October, farmers are generally only to cultivate sweet potato and cabbage, and rarely cultivate other ordinal vegetables which are adversely affected by excessive rainfall in both of quantity and quality. The annual cropping intensity is accordingly kept as low as 130 % in average.

(23) In the Study area, no systematic irrigation is practiced at present due to lack of irrigation water, steep and undulating topography and poorly prepared farmlands. Unit yields are generally low due mainly to 1) lack of irrigation facilities, 2) low level of fertilizer application, 3) inadequate control of pests and diseases, and 4) use of poor quality seeds. However, some farmers have already achieved higher unit yields according to the farmers' household survey. Accordingly, it is expected that the Study area has enormous potentialities converting to highly productive area of vegetables, using abundant land, human resources, and blessed climate.

(24) More than 100 buyers show up at the trading posts to buy and collect vegetables during the harvesting season. The primary wholesalers from Divisoria market in Manila handle 70-80 % of the total products. The wholesalers at Divisoria do business generally with regular partners. There is no auction market at Divisoria. Prices are determined on the spot through negotiations with reference to the purchasing prices in the producing areas.

(25) It is generally and evidently observed that vegetable prices rise from June and reach at the peak in November, and then fall again towards January to May when lowland products becomes available. In the Baguio, one of the advanced vegetable production area, the prices at the trading posts are around 75-85 % of the wholesale prices at Divisoria, while in the Study area, margins are much lower than 75 %, mainly because, compared to Baguio, the Study area is thus disadvantaged by 1) poor in quality of production, 2) higher risk of post-harvest losses such as bruise of vegetables during transportation due to poor road condition, and 3) low bargaining power of the farmers during the negotiation with the dealers.

(26) Major species in the forests are narra, tanguile, mayapis and red lauan. According to DENR, there is no rare, endangered, or threatened fauna and flora in and around the Study area. The field reconnaissance and interviews to farmers indicate that vegetable farmlands located in denuded steep slopes are the most susceptible to soil erosion by heavy rainfall in the wet season because the farmlands are protected by neither vegetation covers nor soil conservation measures.

DEVELOPMENT PLAN

(27) Within the Study area, approximately 100 ha of primary virgin forest in the National Park had already been destroyed and converted to agricultural land. The farmers employ extensive and subsistence-dominated farming in the area (mostly shifting cultivation), and do not employ any soil conservation practices. Impoverishment resulting from such poor farming practices causes further destruction of the forests for their livelihood. If no measures are taken, the present forests of Mts. Banahaw and San Cristobal will be completely destructed within a few decades.

(28) In establishing the framework of the project components, due attention has to be paid mainly to conservation of forest resources as a basis for upland development, eradication of poverty not to cause further forest destruction and enrichment of farmers' understanding in the environmental conservation by taking following approaches:

1) Minimum forest destruction caused by the project implementation.

2) Implementation and improvement of agricultural and marketing infrastructures required for better farm income and living conditions. Agricultural infrastructures, particularly irrigation and road systems, might lead to further exploitation of the reservation area by the implementation, so that the project plan takes not only the project economy but also environmental aspects for the formulation.

3) Inclusion of facility planning for irrigated agriculture and dissemination of environmental conservation.

4) Project planning with due consideration on capability of O&M management organization. In addition, promotion of farmers' participation in the project implementation and O&M planning, and establishment of a system to properly reflect opinions of the beneficiaries to the overall plan.

(29) The current issues and constraints for development in the Study area as follows. The development plans will therefore be formulated keeping these constraints in mind.

