THE HORTICULTURAL DEVELOPMENT PROJECT
IN
THE KINGDOM OF NEPAL

DETAIL DESIGN REPORT
ON
THE CONSTRUCTION
OF
DEMONSTRATION FARMS
IN
NEPALGUNJ AND SINDHULI SUB-CENTERS

MARCH 1986

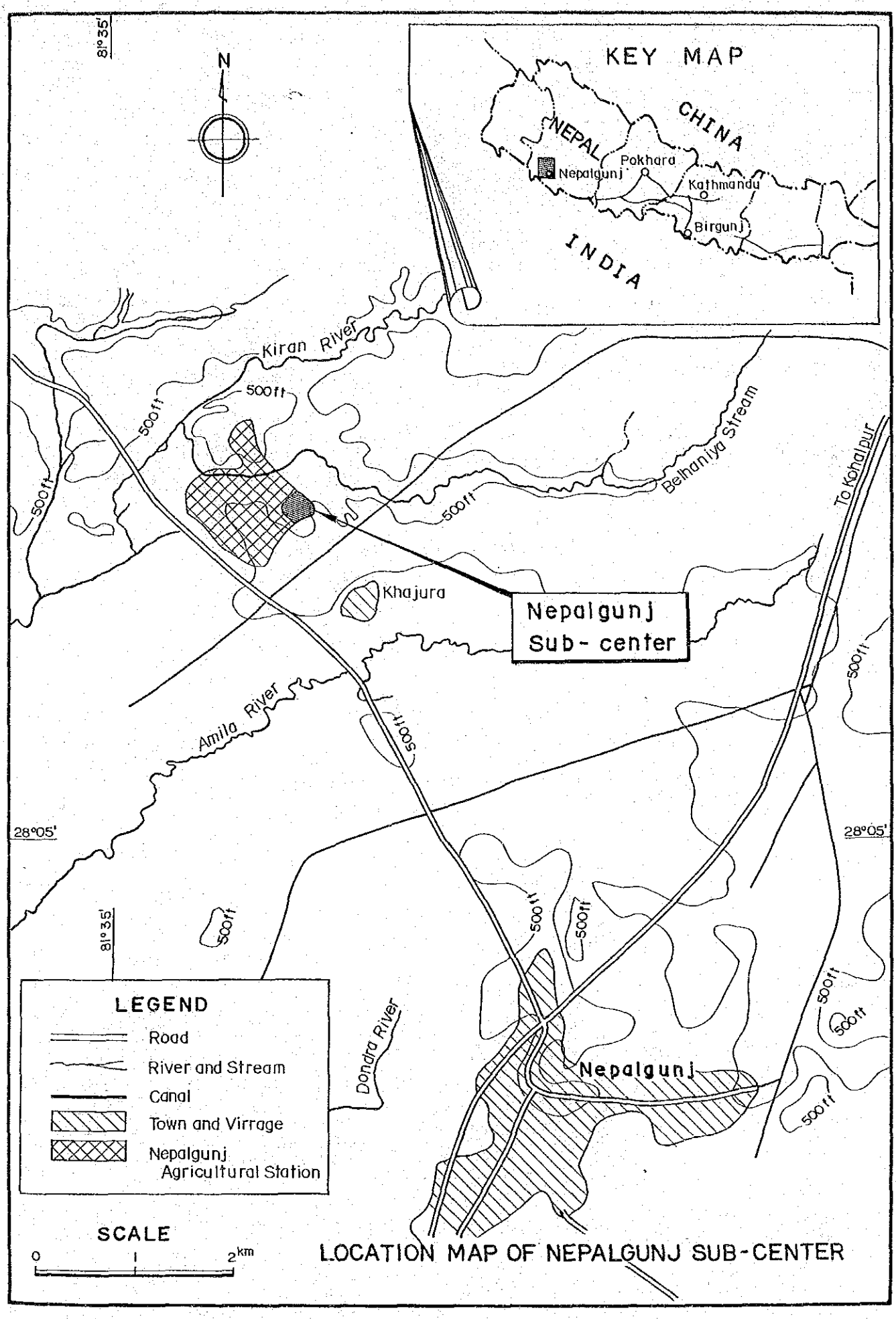
JAPAN INTERNATIONAL COOPERATION AGENCY

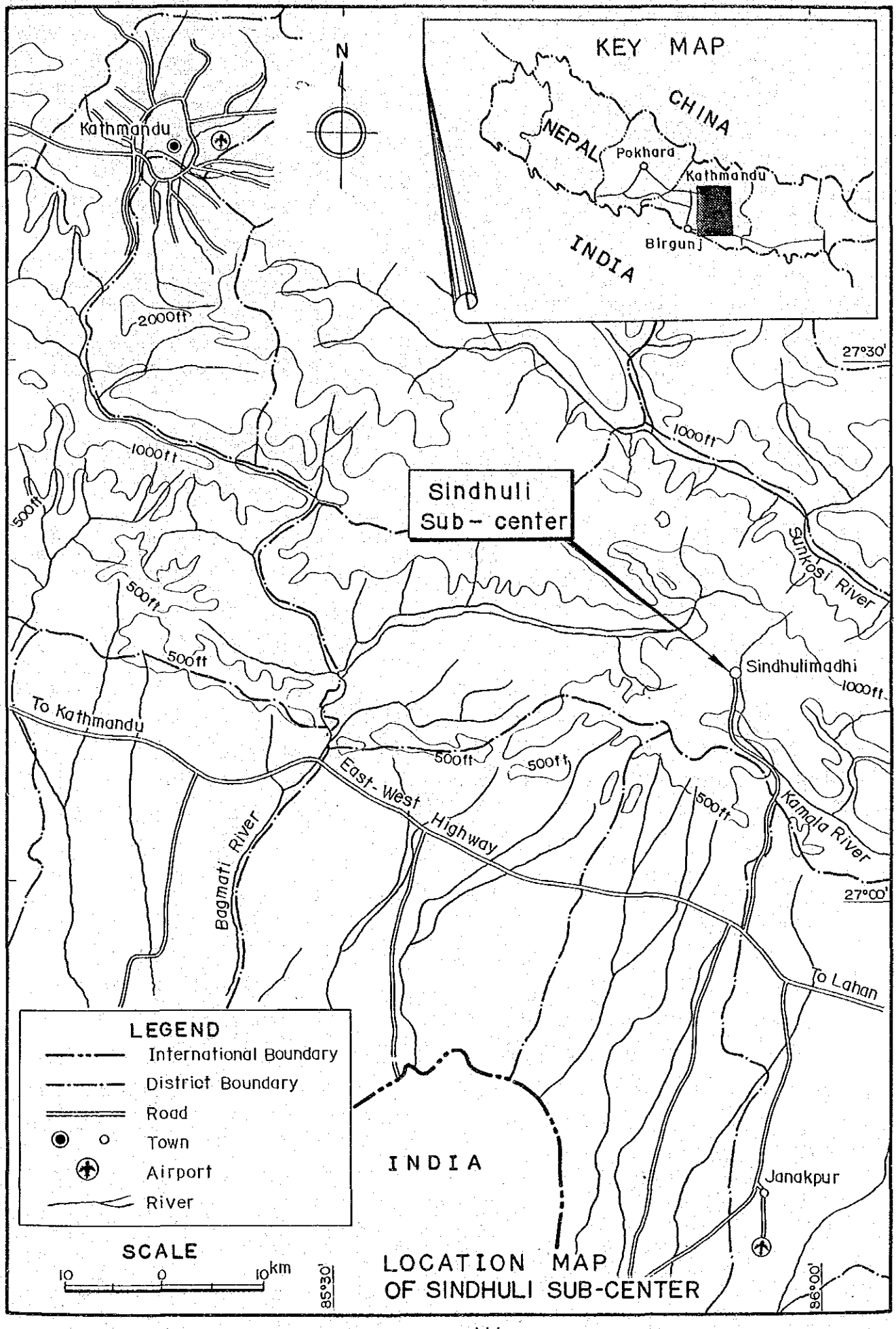
THE HORTICULTURAL DEVELOPMENT PROJECT
IN
THE KINGDOM OF NEPAL

DETAIL DESIGN REPORT
ON
THE CONSTRUCTION
OF
DEMONSTRATION FARMS
IN
NEPALGUNJ AND SINDHULI SUB-CENTERS

MARCH 1986

JAPAN INTERNATIONAL COOPERATION AGENCY


81°35'
N
KEY MAP
NEPAL
CHINA
INDIA
Nepalgunj
Pokhara
Kathmandu
Birgunj
Kiran River
500ft
Belhaniya Stream
To Kohalpur
Khajura
Nepalgunj
Sub-center
Amila River
Dondra River
28°05'
LEGEND
Road
River and Stream
Canal
Town and Virrage
Nepalgunj
Agricultural Station
SCALE
0
1
2km
LOCATION MAP OF NEPALGUNJ SUB-CENTER


KEY MAP
CHINA
NEPAL
Pokhara
Kathmandu
Birgunj
INDIA
N
Kathmandu
2000ft
1000ft
500ft
27°30'
Sindhuli
Sub - center
Sunkosi River
Sindhulimadhi
To Kathmandu
East - West Highway
Bagmati River
Kamala River
27°00'
To Lahan
INDIA
Janakpur
LEGEND
International Boundary
District Boundary
Road
Town
Airport
River
SCALE
10 0 10 km
85°30'
86°00'
LOCATION MAP
OF SINDHULI SUB-CENTER

SUMMARY

Based on results of the survey carried out by the Detail Design Survey Team for the demonstration farms of the Nepalgunj Sub-center and the Sindhuli Sub-center from November 29, 1985 to January 16, 1986, the detailed design of the demonstration farms has been made. The results of surveys, studies and designs are summarized below.

1. Agriculture plays an important role in the Nepal's economy. Farm production and related activities comprise about 60% of GDP. However, the condition of the Nepal's economy becomes serious recently due to the rapid population growth which is over the expansion of farmlands.

2. In the hilly areas, because of poor land conservation and serious deforestration, the growth rate of agricultural production becomes so slow that the minimum subsistence level of food requirement can hardly be secured for the peoples living in these areas.

3. His Majesty's Government of Nepal (HMGN) has formulated the mountain horticultural development plan to develop the fruits gardening suitable to the hilly areas, in order to raise the income of the farmers living in the hilly areas, and has requested the Government of Japan for the technical cooperation and grant aid for the above development plan.

4. The Horticultural Development Project aims to develop techniques for selection of suitable varieties, proliferation of fruit saplings, administration of cultures, control of plant pests and improvement varieties of fruit trees, and implements training of horticultural techniques for key farmers at the project center. It also conducts experiments on praliferation of fruit saplings and demonstrates farms for the purpose of extension toward farmers at the sub-center.

5. In October 1985, the Japanese Implementation Survey Team organized by the Japan International Cooperation Agency (JICA) was despatched in order to work out the details of the technical cooperation program concerning the Horticultural Development Project. As result, the Record of Discussion (R/D) was concluded on 14th October, 1985.

6. According to the R/D, the Detail Design Survey Team was despatched by JICA from November 27, 1985 to January 16, 1986, in order to proceed with surveys, investigations and detail designs for the demonstration farms of sub-centers.

