No. 2

THE JANAKPUR ZONE AGRICULTURE DEVELOPMENT PROJECT IN THE KINGDOM OF NEPAL

REPORT ON IMPLEMENTATION AND DESIGN FOR SHALLOW TUBE-WELL PROGRAMME

DECEMBER 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

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Foreword

Janakpur Zone Agriculture Development Project (JADP) has entered the new phase since the Record of Discussions was renewed in October, 1979.

Although JADP seemed to have concentrated on the construction of the Project Centre, the Sindhli Agricultural Farm and the completion of the Intensive Irrigation Agriculture Programme (IAP) in the past. The new agreement is putting an emphasis on farm extension using these physical facilities to improve agricultural productivity in Janakpur Zone.

A key factor for increasing agricultural production is stabilization and an increase of the quantity of irrigation water. Recently, the Government of Japan has committed to grant the aid for development of shallow tube-well in Terai Plain of Janakpur, where a large amount of ground water is available. For this purpose, all equipment granted is to arrive in Janakpur until the end of this year.

This report is a result of the Detailed Design Team, dispatched by JICA, who carried out the design of irrigated model farms as well as financial analysis at the farmer's level for this programme.

Last but not least, the endeavors made by the Team members and the kind cooperation of both Nepalese and Japanese authorities concerned are very much appreciated.

December, 1980

Toshihisa Murata

Toshihisa Murata
Director,
Department of Agricultural Development Cooperation,
Japan International Cooperation Agency

LOCATION MAP

LEGEND

- River
- Paved road
- Unpaved road
- Airport
- Stol
- Capital
- Town
- Peak
- International boundary
- Zonal boundary
- District boundary

KEY MAP

CHINA

MAHAKAL
KARNALI
SETI
BHERI
RAPTI
DHAULAGIRI
GANDAK
LUMBINI
BAGMATI
NARAYANI
KATHMANDU
JANAKPUR
SAGARMATHA
MECHI
KOSI
BIRGANJ
JANAKPUR
BIRATNAGAR

INDIA

Sharpu
DHUNCHE
PHURBI CHYACHU 6,660m
CHINA (TIBET)
GAURI SHAKER 7146 m
Hum
Lamabagar
Bhairabkund
Kodari
Tatopani
Satar
Ranipauwa
Kakani
Takha
KATHMANDU
Jalbire
CHAUTARA
Shipaghat
SUN KOSI RIVER
DOLKHA
CHARIKOT
JIRI
Those
Chitre
Japhe
BHAKTAPUR
Nala
Panchkhal
BAGMATI ZONE
Panauti
Dapcha
Khopashi
ROSI KHOLA
Mangaltar
Melung
Doramba
Chaulakharka
KHIMTI KHOLA
Bhuji
LIKHU KHOLA
RAMECHHAP
Dumja
JANAKPUR ZONE
HETAUDA
BAGMATI RIVER
Makwanpur Garhi
Thigan
Padampokhari
Hatiya
Amlekhaganj
Phaparbari
KOKHAJOR KHOLA
Hariharpur Garhi
SINDHLI
Khurkot
RAMECHHAP
Nawalpur
SINDLIMADI
JADP CENTER
Pattaiya
Nijgad
Simra
EAST-WEST HIGWAY
Juribela
Chandranigahapur
Raniganj
GOSHALA AREA
Bhiman
IAP AREA
Mahadar
Danda
Hile
DUDH KOSI
Halesi
DIKTEL
Nirmalidanda
Dilpa
Dama
BHOJPUR
Tewari
Yaku
Kerabari
Jitpur
Aurkhaute
Pakhribas
Wokhre
Dandagaon
Haripan
Nawalpur
Lalbandi
PHULJOR RIVER
Belbas
ISWARPUR AREA
SAKHUWA AREA
Raighat
Sworung
Khotang
KOSHI ZONE
NARAYANI ZONE
KALAIYA
BIRGANJ
Murtiya
Gopalpur
KANLA RIVER
SAPHY AREA
Lalbhitti
Wokhreni
Chunbhang
Khoku
Sidhuwa
Chitang
DHANKUTA
TAMUR RIVER
Chaubise
Katahariya
Samanpur
Shitapur
SARLAHI
ANIRWA KHOLA
BAGMITI RIVER
Dhalkewar
MADHA RIVER
RATU RIVER
Chisapani
TANA KHOLA
Katari
Tribeni
SAGARMATHA ZONE
Uddipur Garhi
SUN KOSI
Barahchetra
Donoa Bazar
Sundarpur
Tribhuvan nagar
MAHOTTARI
Goshala
ANGWA
Raghunathpur
Sisautiya
Dumriya
Simra
Pipra
GAUR
Lohar Batti
Balba
Raghunathpur
Dhanusa
Galbazar
Murkuchi
Chaudandi
Chatra
DHARAN
Belhar
GAIGHAT
Khajipur
Fatehpur
Kaliyanpur
Kanchanpur
Chakraghati
SAPT KOSI
Kalyanpur
Lachmaniya
Govindpur
Lahan
Charapatti
Sitapur
Bhagwanpur
Inaruwa
Matin
Bajabaraun
EAST-WEST HIGHWAY
SHRHA
JANAKPUR-NARENDRANAGAR HIGHWAY
DHANUSA
JANAKPUR
Ratbar
JARESWAR
Matihani
KAMLA RIVER
RAJBIRAJ
Hanumannagar
Banainiya