- Lack of irrigation system
- Poor farm-to-market road network
- Low cropping intensity during the wet season
- Predominance of steep slope land
- Low crop yield
- Low farm-gate prices of vegetables
- Poor marketing system

(30) The following are the proposed in the framework of the Project:

1) Irrigation development
2) Improvement of marketing activities
   - Road improvement
   - Trading posts installation
3) Agricultural training and extension
4) Soil conservation
5) Rehabilitation of domestic water supply system

(31) In the public consultation meetings in the respective Barangays in the Study area, the development concept and plans of the Project were explained to the beneficiaries. Almost all attendants broadly appreciated and accepted the plan during the meetings. There were a few respondents who claimed additional improvement of the proposed development concept and plans. These opinions were elaborately examined to make the development concept more realistic, attractive and acceptable to the prospective beneficiaries.

(32) Two irrigation systems are proposed, Nagcarlan irrigation system and Liliw irrigation system. For Nagcarlan irrigation system, water source is Bukal spring located at El. 890 m in the Nagcarlan river, and it is possible to irrigate 155 ha by gravity. For Liliw irrigation system, water source is Luquin spring located at El. 610 m in the Liliw river, and it is possible to irrigate 165 ha by gravity.

(33) The condition of existing farm-to-market roads is very poor in the Study area. Improvement of these roads is inevitable to achieve sustainable agricultural development in the area. Proposed road improvement works are composed of concrete pavement

and appurtenant drainage facilities of the existing farm-to-market roads. Total length of the roads to be improved is 30.8 km, comprising of 18.5 km for concrete pavement and drainage facilities, and remaining 12.3 km, which has been already paved with concrete, for only drainage facilities.

(34) Trading posts will be operated by the marketing cooperatives categorized in beneficiaries' organizations. Trading posts will be constructed to develop the collective marketing system of vegetable products, to strengthen the bargaining power of the farmers against traders, to attain scheduled shipping and production for stabilization of the vegetable prices, and to improve marketing activities through marketing cooperatives. Each trading post includes weighing, washing, bagging and storage facilities as well as office for exchange of marketing information.

(35) Lack of knowledge and extension means on the vegetable production and seed production technologies is limiting the vegetable production. There exists urgent requirements for training and extension on horticulture and irrigation technologies in the Study area. In view of the above, "Upland Horticulture and Irrigation Technology Center" will be established in Bukal, Nagcarlan as one of the key project components. The Center will have the following functions:

- Demonstration and dissemination of the appropriate technologies on new horticulture, irrigation methods, post harvest operation, etc.
- Multiplication and distribution of recommendable vegetable seeds
- Training of agricultural extension workers on the current technologies
- Demonstration of current technologies and field training for leading farmers

The Center will be operated and managed by the DA Region IV office in close coordination with the Municipal government of Nagcarlan, UPLB and NIA.

(36) The Study area is located at mountainous slope, accordingly, susceptible to soil erosion against concentrated rainfall in the wet season. Adoption of soil conservation measures particularly for vegetable farming is a must in the Study area to achieve sustainable agricultural development. Taking of the vegetative measures such as contour hedgerow and SALT promoted by PENRO, DENR in ISF project into account, demonstration fields exhibiting soil erosion control technologies will be established under the Project to enlighten a necessity of soil conservation in the area among farmers. In addition, establishment of "Soil Conservation Extension Center" is also recommended to supply the tree nurseries and transferring of soil conservation technologies to the farmers. The proposed demonstration fields will be directly operated and managed by each owner farmers, while the proposed Soil Conservation Extension Center will be run by PENRO in close coordination with the Municipal offices concerned.

(37) The implementation of the Project will motivate considerable changes on the land use in the Study area. Total area of 1,390 ha, comprising of 340 ha by provision of irrigation systems and 1,050 ha by improving of marketing activities by means of roads and trading posts construction, will be improved as a vegetable farm lands. As explained below, the coconut farms estimated at 630 ha will be gradually converted to vegetable farms resulting from the improvement of marketing activities, i.e., roads construction.