7. The sub-centers will be established in the compound of the Nepalgunj Agricultural Station and the Sindhuli Agriculture Farm. The Nepalgunj Sub-center will conduct adaptative experiments on grapes and the Sindhuli Sub-center will conduct the production and experiment of the Junar saplings.

8. The Nepalgunj Agricultural Station located 7 km west of Nepalgunj was established in 1962 in order to expedite the agricultural development in the Terai plain of the Far Western Development Region and has about 60 ha of farm land. The major objectives of the station were to conduct researches on various kind of cerial crops and to produce improved seeds.

9. The Sindhuli Agriculture Farm with about 7.0 ha of farm land is located in Sindhulimadi where the district headquarters of the Sindhuli District is located. The farm was established for demonstrating cerial and vegitable crops and conducting their trials in 1978.

10. The area of the Nepalgunj Sub-center is generally inclined toward north-western side with an average slope of about 1 to 200. The area of the Sindhuli Sub-center is bounded by the foothill of the small mountain in the west and be inclined eastward with gentle undulation.

11. Climate in the areas of the both sub-centers are characterized by two district seasons: the rainy season from June to September and the dry season from October to May. The annual rainfall is about 1,500 mm in both sites. About 85% and 83% of annual rainfall occurs during the rainy season in the Nepalgunj Sub-center and the Sindhuli Sub-center.

12. The existing deep tubewell located in the Nepalgunj Agricultural Station is used for the irrigation water source of the Nepalgunj Sub-center and the installation of the submergible pump shall be required. The underflow water of the Gwang river which is flowing beside the Sindhuli Agriculture Farm will be the irrigation water source of the Sindhuli Sub-center. The construction of the shallow well and the installation of the intake pump shall be required.

13. The soils in the Nepalgunj Sub-center are classified into sandy loam or silty loam and soil reaction is slightly acid to moderately alkaline with pH 6.0 to 8.0. The soils in the Sindhuli Sub-center are classified into loam or sandy loam and soil reaction is slightly acid with pH 5.

14. The principal features of the sub-centers are summarized below:

PRINCIPAL FEATURES OF NEPALGUNJ SUB-CENTER

I.	Location	:	North-eastern corner of the Nepalgunj Agricultural Station	
II.	Net irrigation area	:	7.75 ha	
III.	Subject crop	:	Grapes	
IV.	Water source	:	Groundwater	
V.	Irrigation method	:	Sprinkler irrigation with pipeline system	
VI.	Facilities			
	1. Pumping facilities			
	Deep tubewell	:	Diameter of well	: 200 mm
			Depth of well	: 136 m
			Groundwater level	: GWL 90.61 m
			Design drawdown level	: LWL 87.51 m
	Submergible pump	:	Design discharge	: 0.65 m^3/min.
			Total head	: 19 m
			Diameter of pump	: 80 mm
			Required power	: 3.7 kW, 50 Hz
	Delivery pump	:	Design discharge	: 1.13 m^3/min.
			Total head	: 36 m
			Diameter of pump	: 80 x 65 mm
			Required power	: 15 kW, 50 Hz
	Pump house	:	17.5 m^2	
	2. Farm pond			
	Effective storage capacity	:	625 m^3	
	High water level	:	HWL 101.41 m	
	Low water level	:	LWL 99.98 m	
	Size of pond	:	19 x 23 m	
	Related structures	:	Inlet pipe	: 1 unit
			Outlet pipe	: 1 unit
			Extra outlet	: 1 unit
			Blow-off valve	: 1 unit
			Spillway	: 1 unit

3. Pipeline irrigation system

Main irrigation pipeline	:	Length	:	about 300 m
		Diameter of pipe	:	150 mm
Branch irrigation pipelines	:	Length	:	about 850 m
		Diameter of pipes	:	150, 100, 75 mm
Hydrants, ø50 mm	:	36 Nos.		
		Conducting pipe ø50	:	about 160 m
Sprinkler system	:	Length	:	60m x 2 lines per 1 set
		Required pressure at the splinker head	:	2.5 kg/cm^2

4. Drainage system

River improvement	:	Length	:	about 260 m
Main drain	:	Length	:	about 520 m
		Base width	:	0.3 - 1.0 m
		Height	:	1.0 - 2.0 m
Collector drains	:	Length	:	about 1,110 m
		Base width	:	0.3 m
		Height	:	0.5 - 1.0 m
Farm ditches	:	Length	:	about 1,550 m
		Base width	:	0.3 m
		Height	:	0.3 m
Sub-surface drain	:	Length	:	about 7,750 m
		Diameter of drainage pipe	:	100 mm
Related structures	:	20 units		

5. Road system

Approach road	:	Length	:	about 720 m
		Width	:	4 m
		Gravel pavement	:	10 cm thick
Main farm road	:	Length	:	about 1,340 m
		Width	:	4 m
		Gravel pavement	:	10 cm thick
Secondary farm road	:	Length	:	about 2,270 m
		Width	:	2 m

6. Vine trellis	:	Total area	:	7.75 ha
		Height	:	1.8 m

7. Farm house	:	Store room	:	24 m^2
		Rest room or office space	:	24 m^2

PRINCIPAL FEATURES OF SINGHULI SUB-CENTER

I.	Location	:	Southern part of the Sindhuli Agricultural Farm	
II.	Net irrigation area	:	1.27 ha	
III.	Subject crop	:	Junar (Citrus) saplings	
IV.	Water source	:	Underflow water of the Gwang river	
V.	Irrigation method	:	Furrow or Basin irrigation with pipeline system	
VI.	Facilities			
	1. Pumping facilities			
	Shallow well	:	Diameter of well	: 1.5 m
			Depth of well	: 8.6 m
			Groundwater level	: GWL 493.97 m (Dry season)
			Design drawdown level	: LWL 492.47 m
	Intake pump	:	Design discharge	: 0.44 m^3/min.
			Total head	: 36 m
			Diameter of pump	: 65 x 50 mm
			Required power	: 9 P.S.
	Discharge pipelines:		Length	: 180 m
			Diameter of pipe	: 80 mm
	Pump house	:	4 m^2	
	2. Farm pond			
	Effective storage capacity	:	50 m^3	
	High water level	:	HWL 517.00 m	
	Low water level	:	LWL 515.33 m	
	Size of pond	:	5 x 6 m	
	Related structures	:	Inlet pipe	: 1 unit
			Outlet pipe	: 1 unit
			Extra outlet	: 1 unit
			Blow-off valve	: 1 unit
			Spillway	: 1 unit

3. Pipeline irrigation system

Main irrigation pipeline	:	Length	:	about 135 m
		Diameter of pipe	:	100 mm
Branch irrigation pipelines	:	Length	:	about 350 m
		Diameter of pipes	:	100, 75, 50 mm
Hydrants ø1/2"	:	16 Nos.		
Gate valve, ø100 mm	:	1 No.		

4. Drainage system

Drainage canals	:	Length	:	about 800 m
		Base width	:	0.3 - 0.5 m
		Height	:	0.5 - 1.0 m
Related structures	:	14 units		

5. Road system

Approach road	:	Length	:	about 290 m
		Width	:	4 m
		Gravel pavement		10 cm thick
Main farm road	:	Length	:	about 110 m
		Width	:	3 m
		Gravel pavement		10 cm thick
Secondary farm roads	:	Length	:	about 580 m
		Width	:	2 m

6. Grafting house	:	Storing place for grafted trees	:	96 m^2
		Store room	:	24 m^2

DETAIL DESIGN REPORT

ON

THE CONSTRUCTION

OF

DEMONSTRATION FARMS

IN

NEPALGUNJ AND SINDHULI SUB-CENTER

TABLE OF CONTENTS

LIST OF TABLES

LIST OF MAPS AND FIGURES

ABBREVIATION

km	:	kilometer
m	:	meter
cm	:	centimeter
mm	:	millimeter
t	:	ton
kg	:	kilogramme
g	:	gramme
km^2	:	square kilometer
m^2	:	square meter
ha	:	hectare
kℓ	:	kiloliter
m^3	:	cubic meter
ℓ	:	liter
m^3/sec	:	cubic meter per second
m^3/min	:	cubic meter per minute
ℓ/sec	:	liter per second
ℓ/sec/ha	:	liter per second per hectare
ℓ/min	:	liter per minute
t/ha	:	ton per hectare
hr(s)	:	hour(s)
mm/day	:	millimeter per day
°C	:	degree centigrade
%	:	per cent
NRS	:	Nepal Rupees
kW	:	kilowatt
GDP	:	Gross Domestic Product
P.S.	:	Horse Power

I. INTRODUCTION

I. INTRODUCTION

1.1 General

Nepal is a rectangular-shaped and landlocked country between China and India. It has a total area of about 147,000 km^2 extending 850 km in the east-west direction with an average width of 170 km. It is divided into three parallel ecological zones running east-west; the Terai Plain, an extending of the Gangestic Plain of India; the Hills, the foothills of Himalayas, ranging from 500 m to 4,000 m in elevation; and the Himalayan Mountains to the north. Rivers and streams running north-south divide the country into several isolated areas.

Agriculture plays an important role in the Nepal's economy. Farm production and related activities comprise about 60% of GDP. However, the condition of the Nepal's economy becomes serious recently due to the rapid population growth which is over the expansion of farmlands.

In the hilly areas, because of poor land conservation and serious deforestration, the growth rate of agricultural production becomes so slow that the minimum subsistence level of food requirement can hardly be secured for the peoples living in these areas.

In order to raise the income of the farmers living in these hilly areas, especially in the areas where the food grain production can not be achieved, and to facilitate the land conservation in the hilly areas, His Majesty's Government of Nepal (HMGN) has formulated the mountain horticultural development plan to develop the fruits gardening suitable to those hilly areas.

Since 1980, the Government of Japan has provided various kinds of horticultural cooperation including the construction of horticultural development center, to expedite the above development plan.

In November 1985, the Detail Design Survey Team on the Horticultural Development Project in the Kingdom of Nepal (the Team) is despatched by the Japan International Cooperation Agency (JICA) in response to the HMGN's request, in order to proceed with surveys, investigations and detail designs for the demonstration farms.

1.2 Members of the Team

The Team consists of four experts including team leader as listed below:

(1)	Team Leader :	Takashi ISHIHARA	Deputy Director, Kinki Regional Administration Office, Ministry of Agriculture, Forestry and Fisheries
(2)	Coordinator :	Tsuneo TAKAHATA	Agricultural Development Division, Agricultural Development Cooperation Department, Japan International Cooperation Agency
(3)	Irrigation and Drainage :	Yutaka NAKANO	2nd Irrigation and Drainage Department, Nippon Koei Co., Ltd.
(4)	Farm Design :	Souichirou YUMOTO	2nd Irrigation and Drainage Department, Nippon Koei Co., Ltd.

1.3 Itinerary of the Team

All members of the Team left Tokyo on November 27, 1985 and arrived in Kathmandu on November 28, 1985. After a courtesy call at the Ministry of Agriculture and Embassy of Japan, the meeting with officials concerned of HMGN was held on November 29, 1985.

After the meeting, all members carried out the reconnaissance survey and field investigations in the Nepalgunj Agricultural Station and the Sindhuli Agriculture Farm, till December 8, 1985.