SCALE
0 10 20 30 40 50 (km)

SUMMARY AND CONCLUSION

1. Purposes of this programme

JADP is shifting the stress of its activities from the several independent sub-projects to the integrated and organized development activities of extension to raise visual farm production in Janakpur Zone.

However, the Terai Plain is called a granary in this Zone, and since the most of this area is cultivated on the rain-fed conditions, the diffusion of new cultivation technique can not promise to raise large quantity of production. In other words, this area might be suitable to farming from the viewpoints of topography and climate, but the cropping intensity there is very low, the average in the three districts, 1976/77 in spite of its advantage i.e. cropping intensity; 103 % : cultivated physical area; 244,600 ha: total cropped area; 252,100 ha. Its reason seems to be mainly lack of irrigation water.

Turning our eyes to the situation of irrigation, there are a surface irrigation project in Dhanusa District with a command area of 2,000 ha, and another project (planning) in the western side of the Kamla River, Dhanusa with approximately 12,500 ha. Thus totaly about 40,000 ha in the Terai, Janakpur, will be irrigated from surface sources in future so the rest of the area; 180,000 - 200,000 ha should be irrigated from other sources. One of the most possible sources must be ground water.

A series of hydro-geological surveys show that the Terai has abundant ground water and many possibilities of artesian wells. However, judging from all the experiences of JADP (IAP) and other organizations, an artesian well has several disadvantages i.e. firstly its water is not always enough but diminishes in water quantity any time. Secondly, the cost of digging a single well is high. Thirdly command area of one well is large. Therefore, it came to be judged that problems will occur in organizing cooperative farms to foster water management organizations.

Consequently, in order to increase production and to improve standard of living through development of management and technology, it is necessary to utilize ground water in an effective manner. It is, therefore, reasonable to diffuse shallow tube-well methods in which 2 to 5 farmers cooperatively share one tube-well with a diesel-engine pump easy to be invested.

The target of this programme is to introduce new inovated technology to farmers through extension services with economic, financial and technical justification for beneficiaries.

By and large, the pilot scheme envisaging diffusion of shallow tube-well irrigation will be set up in JADP. In this scheme, modal farms was selected in each district in the Terai and they will be utilized as demonstration farms in which some trials will be carried out by JADP to collect data and to shows farmers.

Before the Team's arrival in Nepal, JADP had already selected five Irrigated Model Farms, which will be constructed entirely at JICA's expenses.

At the same time, JADP is responsible for training extension workers: JT; JTA; AA and key farmers to develop necessary man-power for the scheme and also trying to diffuse proper water management techniques.