Summary of Land Use Changes by the Project

(Unit: ha)

Land Use	without Project	with Project	Difference
Vegetable farm	760	1,390	+630
- Rainfed	760	1,050	+290
- Irrigated	0	340	+320
Coconuts	1,220	590	-630
Forest/scrub	750	750	0
Others *	270	270	0
Total	3,000	3,000	0

(38) Intensified cropping pattern together with high profitable vegetables is proposed for improvement of farm management (300 % in the irrigated area, and 200 % in the rainfed area). Following 12 vegetables are proposed for cultivation. The yield of the vegetable will remarkably rise by irrigation, even in the rainfed area, they will be increased by dissemination of farming technologies and improved seeds.

Tomato, Cabbage (dry and wet season), Radish, Sweet potato, Beans (Baguio beans and Sitao), Carrots, Chinese cabbage, Celery, Lettuce and Cauliflower

PROPOSED COMPONENTS

(39) Irrigation development

Proposed Irrigation Facilities

Item	Quantity					
	Nagcarlan		Liliw		Total	
Beneficial area	155	ha	165	ha	320	ha
Intake works	1	site	1	site	2	sites
Farm ponds	5	sites	5	sites	10	sites
Pipeline	28,680	m	21,070	m	49,750	m
Common hydrants	95	units	78	units	173	units
Pressure dissipating tanks	2	sites	2	sites	4	sites

Note: Pressure dissipating tanks are installed to control excessive hydraulic pressure in pipeline, etc.

(40) Road improvement

Length of the Proposed Roads

Municipality/Road name	Pavement (1) W = 5 m	Pavement (1) W = 4 m	L-shape Gutter (2)	Bridge	Total
Nagcarlan					
San Francisco-Bukal	1,524 m	4,515 m	581 m	1 no	6,620 m
Sinipian-Silangan Lazaan		764 m	5,267 m		6,031 m
Malinao-Kanlurang Lazaan		1,523 m	127 m		1,650 m
Kanlurang Lazaan-Bukal		2,144 m		3 nos	2,144 m
Liliw					
Ibabang Sungi-Ilayang Sungi		976 m	3,424 m		4,400 m
Novaliches-Luquin	1,607 m	1,603 m	2,490 m		5,700 m
Majayjay					
Pangil-Bukal		3,883 m	397 m		4,280 m
Total	3,131 m	15,408 m			
	18,539 m		12,286 m	4 nos	30,825 m

Notes: (1) L-shape drainage construction is included in pavement works
(2) Total length of 12,286 m of L-shape gutter is constructed along the existing concrete pavement roads

(41) Trading Posts

Fifteen (15) trading posts (eight in Nagcarlan, five in Liliw and two in Majayjay) are proposed along the existing farm-to-market roads with following facilities:

Trading post

Item	Description
- Working space	Floor area of 100 sq.m
- Building	Steel frame structure
- Parking lot	5 m in width, 10 m in length
- Washing basin	with 2 faucets for vegetable washing
- Office equipment	Weighing scales, office tools

(42) Upland Horticulture and Irrigation Technology Center

Upland Horticulture and Irrigation Technology Center

Item	Description
1) Center building	
- Main building	Total floor area of 264 sq.mSeminar room, laboratory, office, accommodation, dining hall
- Garage/storage	Garage and storage room
- Experiment instrument	Soil test equipment, etc.
- Meteorological observation station	Rainfall gauge, wind velocity gauge, etc.
- O&M equipment	Vehicles, office tools, etc.
2) Demonstration farm	
- Total area	1.0 ha (divided into 10 plots)
- Green house	Composed of 3 unit houses
- Irrigation equipment	Pipeline, sprinkler, micro-jet, micro-sprinkler, drip tube, pump equipment, etc.