The first group consisting of two exparts including team leader left Nepal for Tokyo on December 12, 1985, after exchanging views with officials concerned for determination of the basic concept of the both sub-centers.

The second group consisting of two engineers carried out the field survey with the kind collaboration of counterpart personnel, till on January 7, 1986.

The detailed itinerary of the Team is shown below:

	Date	Description
1.	Nov. 27, 1985 (Wed.)	Trio (TYO - BKK), TD-625
2.	Nov. 28, 1985 (Thu.)	Trip (BKK - KTM), TD-311 Greeting to Embassy of Japan
3.	Nov. 29, 1985 (Fri.)	Greeting to Mr. P. N. Rana, Secretary, Ministry of Agriculture Discussion in Department of Agriculture Visiting JICA Kathmandu Office
4.	Nov. 30, 1985 (Sat.)	Trip (KTM - Nepalgunj) by air
5.	Dec. 1, 1985 (Sun.)	Site reconnaissance in Nepalfunj Agricultural Station
6.	Dec. 2, 1985 (Mon.)	Discussion in Nepalgunj Agricultural Station
7.	Dec. 3, 1985 (Tue.)	Trip (Nepalgunj - KTM) by air

(to be continued)

	Date	Description
8.	Dec. 4, 1985 (Wed.)	Visit Kirtipur Horticultural Station
9.	Dec. 5, 1985 (Thu.)	Trip (KTM - Janakpur, JADP) by land Discussion in JADP
10.	Dec. 6, 1985 (Fri.)	Trio (JADP - Sindhulimadi) Site reconnaissance in Sindhuli Agriculture Farm Discussion in Sindhuli Agriculture Farm
11.	Dec. 7, 1985 (Sat.)	Trip (Sindhulimadi - JADP) Site inspection in JADP
12.	Dec. 8, 1985 (Sun.)	Trip (JADP - KTM) by land
13.	Dec. 9, 1985 (Mon.)	Discussion in JICA Kathmandu Office
14.	Dec. 10, 1985 (Tue.)	Discussion in Department of Agriculture
15.	Dec. 11, 1985 (Wed.)	Discussion with Mr. P. N. Rana, Secretary, Ministry of Agriculture Visiting Embassy of Japan
16.	Dec. 12, 1985 (Thu.)	Preparation of field survey Messrs. T. Ishihara and T. Takahata left for TYO by TG-312
17.	Dec. 13, 1985 (Fri.)	Trio (KTM - Bharatpur) by land
18.	Dec. 14, 1985 (Sat.)	Trip (Bharatpur - Nepalgunj) by land
19.	Dec. 15, 1985 (Sun.)	Discussion with Mr. R. B. Shrestha, Farm Manager Nepalgunj Agricultural Station Field Survey
20.	Dec. 16, 1985 (Mon.)	
	〃	Field survey
28.	Dec. 24, 1985 (Tue.)	
29.	Dec. 25, 1985 (Wed.)	Trip (Nepalgunj - Bharatour) by land
30.	Dec. 26, 1985 (Thu.)	Trip (Bharatour - Janakpur, JADP) by land
31.	Dec. 27, 1985 (Fri.)	Preparation for field survey
32.	Dec. 28, 1985 (Sat.)	Trip (JADP - Sindhulimadi) by land

(to be continue)

	Date	Description
33.	Dec. 29, 1985 (Sun.)	Field survey
39.	Jan. 4, 1986 (Sat.)	
40.	Jan. 5, 1986 (Sun.)	Additional field survey Trip (Sindhulimadi - JADP) by land
41.	Jan. 6, 1986 (Mon.)	Construction material survey in Janakpur Trip (Janakpur - Bharatpur) by land
42.	Jan. 7, 1986 (Tue.)	Trip (Bharatpur - DTM) by land
43.	Jan. 8, 1986 (Wed.)	Visiting JICA Kathmandu Office Data collection
44.	Jan. 9, 1986 (Thu.)	Discussion in Department of Agriculture Data collection in Soil Section and Meteorological Section
45.	Jan. 10, 1986 (Fri.)	Data collection in Meteorological Section and Topographic Survey Branch
46.	Jan. 11, 1986 (Sat.)	Preparation of Field Report
47.	Jan. 12, 1986 (Sun.)	Preparation of Field Report
48.	Jan. 13, 1986 (Mon.)	Discussion in Department of Agriculture
49.	Jan. 14, 1986 (Tue.)	Additional data collection
50.	Jan. 15, 1986 (Wed.)	Trio (KTM - BKK) by TG-312
51.	Jan. 16, 1986 (Thu.)	Trio (BKK - TYO) by JL-482

1.4 Official Concerned of HMGN

Official concerned HMGN directly related to the Team are as listed below:

1. Ministry of Agriculture

   - Mr. P. N. Rana — Secretary
   - Mr. K. B. Rajbhandari — Senior Agricultural Advisor

2. Department of Agriculture

- Mr. P. P. Gorichali	Director General
- Mr. S. M. Regmi	Deputy Director General, Planning and Coordination
- Mr. H. P. Gurung	Deputy Director General, Horticulture and Fisheries
- Mr. A. M. Prachanang	Deputy Director General
- Mr. H. P. Shrestha	Planning Officer

3. Kirtipur Horticulture Research Station

- Mr. J. N. Pana	Farm Manager, Horticulturist
- Mr. B. R. Sainju	Fruit Development Division Horticulturist

4. Managing Agricultural Station

- Mr. R. B. Shrestha	Research Coordinator (Farm Manager)
- Mr. R. N. Joshi	Assistant Horticulturist
- Mr. R. S. L. Karna	Assistant Pathologist
- Mr. C. L. Paudel	Assistant Production Agronomist
- Mr. P. S. Sharma	Assistant Agricultural Engineer
- Mr. R. P. Shrestha	Assistant Botanist
- Mr. G. P. Shrestawa	Assistant Soil Scientist
- Mr. B. Dewan	Assistant Agricultural Botanist

5. Agricultural Development Office, Banke

- Mr. K. A. Khan	Agricultural Development Officer
- Mr. G. Chaudhary Assistant	Assistant Agricultural Development Officer

6. Road Department, Banke

- Mr. B. Krahuju	District Engineer

7. Regional Irrigation Office, Nepalgunj

- Mr. R. M. Amatya	Regional Irrigation Director

8. Janakpur Agriculture Development Project (JADP)

- Mr. S. B. B. Shah	Project Manager

9. Sindhuli Agriculture Farm

- Mr. B. R. Kaini	Farm Manager
- Mr. R. L. Prasad	Assistant Plant Protection Officer

10. Division of Soil Science & Agricultural Chemistry

- Mr. R. Shah	Chief Soil Scientist
- Mr. S. K. Shrestha	Assistant Soil Scientist

11. Meteoro-ogical Section (DIHM)

- Dr. J. L. Mayava	Chief Meteorologist
- Mr. L. M. Acharya	Senior Meteorologist

II. BACKGROUND OF THE PROJECT

II. BACKGROUND OF THE PROJECT

2.1 General Situation of Horticulture

Nepal has natural conditions favourable to the growth of fruit trees so that fruits have been cultivated since ancient times. However, those have never been cultivated by the farmers as commercial agricultural products but only for their own consumption. The per capita fruit consumption in Nepal is said to be about 20.2 kg per year.

Various factors are conceivable as reasons why large scale orchards have never been developed in the past, but the foremost reason may be the fact that the country had been long closed to foreigners. There was hardly any road until 1951 or any other means of access to the cities so that the movement of people and flow of commodities were quite limited. Secondly, because fruits are easily damaged when handled and transported in bulk, no one produced in a large scale as commercial merchandise.

As a result, fruits were never cultivated in large quantities as marketable products. What are produced are only a tropical and sub-tropical fruits. The reason that a few number of orchards did exist was only because fruits were necessary for religious and social events and not because there was any economic demand for them.

In the hilly and mountainous regions between 900 to 1,500 m in elevation, a citrus called "suntala", which is a fruit of the same kind as mandarin or tangerine orange, is produced in large quantities. It has been produced since ancient times at Illam, Dhankuta, Bhojpur, Sindhuli, Pokhara and Dailekh, and because of its excellent quality and superior commercial value, its cultivation has been rapidly expanded lately.

Another Nepalese citrus is the "junar". This one is genealogically called Citrus sinensis of Mosumhi Genus and is an original local variety of Nepal. It is very sweet and juicy and compares quite well with any

other orange in the world. At present, it is being produced on a limited scale in a part of Dhankuta, Bhojpur, Sindhuli and Ramechhap. Also, citrus fruits such as lemon (Citrus limon and Citrus jambhili), Kagzilime (Citrus auran tifolia), Pummelo or Shaddock (Citrus grandis), Sweet lime (Citrus limetoides), Citron (Citrus medica), Bitter orange (Citrus aurantiun) and Kumguat (Fortunella japonica) are cultivated in the gardens of homes in all of Nepal to be eaten daily or as an offering at festivals. Since suntala and junar are both excellent in quality, those are quite exportable to foreign markets. Those are therefore quite valuable as the main fruits to be developed. Regarding grape, the Government of Nepal intends to develop it as a newly introduced fruit and to expand its producing areas in Manang and Mustan to increase the planting of varieties for wine as a step toward winery production in Nepal. For the time being, however, it plans to extend the cultivation of table varieties such as Olympia, Cambell, Delaware, and Kyoho in the Banke and Berdia areas. Incidentally, the place of origin for European grapes is said to be Trans-Caucasus. Grapes in Japan were first introduced from China, but they were of European varieties. However, the varieties of grape improved in Japan are adaptable to the climatic conditions in Nepal and are expected to play the leading role in the horticulture development program in Nepal.

2.2 Horticultural Development Project

The Horticultural Development Project aims to contribute to increase in farmers' income and improvement of their living standard through multiple agricultures in hill areas in Nepal. It develops techniques for the selection of suitable varieties, proliferation of fruit saplings, administration of cultures, control of plant pests and so on in order to improve varieties of fruit trees which are suitable to these areas and to develop and establish growing techniques. And at the same time, it implements training for horticultural technicians and key farmers at the project center.

It also conducts experiments on proliferation of fruit saplings and demonstrates farms for the purpose of extension toward farmers at sub-center.

Principal features of the project will be as follows:

1. Organization of the project

   The Ministry of Agriculture, HMGN

2. Enforcement organization of the project

   1) The project center:

      The project center will be established in the compound of the existing Kirtipur Horticulture Research Station.

   2) The sub-centers

      The project sub-centers will be established in the compound of the Nepalgunj Agricultural Station and the Sindhuli Agriculture Farm.

3. Subject crops

   Mainly citrus fruits (Junar), grapes and chestnuts

4. Function of the project center

   The project center will play the role of a center facility for the development of the following items:

   i) Introduction of fruit trees and selection of suitable varieties,

   ii) Proliferation techniques of fruit trees,

   iii) Pomicultural techniques,

   iv) Control techniques of plant pests,

   v) Soil and fertilizer,

   vi) Training of pomicultural technicians, and

   vii) Publicity activities.