2. Outline of STWP

STWP will not only provide pump sets to farmers but also provide soft-ware such as extension services to maximize the use of costly water for better production. Therefore this programme includes the following activities in Table-1.

Table-1 Contents of STWP

Activity	Executing agency	Currency	Related schemes
Shipment of equipment	Government of Japan	F.C.1/	KR Food Production Aid (Grant Aid)
Establishment of irrigated model farmers	JICA	F.C.	Model-Infrastructure Scheme (JICA's term)
Extension & training	JADP	L.C.2/	
Provision of loans	ADBN	L.C.	Fourth Credit Scheme
Provision of pumps and other inputs	AIC*/	L.C.	
Digging & maintenance	JADP	L.C.	

Notes: 1/: Foreign Currency
2/: Local Currency

The term of STWP in this report means the overall programme. In this programme, JICA will provide local cost for 'Irrigated Model Farm Scheme' as its Model Infrastructure Scheme.

JADP as one of main executing agencies in this programme and its role to play widely ranges from working out its plan and schedule to digging wells and maintaining pump sets. Moreover, JADP itself has given trainings to extension workers and key farmers, but in this programme JADP will give them trainings concerning water-management, cultivation methods etc. Therefore, there may be following advantages when JADP is the main body for STWP:

*/: It is reportedly decided that AIC will not participate in STWP in Janakpur Zone.

(1) Sinking wells and installation of pumps will be done by JADP with modest charges to benefitiaries. It may take two and a half days to sink a single well by its own machines. According to the report on the Fourth Agricultural Credit Project, the cost to sink a well at this stage is very high in that project because it is done by hands.[1/];

(2) Since JADP carries out over-all activities, including propagation, installation, extension, etc., it will easily be able to get farmers' real requirement for this programmes; and

(3) JADP has so organized functions that it can quickly provide technical assistance and maintenance services for pumps.

3. Result

This programme, will make it possible to grow winter crops like wheat, maize, tabacco, etc. by means of irrigation, and will provide supplemental water in rainy season for normal paddy.

Table-2 shows comparison of yields by crops at present and with project.

Table-2 Yields by Crops

(Unit: t/ha)

Crop	Present (A)	With project (B)	Balance (B)/(A)	Rate (B)/(A)%
Early paddy	-	3.00	3.00	-
Normal paddy	1.65	3.00	1.35	182
Wheat	1.06	2.50	1.44	236
Maize	1.42	2.80	1.38	197
Mung	0.30	0.50	0.20	167

Source: JADP

1/: This is remarkable advantage for this programme. Comparatively, the Final Report of the Fourth Agricultural Credit Project says that to dig wells in the ADBN project is a crucial point. (page T/53). For instance the digging cost in the report is NRS 9,596 in comparison with NRS 3,000 for JADP's planning.

It is estimated that with project the harvesting yield per ha (t/ha) is increasing very much.

On the other hand, cropping intensity which is a ratio between cultivated physical area and total cropping area a year is 103.0 % (1976/77) in three Terai districts, Janakpur, and 106.6 % (1977/78) in whole areas of Nepal. This programme envisages triple cropping a year i.e. intensity is 300 %, and will introduce more profitable crops like tobacco, wheat, etc.

Furthermore, this programme will be approved from the hygienic viewpoint. It is because hand-dug wells are left open at the surface to allow the bucket to be lowered and therefore are open to be contaminated from rubbish falling into the well mouth, or disease-causing pathogenes being carried into the well on the bucket. However, tube-wells are not. As a result, this programme will provide clean water for domestic use.

The financial analysis shows that the B/C ratio in the case of a 5 ha-farm with project is 1.242 on the condition that a whole set of a pumpset and other necessary materials are purchased and cropping pattern recommended by JADP is fully accepted.