(43) Demonstration and Extension of Soil Conservation Technology

Soil Conservation Dacilities

Item	Description	
1) Demonstration Fields		
- Nagcarlan	3 sites	3.6 ha
- Liliw	5 sites	7.3 ha
- Majayjay	1 sites	1.2 ha
Total	9 sites	12.1 ha
2) Soil Conservation Extension Center		
- Total area	3,000 sq.m	
- Tree nursery	2,000 sq.m	
- Irrigation facilities	Water tank, pipeline, etc.	
- Center building	156 sq.m (Seminar rooms and Office)	
- Garage/Storage	Garage and storage room	

(44) Rehabilitation works of rural water supply systems are proposed as follows:

Rehabilitation of Rural Water Supply Systems

System name	Spring name	Rehabilitation works	Quantity	Remarks
Abo RWSS in Nagcarlan	Bukal	Intake conduit	1 unit	ø100mm
Gawanan RWSS in Liliw	Gawanan #1	Intake box	1 no	4.0 x 3.5 x 2.5m
		Conduit	270 m	steel pipe (ø150mm)
	Gawanan #2	Intake box	1 no	4.0 x 3.5 x 2.5m
		Conduit	270 m	steel pipe (ø200mm)

(45) The construction works will be completed within 18 months including mobilization/demobilization. The project implementation schedule consists of three stages, viz., 1) preparatory works for project implementation stage, 2) detailed design stage and 3) construction/supervisory stage. Preparatory works are composed of submission of the Project Description, project proposal, establishment and strengthening of beneficiaries' organizations, and financial allocation and supplements for the project implementation and O&M by related agencies.

(46) Project costs are estimated and presented by items as follows:

Project Cost

(₱ million)

Item		Cost
I.	Preparatory works for implementation and detailed design costs	15.2
II.	Construction cost	332.1
	1) Construction cost	214.6
	2) Procurement cost for O&M	12.2
	3) Administration cost	2.9
	4) Engineering service cost	25.5
	5) Land acquisition cost	2.1
	6) Physical contingency (10 %)	27.3
	7) Price contingency (4 % for foreign portion, 8 % for local portion)	47.4
Total Project cost		347.3
	(Foreign currency portion)	179.0
	(Local currency portion	168.3

Note: The exchange rate used in the estimate is US$ 1.00 = ₱ 27.00 = J¥ 100.00.

ORGANIZATION AND MANAGEMENT

(47) Major governmental organizations related to Project implementation and O&M are National Irrigation Administration, Department of Agriculture, Department of Environmental and Natural Resources, Department of Agrarian Reform, Provincial Government of Laguna, and Municipal Governments of Nagcarlan, Liliw and Majayjay. The project implementation arrangement shall be planned premising that the related governmental agencies mutually give technical and financial assistance in conformity with the project implementation plan and schedule, and also these implementing/cooperating agencies shall assist the beneficiaries associations/cooperatives for its establishment and strengthening prior to the commencement of the construction works of the Project. To achieve smooth project implementation, NIA is responsible for coordination of the related agencies. The

Project Steering Committee composed of related governmental agencies will be established undertaking overall implementation works.

(48) After completion of the construction works, responsible governmental agencies and beneficiaries' organizations will undertake necessary O&M works for each facilities and supporting services for beneficiaries. O&M Committee (OMC), as a general assembly committee, will be organized to provide overall activities necessary for the maximization of the entire project benefit from project facilities. OMC is composed of Regional offices of DA, DENR, and PGL, Minicipal governments, chaired by Regional office of NIA. Environmental Evaluation Unit (EEU) composed of relevant Municipal governments and PENRO will also be organized for legeslation, monitaring and evaluation of farm activities in the Public Forest lands. The followings are principal roles of OMC:

- coordination of related O&M bodies and EEU
- guidance and assistance of beneficiaries' organizations on its management
- preparation of operation and maintenance program of all project facilities
- maintenance and repair of project facilities
- training of staff for project management
- periodical monitoring and evaluation

PROJECT JUSTIFICATION

(49) The Economic Internal Rate of Return (EIRR) of the Project is estimated from the project costs and incremental project benefits. Net crop production values under future condition without the Project are estimated at ₱ 24,965 per ha, while these values will greatly increase up to ₱ 210,498 per ha in irrigated area under with project condition. Incremental benefits by irrigation development will be ₱ 59.370 million in total from the irrigated area of 320 ha, and incremental benefits accrued from the improved farm-to-market roads are estimated at ₱ 28.888 million in total. The financial project costs of ₱ 347.3 million excluding of price contingencies are converted to the economic costs as ₱ 274.7 million in total. The annual economic O&M costs are estimated at ₱ 5.4 million. Based on the above estimations, economic costs and benefits are computed for a period of 1996 - 2025 (30 years). EIRR of the overall project has finally been estimated at 18.5 %.