5. Function of the sub-centers

The Nepalgunj Sub-center and the Sindhuli Sub-center will conduct adaptative experiments on grapes and saplings of Junar, in their suitable areas for cultures, and at the same time to give guidance and advice on experimental proliferation of suitable varieties and saplings.

2.3 Technical Cooperation

The HMGN requested the Government of Japan for technical cooperation and grant aid for the impremention of the Horticultural Development Project in 1983 by the note of verbal. According to the request, JICA despatched the Preliminary Survey Team for the project formulation in June 1984 and the Basic Design Study Team for the Kirtipur Horticultural Development Center (the project center) by the grant aid in September 1984.

In October 1985, the Japanese Implementation Survey Team organized by JICA was despatched in order to work out the details of the technical cooperation program concerning the Horticultural Development Project. The scope of the technical cooperation was concluded with the Record of Discussion (R/D) on 14th October, 1985. The major items of the technical cooperation are as follows:

1. Cooperation period : 5 years

2. Dispatch of experts under the Colombo Plan Technical Cooperation Scheme

- Long term :

Team leader	1 person
Pomiculturs	
Citrus	1 person
Grapes	1 person
Agricultural Machinery	1 person
Coordinator	1 person

- Short term : To be dispatched as required for the smooth implementation of the Project.

3. Provision of machinery and equipment

4. Provision of special measures to supplement a portion of local cost expenditures.

5. Training of Nepalese personnel in Japan.

Based on the R/D, the construction of the demonstration farms of the Nepalgunj Sub-center and the Sindhuli Sub-center are to be taken by the Japanese Government for the special measure project.

The Detail Design Survey Team was despatched by JICA from November 27, 1985 to January 16, 1986 under the above condition, in order to proceed with surveys, investigations and detail designs for the demonstration farms of the Nepalgunj Sub-center and the Sindhuli Sub-center.

2.4 Nepalgunj Sub-center

The Nepalgunj Sub-center will be established in the compound of the Nepalgunj Agricultural Station located in the Banke District of the Bheri Zone. The cultivation of grapes for the table varieties has been carried out in the station by the guidance of Japanese expert since 1980. Therefore the station is devoted for the sub-center in order to conduct adaptative experiments on grapes in the sub-tropical zone.

The required facilities for the sub-center are as follows:

1. Pumping facilities using the existing deep tubewell,
2. Irrigation pipeline with sprinkler,
3. Drainage facilities, and
4. Vine trellis.

About 10 ha in gross is prepared for the area of the sub-center.

2.5 Sindhuli Sub-center

The Sindhuli Sub-center will be established in the compound of the Sindhuli Agriculture Farm located in Sindhulimadi where the district headquarters of the Sindhuli District is located. Junar is a major production in the Sindhuli District and the farm has been carried out the production and distribution of Junar saplings in accordance with the Junar production program. In this point of view, the farm is devoted for the sub-center in order to conduct the production and experiment of Junar saplings.

The required facilities for the sub-center are as follows:

1. Intake facilities for lifting up the underflow water,
2. Irrigation pipeline,
3. Drainage facilities, and
4. Grafting house

About 1.5 ha in gross is prepared for the area of the sub-center.

III. PRESENT CONDITIONS

III. PRESENT CONDITIONS

3.1 Nepalgunj Agricultural Station

The Nepalgunj Agricultural Station which is located 7 km west of Nepalgunj was established in 1962 in order to expedite the agricultural development in the Terai plain of the Far Western Development Region. The major objectives of the station were to conduct researches on various kind of cerial crops and to produce improved seeds. Four ha of farm land, which was allocated to the station when it was established, have been increased to meet the growing farmers' demand, and at present, it has about 60 ha of farm land.

The following units are at present involved in the station.

- Horticultural unit,
- Agronomy unit (crop research),
- Seed testing laboratory,
- Out-reach program such as agri-extension and research program, and
- Regional Agricultural Training Center.

Among these units, the horticultural unit established in 1977 is considered to be one of the most important unit, and about 16 ha is used for the horticultural research activities. The various kinds of tropical or sub-tropical fruits such as mango, guava, papaya, banana, grape are planted in its farm land and about 0.209 ha is used for grape planting.

The demonstration farm to be constructed in this station will be used for trials and tests of improved grape varieties and farming technics as well as their extension.

3.2 Sindhuli Agriculture Farm

The Sindhuli Agriculture Farm of about 7.0 ha is located in Sindhulimadi where the district headquarters of the Sindhuli District is located. The farm was established in 1978 with an area of about 1.2 ha for demonstrating cerial and vegetable crops and conducting their trials. The present activities of the farm are summarized below:

- Demonstration of the farming practices of cerial and vegetable crops,
- Production and distribution of Junar sapling in accordance with the Junar production program,
- Multiplication and distribution of improved seeds of cerials and vegetables,
- Production and distribution of vegetable seedlings,
- Agricultural extension services to the farmers in coordination with District Agriculture Development Office,
- Technical supervision of the Junar production program,
- Training of the agriculture assistants and leading farmers, and
- Trials on cereals, vegetables and fruits crops to solve the problems of farmers.

The demonstration farm to be constructed in this farm will be used for trials and tests of improved Junar varieties and farming technics as well as their extension.

3.3 Natural Conditions

3.3.1 Nepalgunj Sub-center

The proposed site of the Nepalgunj Sub-center is located in the northeastern part of the Nepalgunj Agricultural Station. Natural conditions of the proposed site are clarified through the field investigations.

(1) Topography

The proposed site is generally inclined toward north-western side with an average slope of about 1 to 200. A depressed low land is found along the center line of proposed site in north-western direction, and along this depression a temporary drainage canal is provided. The excess water is drained through this drainage canal to the Belhaniya stream, one of the tributaries of Kiran river. Some farm roads are provided surrounding and traversing the area, and the culvert is provided at the crossing of the drainage canal and existing farm road.

Topographic survey was carried out in the Nepalgunj Agricultural Station area and the topographic maps of the scale of 1:1,000 was prepared for i) the demonstration farm, ii) the approach road and iii) the drainage canal. The acreage of the proposed site surrounded by the fence was measured to be about 10.75 ha. Topographic maps are shown in tender drawings No. N100-05, N100-06 and N400-01.

(2) Climate

The climate of the Nepalgunj is sub-tropical in nature and characterized by two distinct seasons; the rainy reason from June to September and the dry season from October to May. About 85% of annual rainfall occures during the rainy season. The annual rainfall is about 1,500 mm.

Mean temperature varies from 14°C in January to 31°C in May. The average monthly relative humidity at 8:40 AM varies from 53 to 88%. Evaporation varies widely through a year from 4 mm/day in January to 12 mm/day in May. Annual evaporation is about 2,500 mm on average.

The observed records are available at the Nepalgunj Agricultural Station and the Nepalgunj Regional Office. The Available meteorological data and observed period are shown in Fig. 3.1. These data are used for the detail design of the Nepalgunj sub-center. The climatic conditions are summarized in Table 3.1 and graphically shown in Fig. 3.2.

(3) Water sources

Groundwater pumped up from the existing deep tubewell is used for irrigation of the Nepalgunj Sub-center. The existing deep tubewell is located south-west of the site. The records of pumping test prepared by the Indian boring firm in 1980 were collected at the site, and in addition the exact depth and diameter of the tubewell were measured to check the above records through the field investigation.

According to the above records and check results, it would be possible to lift up water enough to irrigate the proposed horticultural farm, through the silt of about 8.5 m in thick on the bottom of the tubewell should be removed. The required discharge of 0.65 m^3/sec for the sub-center can be expected with draw down of 3.1 m. The profile of the existing deep tubewell is shown in Fig. 3.3.

(4) Soil

The soils of the proposed site include somewhat poorly to moderately well drained soil occupying mostly on flat lower piedmont ridges and depression with recent to subrecent alluvium. These soils are classified into sandy loam or silty loam and soil reaction is slightly acid to moderately alkaline with pH 6.0 to 8.0.

(5) Land use

At present, most of the proposed farm area is grass or bush land, but some fruits such as banana, lemon, litchi are planted under rainfall condition in a part of the area.

(6) Field tests

The basic intake rate test was conducted in the proposed farm area. Through the test, the basic intake rate of 6.10 mm/hr is obtained and the intake rate for the first 20 minutes is estimated at 51.15 mm/hr as shown in Fig. 3.4, Results of Basic Intake Rate.

It is considered that basic intake rate will become around 50 mm/hr after improvement of drainage condition.

The bearing capacity was tested by cone penetrometer at the proposed pump house, and the results reveal that the bearing capacity of the soil would be about 40 t/m^2, which is quite sufficient for the foundation of pump house and farm house.

3.3.2 Sindhuli Sub-center

The proposed site of the Sindhuli Sub-center is located in the southern part of the Sindhuli Agriculture Farm. Natural conditions of the proposed site are clarified as follows through the field investigations.

(1) Topography

The proposed site is bounded by the existing fence in the south, by the foothill of the small mountain in the west, by the approach road of the Farm in the north and the farm road running from north to south in the east. The existing irrigation canal traverses the area running from north to south. The western side of this canal is the orchard inclining eastward with gentle undulation, while the eastern side consists of terraced fields of vegitable and Junar lowering eastward.

Topographic survey was carried out in and around the Sindhuli Agriculture Farm and the topographic map of the scale of 1 to 1,000 was prepared. The proposed farm area is measured to be about 1.6 ha. Topographic map is shown in tender drawing No. S100-03.

(2) Climate

The climate of the Sindhuli is sub-tropical in nature and characterized by two distinct seasons: the rainy season from June to September and dry season from October to May. About 83% of annual rainfall occures during the rainy season. The annual rainfall is about 1,500 mm.

The rainfall records are available at the Tulsi station. Since the climatic records except rainfall are not available near the Sindhuli Agriculture Farm, the climatic records at the Hetauda station located 90 Km west of the Sindhuli Agriculture Farm are used for design. The available meteorological data and observed period are shown in Fig. 3.1.

Mean temperature of the Hetauda station varies from 14°C in January to 27°C in June. The average monthly relative humidity at 8:40 AM varies from 63 to 86%. The climatic conditions are summaried in Table 3.1 and graphically shown in Fig. 3.2.

(3) Water sources

The Gwang river which is flowing along the northern side of the farm will be the irrigation water source of the sub-center. The underflow water of the river will be lifted up by pump from the shall well constructed on the riverbed beside the right bank of the river. The underflow water is perennial and is sufficient for irrigating the farm even in drought month between April and May according to the interview made at the site. In addition, a test pit was dug to confirm the availability of the underflow water at the site. Consequently it is judged that the underflow water is sufficient for irrigation of the proposed farm.

(4) Soil

The soils of the proposed site are well drained soils and be classified into sandy loam or loam. The soil reaction is slightly acid with pH 5.

(5) Land use

Most of the proposed farm area is used for various kinds of demonstrations and trials of fruits and Junar, mango, litchi and vegetables such as radish and cabbage are planted.

(6) Field tests

The basic intake rate test was conducted through the field investigation. The basic intake rate of 29.2 mm/hr is obtained. It is considered that the rate is sufficient for the furrow or basin irrigation. The results of the test are shown in Fig. 3.5.