REPORT

ON

IMPLEMENTATION AND DESIGN

FOR

SHALLOW TUBE-WELL PROGRAMME

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ABBREVIATION

ADBN	Agricultural Development Bank, Nepal
ADO	Agricultural Development Office or Officer
AIC	Agricultural Inputs Corporation
FIWUD	Farm Irrigation and Water Utilization Division
IAP	Intensive Irrigation Agriculture Programme
JADP	Janakpur Agriculture Development Project
JICA	Japan International Cooperation Agency
JT	Junior Technician
JTA	Junior Technical Assistant
STWP	Shallow Tube-well Programme

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	^oC	degree centigrade
%	per cent	FY	Fiscal Year
NRS	Nepal Rupees		

CHAPTER I

INTRODUCTION

CHAPTER I INTRODUCTION

I-1 Background of the Survey

JADP is envisaging progress of agricultural production in the whole areas of Janakpur Zone so that its staff worked out the Long-Term Plan of Janakpur Zone just before the termination of the former agreement, November, 1979. In that plan, the potentiality of abundant ground water in the Terai is given attention. Accordingly, JADP made its proposal: 'The Expanded Programme of Shallow Tube-Well Development in Janakpur Zone (Terai Area)', February, 1979. This proposal includes the actual schemes like water management, training etc.

On the other hand, according to the plan of ADBN itself, at present there are 5,873 on-going of planning wells of the Terai area in whole Nepal, and the component of it is as follows:

Project	Nos. of wells
(1) Fourth Credit Project	810
(2) Sagarmatha Project	1,530 tube-well and 1,380 dug wells
(3) JADP	1,000
(4) Third Credit Project	1,143
Total	5,863

The Fourth Agricultural Credit Project carried out by ADBN is sponsored or going to be spnnsored by various international institutions like IBRD and ADB (Asian Development Bank), and by the Department of Irrigation of HMG itself, and ADBN will start the following activities to organize the project in an effective manner.

(1) The executing agency is ADBN with many experiences and know-how in this field;

(2) ADBN will procure necessary materials or equipment and sell them to farmers;

(3) The Engineers hired by ADBN will give farmers any necessary technical advice including water management if any;

(4) ADBN will work out a plan for extension services;

(5) Geologists, related to ADBN, will make a manual concerning technical matters;

(6) ADBN will explain its activities for STWP to farmers; and

(7) Others.

For implementation of the above activities, the costs breaks down in the following table.

Table-3 Break-down of ADBN's Project

(Amount in Thousand NRS)

Project components	No. of Unit	Unit Cost	Total	F.C. 1/	L.C. 2/
1. Shallow tube-well with pumpsets 4" size	810	16.60	13,446	10,983	2,463
2. Pumpsets of 4" size	590	7.00	4,130	4,130	-
3. Spare parts for pumpsets at 10% of the cost of pump	1,400	0.70	980	980	-
4. Test well drilling	40	1.00	40	-	40
5. Training to ADBN Staff	36	1.70	61	-	61
6. Extension	1,400	0.25	350	-	350
7. Technical Assistance	1	1,330	1,330	1,152	178
8. Working capital					
a) Fertilizers	2,738	-	7,282	7,282	-
b) Diesel oil	1,230 K. Lit.	4.60	5,658	5,658	-
Total In NRS (thousand):			33,277	30,185	3,092
In US$ (thousand):			2,773	2,515	258

Source: The Fourth Agricultural Credit Project

Notes: 1/ : Foreign Currency
2/ : Local Currency

On the basis of the proposal worked out by JADP, the Japanese grant aid was embodied by the Exchange of Notes signed by both governments on the 22nd November, 1979 and this programme began.

Prior to the Team, JICA dispatched a hydro-geologist to survey the situation and the endowment of the ground water in the Terai for a short period in September, 1980, and it was found that there was a zonal belt with a great quantity of water described in the next chapter.

Accordingly, JICA is prepared to provide a portion of local costs necessary for construction of model farms in Janakpur Zone, in order to diffuse improved irrigation techniques through encouragement of STWP.

It is reported that the price of fuel for pumps have recently been increased. Putting consideration on the current situation of oil supply and its prices in this country, the Team made financial analysis for future expansion of the activities of STWP.