(50) Farm budget analyses have been made for typical farmers both under with and without project conditions. For typical farm household with vegetable farm size of 0.46 ha in the irrigated area, the post-project net reserves will be ₱ 60,500. Meanwhile for typical farm household with vegetable farm size of 0.62 ha in the rainfed area, the post-project net reserves will be ₱ 25,700.

(51) The Project will uplift the farmers' income to be sufficient level for their livelihood depending on existing limited farmlands and without further devastation of the forests. In addition to the direct benefit counted in the economic and financial evaluations, various secondary and socio-economic benefits are expected from the Project as follows:

- Environmental conservation
- Environmental protection in the downstream reaches of the Project area
- Increase in employment opportunity
- Improvement of local transportation
- Stable supply of vegetables to Metro Manila

(52) Soil erosion and destruction of natural vegetation are, in general, typical environmental impacts of farm land development and road development in the uplands. However, the Project was formulated including the construction components and O&M in ways to protect the natural environment and to adopt sufficient countermeasures against the environmental deterioration. It is predicted, therefore, that the Project would not cause significant adverse impacts on the environment. In this connection, sustainable development regarding agricultural productivity will be expected through extension services for soil conservation practices.

RECOMMENDATIONS

(53) The Project is formulated primarily to control the everlasting devastation of the forests of Mts. Banahaw and San Cristobal attributed to poor living conditions and low farm incomes in the area. To improve these constraints of the area, irrigation, marketing system and agricultural/soil conservation extension development are proposed in the Project. Farmers are also very anxious for the implementation of the Project, especially for forest protection from devastation, according to the results of the public consultation survey. The Project has been verified to be technically sound and economically feasible with EIRR of 18.5 %. It is recommended, therefore, to implement the Project at the earliest opportunity.

(54) In order to ensure sustainable agricultural development and environmental preservation in the area, the following measures are recommended for properly and timely implemented:

- Encouragement for farmers who own farms within the Public Forest lands to apply for ISF program
- Strict control of any development activities in National Park area
- Restoration of environment damaged by the project implementation

- Allocation of adequate budget and staff for the proper operation and maintenance of the Soil Conservation Extension Center
- Monitoring and evaluation of forest resources in the Public Forest lands and the National Park area
- Employment of proper construction methods to avoid severe soil erosion during the construction works

(55) Farmers' participation is an important and effective approach for the successful implementation of the Project. Land acquisition is, generally, one of the most time-consuming factors for project implementation, so that it should be worked out as soon as possible through a series of public consultation and focus group discussions.

(56) NIA will be the lead implementing agency for project implementation. Other agencies such as DA, DENR, DAR, PGL, and Municipal governments of Nagcarlan, Liliw and Majayjay will also participate in the implementation. It is recommended that the Project Steering Committee, comprising all the related agencies and chaired by the Director of NIA Region IV, be established in order to ensure close coordination among them.

(57) After completion of the construction works, responsible governmental agencies and beneficiaries' organizations shall undertake necessary O&M of the project facilities and provide supporting services for the beneficiaries. It is recommended that the O&M Committee be organized in order to administrate overall O&M activities of the Project. Major tasks of OMC are demarcation of responsibilities and allotment of funds between agencies and/or organizations. OMC shall be established before the completion of the construction works.