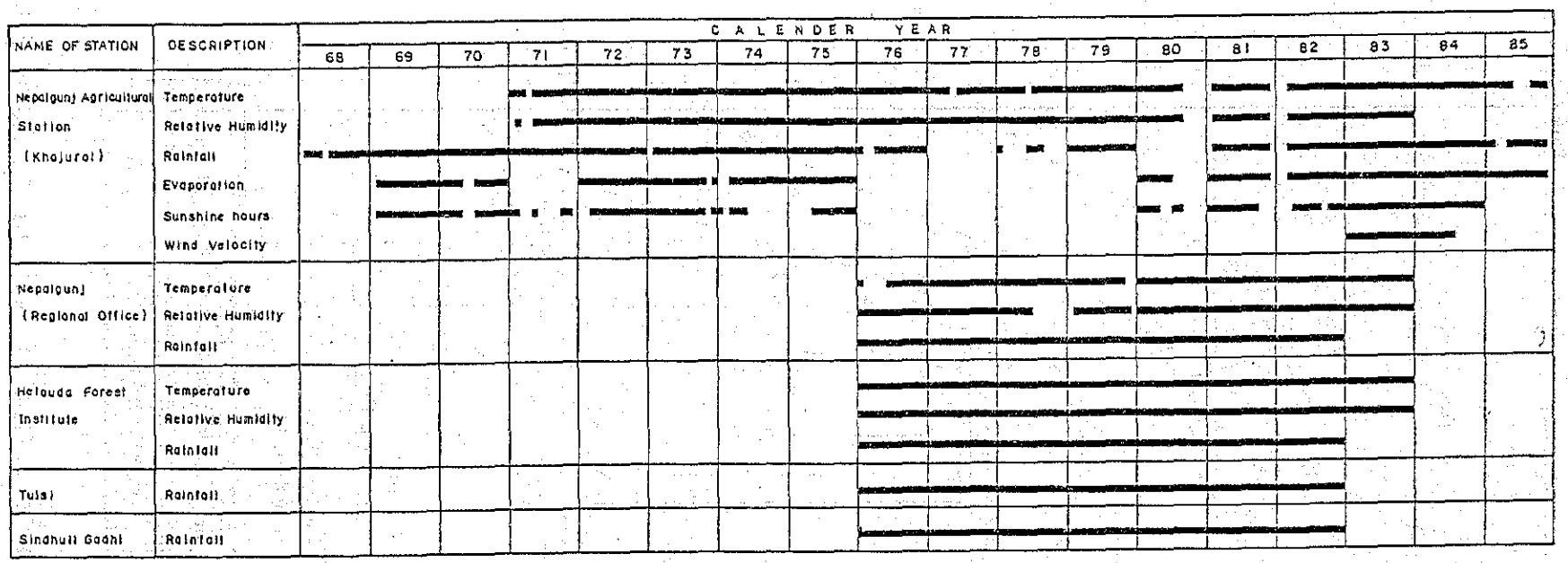
The bearing capacity was tested by cone penetrometer at the proposed pump house site, and the results reveal that the bearing capacity of the soil would be sufficient. The results of the test are shown below:

Location	Bearing Capacity	Depth
1. Proposed Grafting House	20 t/m^2	1.3 m
2. Proposed Farm Pond	20 t/m^2	1.4 m
3. Proposed Pump House	20 t/m^2	0.1 m

Table 3.1 Summary of Climatic Conditions

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average or Total
(I) NEPALGUNJ AGRICULTURAL STATION (KHAJURA)														
Temperature														
(Maximum)	°C	22.4	24.9	30.8	34.1	37.4	36.1	32.8	32.7	31.7	30.8	27.8	23.7	30.9
(Minimum)	°C	6.5	8.5	12.6	19.1	23.6	25.3	25.9	25.7	24.4	19.3	12.7	8.1	17.5
(Daily)	°C	14.4	16.7	21.7	27.8	30.6	30.6	29.4	29.2	28.1	25.1	20.3	15.9	24.1
Relative Humidity														
(08:40)	%	87.8	82.6	67.1	53.1	58.2	70.9	83.6	84.9	86.3	82.3	81.3	78.9	76.7
(17:40)	%	70.6	61.0	48.1	43.2	44.6	58.6	78.8	81.5	81.4	74.4	70.1	72.3	65.3
Precipitation	(mm/month)	16.6	12.7	12.4	21.1	48.5	223.6	441.7	326.7	305.5	75.1	4.3	7.4	1,495.6
Evaporation	(mm/day)	3.9	5.5	7.6	9.8	11.7	9.4	7.0	5.9	6.1	5.7	4.4	4.3	6.8
Sunshine-hours	(hr/day)	7.0	8.0	8.6	9.3	9.2	7.3	5.4	6.0	5.8	8.4	8.8	7.8	7.7
Wind Velocity	(km/hr)	1.7	3.1	2.9	4.1	5.2	5.3	4.3	4.6	3.6	2.3	1.6	1.8	3.4
(II) HETAUDA FOREST INSTITUTE														
Temperature														
(Maximum)	°C	22.1	24.2	29.4	31.9	32.8	31.8	30.9	31.0	30.5	28.6	26.3	22.9	28.5
(Minimum)	°C	6.3	8.2	11.9	17.7	21.1	22.6	23.0	23.0	21.6	16.6	11.8	7.0	15.9
(Daily)	°C	14.2	16.3	20.7	24.8	27.0	27.2	27.0	26.9	26.1	22.6	19.1	15.0	22.3
Relative Humidity														
(08:40)	%	82.6	77.8	65.3	62.8	69.1	77.9	83.3	83.8	82.4	78.3	82.5	85.5	77.6
(17:40)	%	79.9	70.6	57.0	58.6	66.4	77.1	84.0	86.1	84.6	80.5	84.5	80.0	75.4
Precipitation	(mm/month)/1	5.0	7.7	17.9	50.0	101.7	245.6	379.9	356.6	255.9	58.7	13.7	5.3	1,498.0

Note: /1: Precipitation measured in Tulsi is adopted.



List of Meteorological Station

INDEX NO.	NAME STATION	LAT-LONG (deg/min)	ELEVATION (m)	ESTABLISHED DATE
0409	Nepalgunj Agricultural Station (Khajura)	2806 - 8134	190	Jan. 1968
0416	Nepalgunj (Regional Office)	2804 - 8137	144	Feb. 1973
0906	Helauda Forest Institute	2725 - 8503	474	Aug. 1966
1110	Tulsi	2702 - 8555	457	Mar. 1973
1107	Sindhuli Gadhi	2717 - 8558	1463	Oct. 1971

Location of Meteorological Station

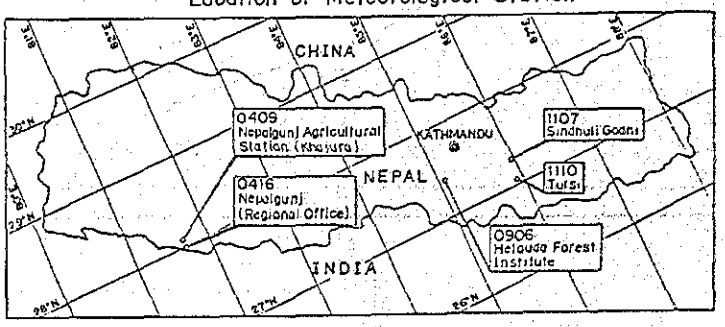


Fig. 3.1 Available Meteorological Data and Location of Meteorological Station

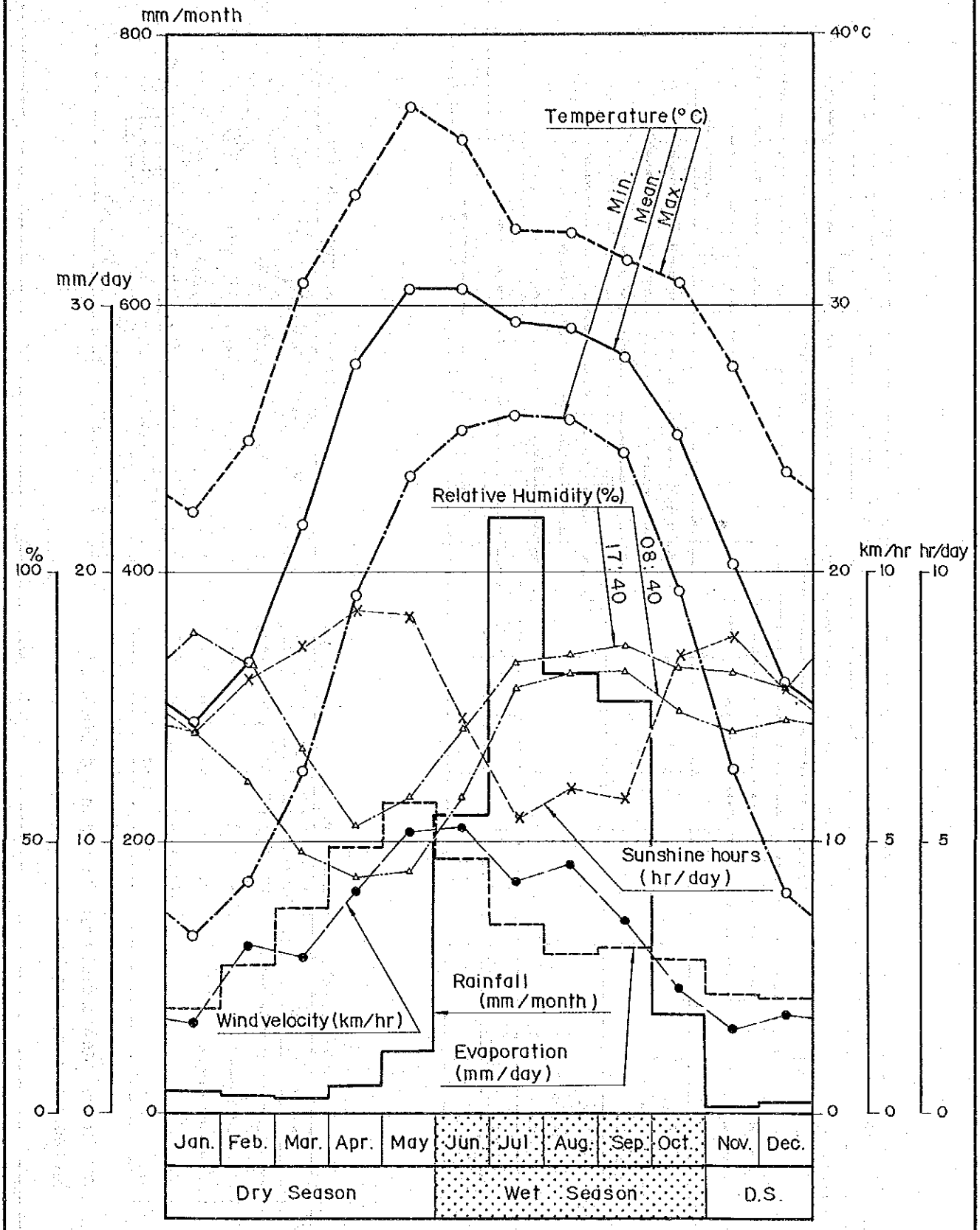


Fig.3.2 (1/2) Meteorological Characteristics of Nepalgunj Agricultural Station (Khajura)