In order to design model farms, this Team surveyed those areas and prepared arrangement for the construction.

I-2 Main Purposes of STWP

Table-4 shows monthly data of precipitation observed at the Hardinath Agricultural Farm from 1971 to 1979. In the table, considering the standard deviations ($\sigma_{n-1}x$) of monthly rainfalls for 8 or 7 years, rainy season specially August is the greatest, and July and September follow. Although the ratio ($\sigma_{n-1}x/\bar{x}$) between the mean ($\bar{x}$) and the standard deviation ($\sigma_{n-1}x$) of August is low even below one (1), its standard deviation ($\sigma_n x$) is absolutely high. Consequently, the table suggests that the rainfalls during rainy season are very much fluctuated year by year.

Hence, additional water sources are necessary because of the following reasons.

Firstly, irrigation water should be supplemental sources against the fluctuation of rainfalls during rainy seasons and stabilize water supply and farm outputs in this region. Secondly, during dry season irrigation should bring additional water to add cropping patterns and to increase land intensity.

Table-4 Monthly Precipitation of Terai (1971 - 1979)

(Unit: m/m)

Month	1971	1972	1973	1974	1975	1976	1977	1978	1979	σ_x	$\bar{x}$	$\sigma_{x/m}$
Jan.		0.1	54.4	8.6	15.3	14.5	0	9.1	9.7	16.2	14.0	1.16
Feb.		28.6	10.7	0.5	9.2	0.4	1.3	5.9	25.6	10.4	10.3	1.01
Mar.		20.3	13.2	43.9	4.6	0	0	30.8	3.6	15.0	14.6	1.03
Apr.		10.0	15.2	33.7	21.6	2.5	77.1	43.0	70.4	25.8	34.2	0.76
May		20.2	207.0	110.6	24.6	112.3	75.8	136.9		60.6	98.2	0.62
Jun.		231.1	406.6	130.0	213.2	107.6	45.2	173.1		107.4	186.7	0.58
Jul.	269.9	210.0	200.9	721.9	782.6	257.4	305.1	239.6		221.4	373.4	0.59
Aug.	339.5	154.7	294.5	397.7	180.4	1,271.3	301.8	135.6		346.4	384.4	0.90
Sep.	106.0	343.9	123.0	168.5	284.7	107.0	62.4	361.2		110.1	194.6	0.57
Oct.	43.0	24.6	144.3	37.5	42.3	0.9	180.9	216.6		74.1	82.5	0.90
Nov.	0.1	5.4	0	0	0	0	45.4	2.8		14.7	6.7	2.20
Dec.	0	0	0.1	1.8	0	0	27.1	0.6		8.8	3.8	2.31

Table-5 shows cropping intensity in the whole territory of Nepal in the past ten years and it is found that these ratioes have had declining tendency or kept almost the same level.

Table-5 Cultivated Physical Area & Cropping Intensity

Year	Cultivated Physical Area (10^3 ha)	Total* Cropped Area (10^3 ha)	Cropping Intensity
1968/69	1,845	2,137.0	115.8
1969/70	1,980	2,193.1	110.8
1970/71	1,980	2,231.5	112.7
1971/72	1,980	2,265.2	114.4
1972/73	1,980	2,235.0	112.9
1973/74	1,980	2,328.5	117.6
1974/75	2,326	2,364.2	101.6
1975/76	2,326	2,410.0	103.6
1976/77	2,326	2,426.8	104.3
1977/78	2,326	2,481.2	106.6

Note: *:Cropped Area includes - Paddy, Maize, Wheat Barley, Millets, Potato, Sugarcane, Oilseeds, Tobacco and Jute.

Source: Department of Food, Agriculture and Marketing Services.

These figures mean only a single crop a year to be cultivated in a plot in Nepal. Although there are abundant water sources existing in the Terai Plain, the fields are kept idle for the two-thirds of a year. In order to increase cropping intensity, water to be pumped up and the idle fields during rainy season have to be utilized more effectively. Moreover, for more intensive farming, mixed cropping and relay cropping have to be taken consideration.