(58) IAs established under the supervision of NIA are responsible for O&M of irrigation facilities constructed by the Project. Major tasks of IAs are O&M of irrigation facilities, irrigation planning, collection of irrigation fees, etc. To accomplish sustainable O&M activities by IAs, guidelines and operation manuals regarding IAs' managerial organizations and irrigation practices shall be prepared with technical assistance of NIA.

(59) It is inevitable to establish marketing cooperatives not only to strengthen bargaining power of farmers but to facilitate collective production programming, procurement of farm inputs and transfer of production and marketing technologies. Municipal governments are required to support farmers in establishing such cooperatives and to coordinate their activities. Furthermore, there is a real need for farm credit, and therefore establishment of a crediting system accessible by individual farmers is recommended. For the long term, it is also recommended that the cooperatives operate farm crediting by themselves using the reserved funds saved by the members.

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FEASIBILITY STUDY ON
THE UPLAND IRRIGATION AND RURAL DEVELOPMENT PROJECT
IN SOUTHERN LUZON

VOLUME I MAIN REPORT

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Glossary of Acronym and Abbreviations

(1) Acronyms

A&D	:	Alienable and Disposable
ADB	:	Asian Development Bank
AM	:	Available Moisture
ATI	:	Agricultural Training Institutes
ATs	:	Agricultural Technologists
BAI	:	Bureau of Animal Industry
BAR	:	Bureau of Agricultural Research
BAS	:	Bureau of Agricultural Statistics
BFAR	:	Bureau of Fisheries and Aquatic Resources
BPI	:	Bureau of Plant Industry
BSWM	:	Bureau of Soil and Water Management
BWSAs	:	Barangay Water Works and Sanitation Associations
CARP	:	Comprehensive Agrarian Reform Program
CDA	:	Cooperative Development Authority
CEC	:	Cation Exchange Capacity
CENRO	:	Community Environment and National Resources Office
CIF	:	Cost Insurance and Freight
CIS	:	Communal Irrigation System
CRBL	:	Cooperative Rural Bank Laguna
CSC	:	Certificate of Stewardship Contract
CSCF	:	Commodity Specific Conversion Factor
DA	:	Department of Agriculture
DAR	:	Department of Agrarian Reform
DBM	:	Department of Budget and Management
DBP	:	Development Bank of the Philippines
DCIEP	:	Diversified Crops Irrigation Engineering Project
DEENR	:	Department of Environment, Energy and Natural Resources
DENR	:	Department of Environment and Natural Resources
DMCOG	:	Depletion of Moisture Content for Optimum Growth
DOH	:	Department of Health
DOLE	:	Department of Labor and Employment
DOST	:	Department of Science and Technology
DPWH	:	Department of Public Works and Highways
DTI	:	Department of Trade and Industry
ECC	:	Environmental Compliance Certificate
EIRR	:	Economic Internal Rate of Return
EIS	:	Environmental Impacts Statement
EMB	:	Environmental Management Bureau
ERDB	:	Ecosystem Research and Development Bureau
FAO	:	Food and Agriculture Organization
FMB	:	Forest Management Bureau
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
GOP	:	Government of Philippines
GOJ	:	Government of Japan
GVA	:	Gross Value Added
I/A	:	Implementing Arrangement
IAs	:	Irrigator's Associations
IBRD	:	International Bank for Reconstruction and Development
IDOs	:	Irrigation Development Offices
IEE	:	Initial Environmental Examination
IPB	:	Institute of Plant Breeding
IRRI	:	International Rice Research Institute
IS	:	Irrigation Superintendent
ISOs	:	Irrigation System Offices
ISFP	:	Integrated Social Forestry Program

SCUs	:	State Colleges and Universities
SMEP	:	Soil Moisture Extraction Pattern
SPT	:	Standard Penetration Test
TRAM	:	Total Reading Available Moisture
UPLB	:	University of the Philippines, Los Baños
VOC	:	Vehicle Operation Costs
WDs	:	Water Districts
WID	:	Women in Development