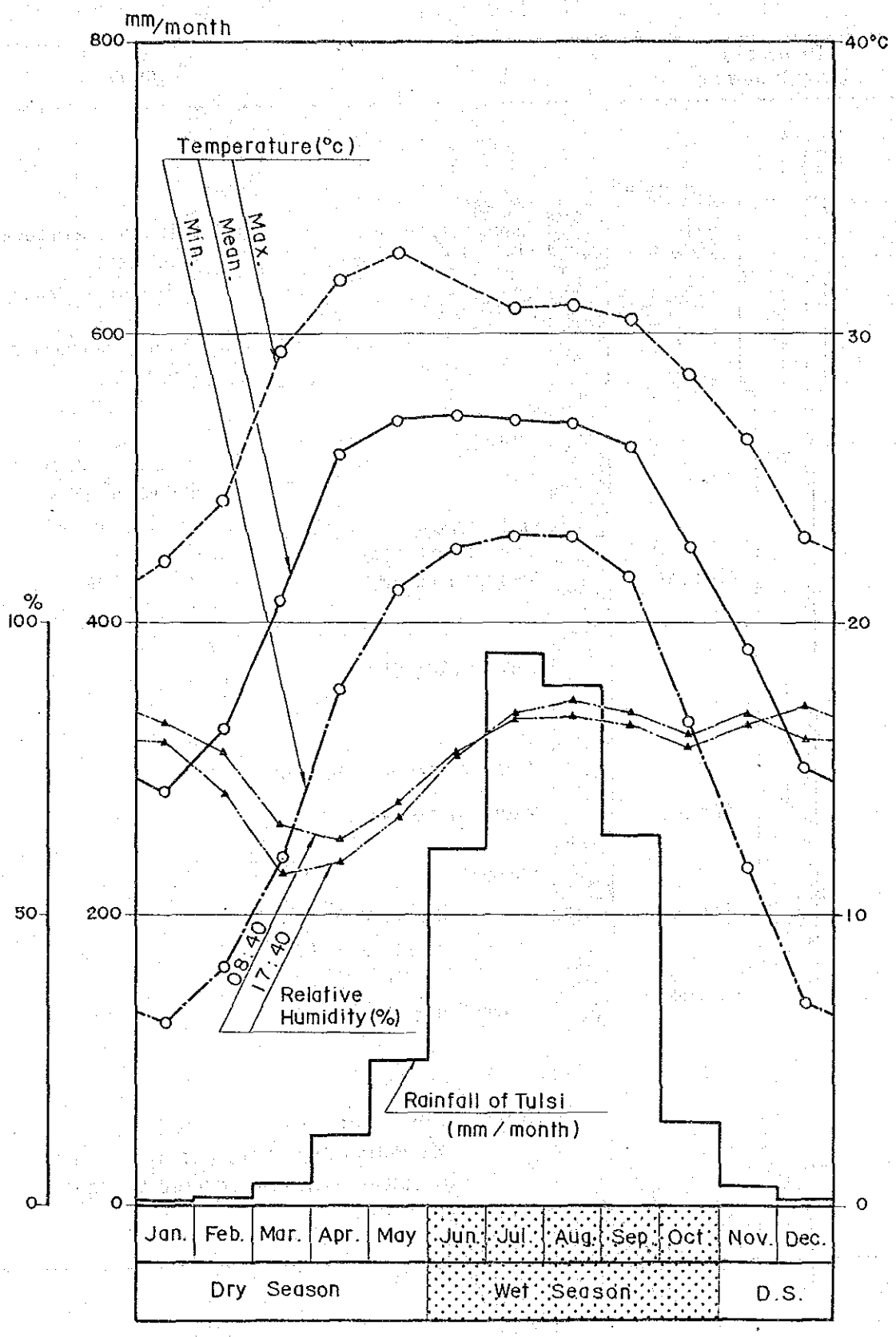
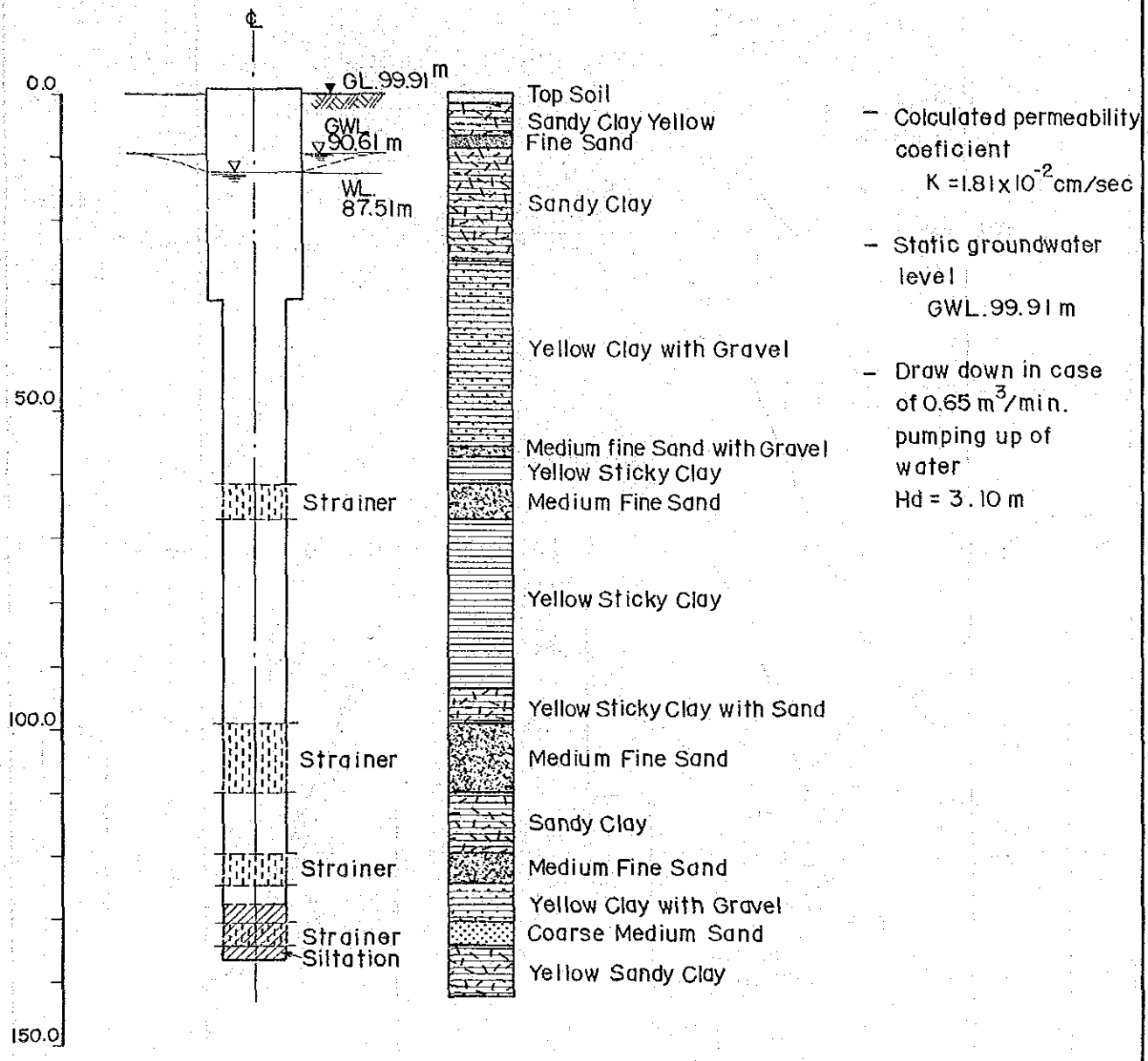


Fig. 3.2 (2/2) Meteorological Characteristics of Hetauda Forest Institute



Note : Above data was prepared by the Indian firm based on the results of pumping up test carried by them in 1980.

Fig. 3.3 Profile of Existing Deep Tubewell

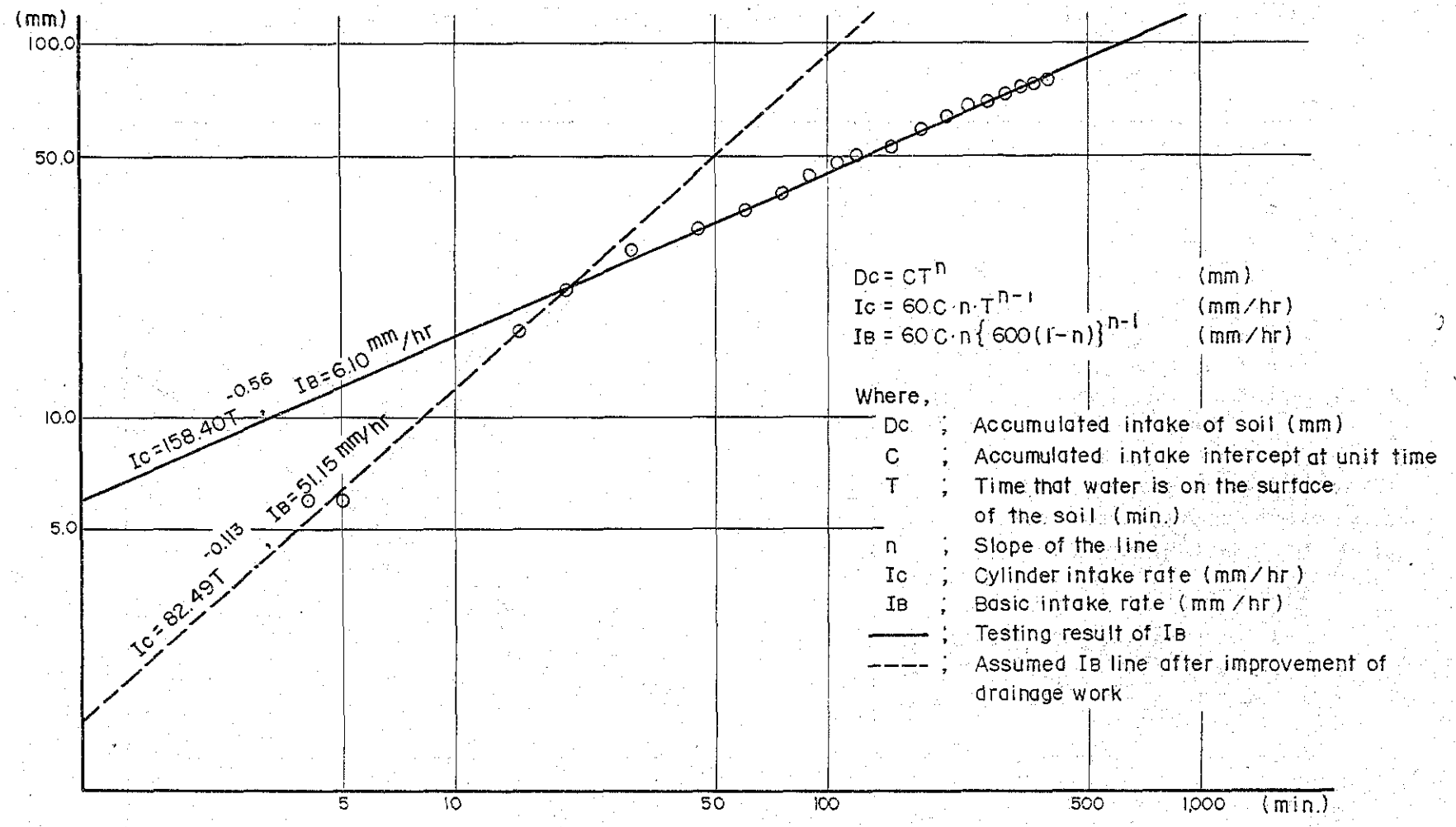


Fig. 3.4 Results of Basic Intake Rate Test at Nepalgunj Sub-center

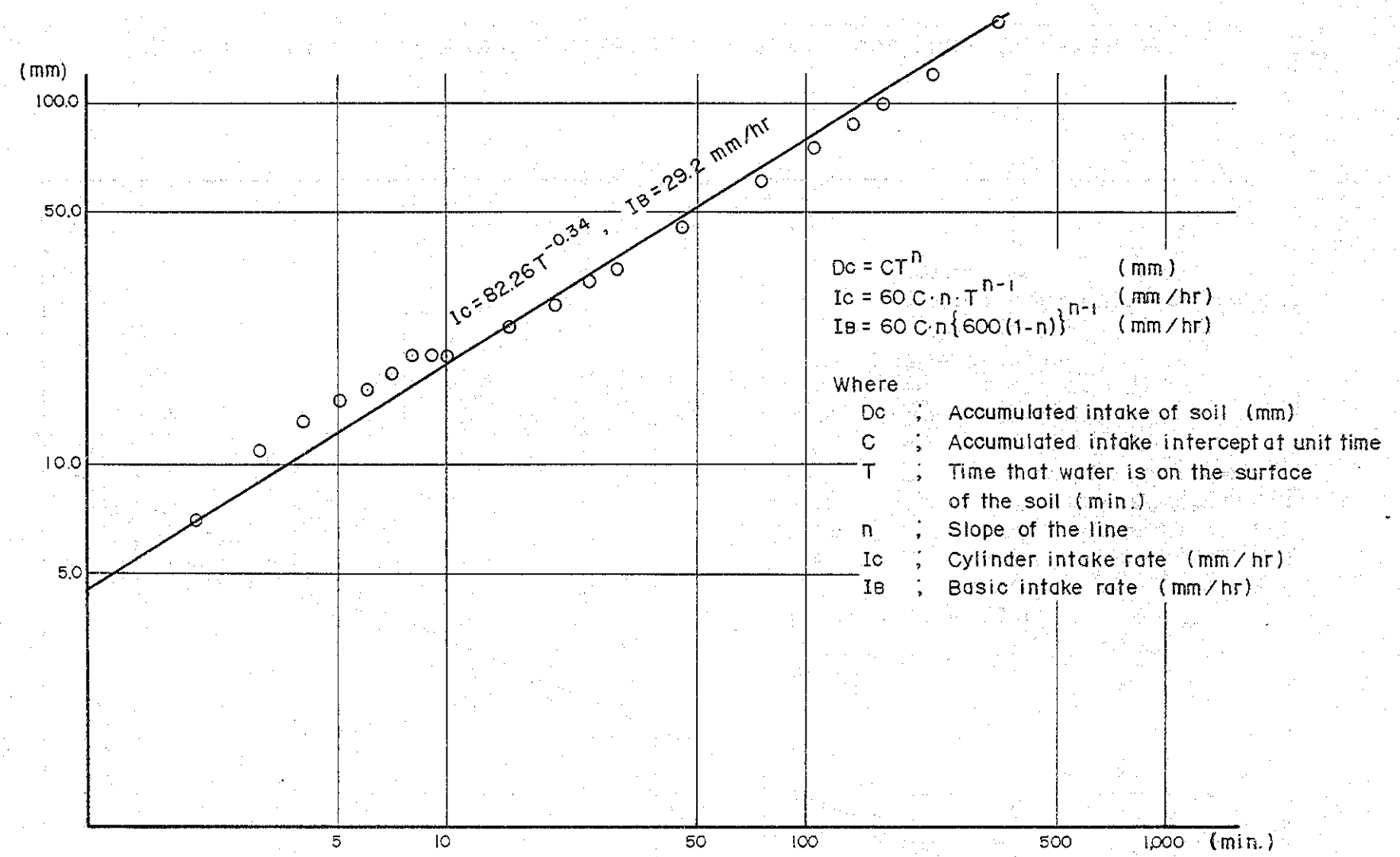


Fig. 3.5 Results of Basic Intake Rate Test at Sindhuli Sub-center

IV. DETAIL DESIGN OF FACILITIES

IV. DETAIL DESIGN OF FACILITIES

4.1 General

The detail design of facilities is mostly made on the basis of the results of field investigations. The outlines of the detail design for the Nepalgunj Sub-center and the Sindhuli Sub-center are given hereinafter. Principal features of the both sub-centers are summarized in clause 14 of summary.

4.2 Nepalgunj Sub-center

4.2.1 Water sources

Water sources for the Nepalgunj Sub-center will be groundwater to be lifted from the existing deepwell which was drilled in 1980 by the Indian firm. According to the records obtained on completion of drilling, design discharge of 0.65 m^3/min. can be expected with drawdown of 3.1 m.

4.2.2 Irrigation water requirements

Irrigation water requirements of grapes are estimated by using the methods which are suggested in "Crop Water Requirement", FAO Irrigation and Drainage Paper No. 24. The meteorological data recorded at the Nepalgunj Agricultural Station are used for above estimate.
The procedures for estimation are as follows:

(1) Calculate potential evapotranspiration (ETo) by using Blany-criddle Method, Radiation Method, Modified Penman Method and Pan Evaporation Method, and employ the mean value of their results.

(2) Multiply ETo by crop factor to obtain crop evapotranspiration.

(3) Deduct the effective rainfall from the crop evapotranspiration to obtain the crop water requirement.

(4) Divide the crop water requirement by filed efficiency of 85% to obtain field water requirement.

(5) Divide the field water requirement by conveyance efficiency of 90% to obtain diversion water requirement.

(6) Estimate application interval by the relationship of crop water requirement and readily available soil water.

Peak crop water requirement and peak field water requirement are estimated at 4.97 mm/day and 5.84 mm/day, respectively. Application interval is estimated at 5 days. Calculation results of peak water requirements are shown in Table 4.1.

4.2.3 Irrigation system

Irrigation water will be lifted up by a submergible pump provided at the existing deep well and will be stored in the farm pond. The water in the pond will be conveyed through the pipelines to the farm blocks equipped with sprinkler sets by the delivery pump. To regulate the water supplied by the pipelines, hydrants will be installed in the pipelines. Layout of irrigation system is shown in Fig. 4.1.

(1) Design discharge

The field will be divided into 5 blocks for the sprinkler irrigation and one block will be irrigated in a day by removable sprinkler sets.

Irrigation intensity is determined to be 6.36 mm/hr or the basis of the following conditions:

(i) Field water requirement for once irrigation is estimated at 29.2 mm.

(ii) Sprinkler will be operated on a 4.6 hr/shift and 2 shift/day basis.

(iii) Assumed basic intake rate is to be about 50 mm/hr after construction of sub-surface drain.

Design discharge of the beginning point of the pipeline is estimated at 1.13 m^3/min. Irrigation diagram and design discharge of pipelines are shown in Fig. 4.2.

Design discharge of submergible pump is estimated at 0.65 m^3/min. on the basis of following conditions:

(i) Water for once irrigation is lifted in a day.

(ii) Operation hour of the pump is 16 hours in a day.

(2) Pumping facilities

Submergible pump and delivery pump will be installed at the southward outside of the sub-center. Submergible pump will be used as a intake pump to lift groundwater of 0.65 m^3/min. and convey the water to the farm pond through the discharge pipe of dia. 80 mm. Delivery pump will convey the irrigation water of 18.84 ℓ/sec through the pipelines to the farm blocks.

Principal features of each pump are as follows:

Submergible pump

Diameter of pump	:	80 mm
Discharge	:	0.65 m^3/min.
Total head	:	19 m
Required power	:	3.7 kW
Discharge pipe	:	L = 32 m, Dia. 80 mm

Delivery pump

Diameter	:	80 x 65 mm
Discharge	:	1.13 m^3/min. (18.84 ℓ/sec)
Total head	:	36 m
Required power	:	15 kW
Suction pipe	:	L = 16 m, Dia. 100 mm

(3) Farm pond

Farm pond is to be stored the irrigation water of 625 m^3 which will be irrigated in a day. The farm pond will be constructed beside the pumping facilities with earth embankment and brick masonry lying. The pond will have a side slope of 1 : 1 and be 2.8 m in height and 2.0 m in crest width.

Principal features of the pond are as follows:

Effective storage capacity	:	625 m^3
High water level	:	101.41 m
Low water level	:	99.98 m
Size of pond	:	19 x 26 m

Related facilities (except inlet and outlet)

Blow-off valve	:	1 unit
Extra outlet	:	1 unit
Spillway	:	1 unit

(4) Pipelines

Pipeline system consists of one main irrigation pipeline and five branch irrigation pipelines. Irrigation water in the farm pond will be conveyed through these pipelines to the farm plots by the delivery pump. Each branch irrigation pipeline will be equipped with hydrants for connecting the sprinkler set. Two hydrants will be installed for one farm plot. Four branch irrigation pipelines will be covered four plots, respectively and remaining one branch irrigation pipeline will be covered two plots. Layout of pipeline system is shown in Fig. 4.1.

Principal features of pipeline system are as follows:

	Length	Diameter
Main Irrigation Pipeline	303.0 m	150 mm
Branch Irrigation Pipeline-1	83.5 m	150 mm
	103.0 m	100 mm
	41.0 m	75 mm
Branch Irrigation Pipeline-2	109.0 m	100 mm
	41.0 m	75 mm
Branch Irrigation Pipeline-3	112.0 m	100 mm
	45.0 m	75 mm
Branch Irrigation Pipeline-4	112.0 m	100 mm
	42.0 m	75 mm
Branch Irrigation Pipeline-5	116.0 m	100 mm
	41.0 m	75 mm

(5) Sprinkler

A portable sprinkler set with two lines and twelve sprinkler heads will be connected to each hydrant. Four sprinkler sets will be simultaneously operated at the full development stage and two sprinkler sets will be used in one farm plot.

Principal features of the sprinkler set are as follows:

Sprinkler line	Length	:	60 m x 2 lines
	Diameter of pipe	:	50 mm
Sprinkler head	Required pressure	:	2.5 kg/cm^2
	Water irrigated by a sprinkler head	:	21.2 ℓ/min.
	Diameter of irrigation area covered by a sprinkler head	:	21.0 m
	Trajectory angle	:	10°

4.2.4 Drainage water requirements

The drainage system for the Nepalgunj Sub-center will be provided in order to drain excess water and rainfall for stable growth of grapes and to ensure the trafficability of agricultural machinery. The drainage water requirements are estimated at 0.3 m^3/sec for the project area and 2.37 m^3/sec for the Belhaniya stream area by using Mac Math's formula which is suggested in "Drainage Manual" published by USBR. For the estimates, the daily maximum rainfall with 5-year return period is employed from the rainfall data recorded at the Nepalgunj Agricultural Station from 1968 to 1985.