(2) Abbreviations, others

mm	:	millimeter	cm	:	centimeter
m	:	meter	km	:	kilometer
MSL	:	mean sea level	El.	:	elevation above MSL
sq.cm	:	square centimeter	sq.m	:	square meter
sq.km	:	square kilometer	ha	:	hectare
MSM	:	million square meter			
lit	:	liter (= 1,000 cubic cm)	cum	:	cubic meter
MCM	:	million cubic meter	GPM	:	gallons per minute
mg	:	milligram	g	:	gram
kg	:	kilogram	t (ton)	:	1,000 kg
sec	:	second	min	:	minute
hr	:	hour	yr	:	year
CY	:	calendar year			
kV	:	kilovolt	kW	:	kilowatt
kWh	:	kilowatt-hour	MW	:	megawatt
MWh	:	megawatt-hour	GWh	:	gigawatt-hour
%	:	percent	PS	:	horse power
C	:	centigrade	cum/sec	:	cubic meter per second
pcpd	:	per capita per day			
cm/sec	:	centimeter per second	ton/ha	:	ton per hectare
ppm	:	part per million			
No(s), no(s)	:	number(s)	ET	:	evapotranspiration
P	:	percolation	ETo	:	potential evapotranspiration
J¥	:	Japanese Yen	Kc	:	crop coefficient
US$	:	US Dollar	FC	:	water holding capacity
₱	:	Philippine Peso			

JICA	:	Japan International Cooperation Agency
KSL	:	Kauncaran Sa Laguna
LBP	:	Land Bank of the Philippines
LGUs	:	Local Government Units
LLDA	:	*Laguna Lake Development Authority*
LMB	:	Land Management Bureau
LWUA	:	Local Water Utilities Administration
MAO	:	Municipal Agricultural Officer
MAT	:	Municipal Agricultural Technician
MERALCO	:	Manila Electric Company
MGSB	:	Mines and Geo-Science Bureau
MPDC	:	Municipal Planning and Development Coordinator
MTPDP	:	Medium-Term Philippine Development Plan
NAPOCOR	:	National Power Corporation
NCPC	:	National Crop Protection Center
NGOs	:	Non-governmental Organizations
NEA	:	National Electrification Administration
NIA	:	National Irrigation Administration
NIPAS	:	National Integrated Protected Area System
NISs	:	National Irrigation Systems
NEDA	:	National Economic and Development Authority
NGOs	:	Non-Governmental Organizations
NPV	:	Net Production Value
NRDN	:	National Research and Development Network
NSO	:	National Statistics Office
NWRB	:	National Water Regulatory Board
NWRB	:	National Water Resources Board
NWRC	:	National Water Resources Council
O&M	:	Operation and Maintenance
OMC	:	Operation and Maintenance Committee
OIC	:	Officer in-charge
PAGASA	:	Philippines Atmospheric Geophysical and Astonominal Services Administration
PAOs	:	Provincial Agricultural Officers
PAWB	:	Protected Area and Wildlife Bureau, DENR
PCARRD	:	Philippine Council for Agriculture and Resources Research and Development
PD	:	Presidential Decree
PD	:	Project Description
PDC	:	Provincial Development Council
PDD	:	*Project Development Department, NIA*
PENRO	:	Provincial Environment and National Resources Office
PIE	:	Provincial Irrigation Engineer
PIO	:	Provincial Irrigation Office
PLDT	:	Philippine Long Distance Telephone Company
PNB	:	Philippines National Bank
PPDO	:	Provincial Planning and Development Office
PSC	:	Project Steering Committee
PSSD	:	Philippine Strategy for Sustainable Development
PT	:	Production Technician
PURC	:	Philippines Uplands Resources Center
RDC	:	Regional Development Council
RIA	:	Road Influence Area
RID	:	Regional Irrigation Director
RIO	:	Regional Irrigation Office
RWSS	:	Rural Water Supply System
SALT	:	Sloping Agricultural Land Technology
SCF	:	Standard Conversion Factor