4.2.5 Drainage system

(1) Drainage canal system

An alignment of drinage canal system is worked out as shown in Fig. 4-3, taking topographic condition into account. The drainage canal will be a trapezoidal open channel with a side slope of 1 : 1. The base and longitudinal gradient of canals will be 30 to 100 cm and 1/60 to 1/1000, respectively. At the crossing point with road, culvert structures of concrete pipes will be provided.

Principal features of drainage canal system are as follows:

Improvement of Belhaniya stream	:	Length	264 m
Main Drain (M.D.)	:	Length	520 m
		Base width	0.3 - 1.0 m
		Height	1.0 - 2.0 m
Collector Drains (C.D.)	:	Base width	0.3 m
		Height	0.5 - 1.0 m
		Length	
		C.D.-1	221 m
		C.D.-2	119 m
		C.D.-3	124 m
		C.D.-4	213 m
		C.D.-5	181 m
		C.D.-6	140 m
		C.D.-7	113 m
Farm ditches	:	Length	1,550 m
		Base width	0.3 m
		Height	0.3 m
Culvert structures	:	18 units	
Drop structures	:	2 units	

(2) Sub-surface drain

The field for grapes is required the good drainage condition, and irrigation intensity for sprinkler irrigations estimated at 6.36 mm/hr. While the basic intake rate is estimated at 6.10 mm/hr by the field intake rate test and allowable irrigation intensity is assumed at 2 to 3 mm/hr on the present condition. In order to grow the grapes and to apply the sprinkler irrigation, sub-surface drain will be employed for the improvement of drainage condition.

Principal features of the sub-surface drain are as follows:

Installation area of sub-surface drain	:	7.75 ha
Interval of drainage pipes	:	10 m
Installation depth of drainage pipes	:	0.8 - 0.9 m
Total length of drainage pipes	:	7,729 m

4.2.6 Road system

The road system consists of approach road and farm roads. The existing farm road of the Nepalgunj Agricultural Station will be improved and used as an approach road. Farm roads consist of the main farm roads and the secondary farm roads. The approach road and the main farm roads will be paved with the gravel.

Principal features of road system area as follows:

Approach road	Length	: 720 m
	Total width	: 4 m
	Effective width	: 3 m
	Gravel pavement	: 10 cm thick
Main farm roads	Length	
	Total width	: 4 m
	Effective width	: 3 m
	Gravel pavement	: 10 cm thick
Secondary farm roads	Length	: 2,270 m
	Width	: 2 m

4.2.7 Land grading

Existing depressions in the field will be grade for simple cultivation. Total area of land grading is 7.75 ha.

4.2.8 Vine trellis

Vine trellis will be required for growth of the mature grapes. Several types of vine trellis are considered i.e. flat type; waving type, fence type, etc. The vine trellis for the demonstration farm will be employed the flat type, since such Japanese kinds of grapes as Neo-Muscat, Bailey A and Kyoho will be grown in the farm.

Arrangement of center posts, border posts and main wires will be decided as follows based on the weight of grapes:

Arrangement

Center posts	:	ø200 mm, 5 meter interval
Border posts	:	ø42.7 mm, 2.5 meter interval
Main wires	:	ø3.2 mm, 2.5 meter interval
Small tension wires	:	ø2.0 mm, 0.3125 meter interval
Trellis height	:	1.8 m

4.2.9 Farm house

Farm house is required for a resting place and a storing place for the sprinkler sets. The house will be located beside the pumping facilities. The house consists of two rooms which are the resting room or office and the store room. Necessary floor area are determined in due consideration of dimensions of the sprinkler sets, etc.

The principal features of the farm house are as follows:

Type of construction

Foundation	:	Wet brick masonry footing
Superstructure	:	Wet brick masonry wall, wood truss and CGI roofing

Floor area

Resting room or office	:	24 m^2
Store room	:	24 m^2

4.3 Sindhuli Sub-center

4.3.1 Water sources

Water sources for the Sindhuli Sub-center will be underflow water of the Gwang river to be lifted at the northern site of the Sindhuli Agriculture farm. Groundwater level at the site was measured by the test pit and confirmed to be equal to water level in the river. Design discharge of 0.44 m^3/min. can be expected with drawdown of 1.5 m.

4.3.2 Irrigation water requirements

Irrigation water requirements for junar (citrus) are estimated by using the same method for the Nepalgunj Sub-center. The meteorological data recorded at the Tulsi and Hetauda stations are used for the above estimate. The procedures for estimation are as follows:

(1) Calculate potential evapotranspiration (ETo) by using Blang-criddle Method and Radiation Method, and employ the mean value of their results.

(2) Multiply ETo by crop factor to obtain crop evapotranspiration.

(3) Deduct the effective rainfall from the crop evapotranspiration to obtain the crop water requirement.

(4) Divide field water requirement by field efficiency of 65% to obtain field water requirement.

(5) Divide field water requirement by conveyance efficiency of 80% to obtain diversion water requirement.

(6) Estimate application interval by the relationship of crop water requirement and readily available soil water.

Peak crop water requirement and peak field water requirement are estimated at 2.6 mm/day and 4.0 mm/day, respectively. Application interval is estimated at 5 days. Calculation results of peak water requirements are shown in Table 4.1.

4.3.3 Irrigation system

Irrigation water will be lifted up by a intake pump provided at the shallow well which will be constructed at the right bank of the Gwang river, and will be conveyed to the farm pond which will be constructed on the steep slope forming the western boundary of the Sindhuli Agriculture Farm. The water in the pond will be conveyed through the pipelines to the farm blocks by static pressure. To regulate the water supplied by the pipelines, hydrants will be installed in the pipelines. Layout of irrigation system is shown in Fig. 4.4.

(1) Design discharge

The field will be divided into 2 blocks for the irrigation. One block will be irrigated in a day through eight hydrants by furrow or basin irrigation method.

The field water requirement and the diversion water requirement are estimated at 27.7 mm and 25 mm, respectively.

Irrigation hour and operation hour of the intake pump is decided to be 8 hours and 6 hours, respectively for the detail design, considering the sale of sub-center. Design discharge of the beginning point of the pipeline is estimated at 5.51 ℓ/sec. Design discharge of intake pump is estimated at 0.44 m^3/min.

Irrigation diagram and design discharge of pipelines are shown in Fig. 4.5.

(2) Shallow well

Shallow well will be constructed on the river bed beside the right bank of the Gwang river. Design discharge of 7.33 ℓ/sec (0.44 m^3/min.) can be expected with drawdown of 1.5 m.

Principal features of shallow well are as follows:

Type of construction	:	Open well by wet stone masonry
Diameter	:	1.5 m
Depth	:	8.6 m EL. 497.60 m - EL. 489.00 m
Low water level	:	LWL 492.47 m

(3) Intake pump and discharge pipeline

Intake pump will be installed beside shallow well. Intaked water will be conveyed through the discharge pipeline of dia. 80 mm.

Principal features of intake pump and discharge pipeline are as follows:

Intake pump

Diameter of pump	:	65 x 50 mm
Discharge	:	0.44 m^3/min. (7.33 ℓ/sec)
Total head	:	36 m
Required power	:	9 P.S.

Discharge pipeline

Diameter	:	80 mm
Length	:	185 m

(4) Farm pond

Since operation hour of the pump, 6 hours is shorter than irrigation hour of 8 hours, a farm pond is required to store the irrigation water. Effective storage capacity is calculated at 50 m^3. The farm pond will be constructed on the steep slope forming the western boundary of the Sindhuli Agriculture Farm with wet stone masonry wall.

Principal features of the pond are as follows:

Effective storage capacity	:	50 m^3
High water level	:	HWL 517.00 m
Low water level	:	LWL 515.39 m
Size of pond	:	5 x 6 m

Related facilities (except inlet and outlet)

Blow-off valve	:	1 unit
Extra outlet	:	1 unit
Spillway	:	1 unit

(5) Irrigation pipelines

Irrigation pipeline system consists of one main irrigation pipeline and four branch irrigation pipelines. Irrigation water in the farm pond will be conveyed through these pipelines to the farm blocks by static head. Each branch irrigation pipeline will be equipped with hydrant of dia. 1/2" for regulating the irrigation water. One gate valve will be installed at the crossing point of the Branch irrigation pipeline-1 and the existing open canal for irregular supplying to existing canal.

The principal features of pipeline are shown below:

	Length	Diameter
Main Irrigation Pipeline	135 m	100 mm
Branch Irrigation Pipeline-1	17 m	100 mm
	39 m	50 mm
Branch Irrigation Pipeline-2	88 m	50 mm
Branch Irrigation Pipeline-3	80 m	50 mm
Branch Irrigation Pipeline-4	41 m	75 mm
	85 m	50 mm

4.3.4 Drainage water requirement

The drainage system for the Sindhuli Sub-center will be provided in order to drain excess water and rainfall for stable growth of junar nursary and to ensure the trafficability of agricultural machinery. The drainage water requirements are estimated by using MacMath's formula. For the estimates, the daily maximum rainfall with 5-year return period is employed from the rainfall data recorded at the Tulsi station from 1976 to 1982. The drainage water requirements of the steep sloped portion and the flat portion are estimated at 0.159 m^3/sec and 0.065 m^3/sec, respectively.

4.3.5 Drainage system

An alignment of drainage canal system is worked out as shown in Fig. 4-6, taking topographic condition into account. The drainage canal will be a trapezoidal open channel with side slope of 1 : 1 and be lined by wet stone masonry at the steep descent portion. The base and longitudinal gradient of canals will be 30 to 50 cm and 1/20 to 1/500, respectively. At the crossig point with road, culvert structures of concrete pipes will be provided. Drop structures will be provided at the steep descent portion of canal.

Principal features of drainage canal system are as follows:

Main Drain - 1, 2	148 m
Minor Drain 1-1, 2	194 m
Minor Drain 2-1, 2	226 m
Catch Drain	227 m

4.3.6 Road system

The road system consists of approach road and farm roads. The existing road running north-south in front of the main office of the Agriculture Farm will be improved and used as an approach road. Farm roads consist of the main farm road running north-south in demonstration farm and the secondary farm roads branching out from the main farm road. The approach road and the main farm road will be paved with the gravel.

Principal features of road system are as follows:

Approach road	Length	:	290 m
	Total width	:	4 m
	Effective width	:	3 m
	Gravel pavement	:	10 cm thick
Main farm road	Length	:	111 m
	Total width	:	3 m
	Effective width	:	2 m
	Gravel pavement	:	10 cm thick
Secondary farm roads	Length	:	579 m
	Width	:	2 m

4.3.7 Grafting house

Grafting house consists of the storing place of grafted trees and store room for tools. The house will be located in the western part of the demonstration farm. The storing place for grafted trees will be bounded with 1-meter height of wall and be covered by roof.

The principal features of the grafting house are as follows:

Type of construction

Foundation	:	Wet stone masonry footing
Superstructure	:	Wet stone masonry wall, wood truss and CGI roofing

Floor area

Storing place for grafted trees	:	96 m^2
Store room	:	24 m^2