Table-6 shows the irrigated area in Janakpur Zone and in the Terai Plain the present irrigation ratio is only 16%. This figure has to be increased.

Table-6 Irrigated Area in Janakpur Zone

		Terai	Hill	Total
Cultivated land	(ha) (1)	244,600	26,500	271,100
Irrigated area present	(ha) (2)	39,000	6,000	45,000
Irrigable area in future increasing area	(ha)	30,250	2,450	32,700
Total	(3)	69,250	8,450	77,700
Present (2)/(1)	(%)	16	22	16.5
Future (3)/(1)		28	31	28.5

Notes: (1) The items of irrigable area in future

Shallow tube-well plan:	Terai	19,050 ha
	Hill	-
Minor irrigation plan:	Terai	11,200 ha
	Hill	2,450

(2) Irrigable area in future is quoted from Long-Term Plan of JADP.

Source: JADP

In general, when rural development or agricultural development in a certain area is planned, equity and income distribution should be taken into account through the bottom-up strategy. Table-7 shows that the average acreage of cultivated land in 3 districts in the Terai is a bit large than 1 ha. In places densely populated like the Terai, land productivity should be increased by external impact i.e. investment etc. Although a capital is scarce for small-scaled farmers, they can cooperatively share a single pump and carry out proper water management to economize costly water. As a result, the equal distribution of the riches in a society must occur gradually and, therefore, the more effective use should be made.

For this purpose, the steady extension system will be set up to diffuse water management and to organize the programme.

Table-7 Size Distribution of Farms in Janakpur Zone

(Unit: ha)

Nation	Less 0.1	0.1-0.3	0.3-0.5	0.5-1.0	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	5.0 over	Total
Dolkha	6,622	9,751	1,151	3,325	861	70	35	14	35	24,864
	(27)	(39)	(17)	(13)	(4)	(0)	(0)	(0)	(0)	(100)
Ramechhap	4,627	11,711	5,523	4,858	1,582	259	91	56	35	28,742
	(16)	(41)	(19)	(17)	(6)	(1)	(0)	(0)	(0)	(100)
Sindhuli	3,430	5,824	3,913	3,325	1,708	406	147	70	119	18,942
	(18)	(31)	(21)	(17)	(9)	(2)	(1)		(1)	(100)
Sarlahi	2,002	2,072	2,576	5,250	6,083	2,765	1,309	679	1,491	24,227
	(8)	(9)	(11)	(22)	(25)	(11)	(5)	(3)	(6)	(100)
Mahottari	6,223	8,106	5,754	7,994	8,036	3,955	1,820	987	3,003	45,878
	(14)	(18)	(13)	(17)	(17)	(9)	(4)	(2)	(6)	(100)
Dhanusa	4,242	6,888	4,634	7,098	7,385	3,227	1,596	665	1,071	36,806
	(11)	(19)	(13)	(19)	(20)	(9)	(4)	(2)	(3)	(100)
Total	27,146	44,352	26,551	31,850	25,655	10,682	4,998	2,471	5,754	179,459
	(15)	(25)	(15)	(18)	(14)	(6)	(3)	(1)	(3)	(100)

Source: National Sample Census of Agriculture, 1971/2 (District)

I-3 Survey Team

I-3-1 Members of the Team

Assignment	Name	Present Position
I. Negotiation Group		
1. Team Leader	Akira MORI	Chief, Farm Management Section, Chugoku Agriculture Experimental Station, Ministry of Agriculture, Forestry and Fisheries
2. Irrigation Engineering	Yasunobu MATOBA	Deputy Head, Division of Agricultural Development, JICA
3. Planning/ Coordination	Hidetoshi TAKAMA	Project Officer, Division of Agricultural Development, JICA
II. Design Group		
4. Irrigation Engineering	Toshikazu HIGASHIKAWA	Technical Staff, Irrigation Department, Nippon Koei Co., Ltd.
5. Land Consolidation	Soichiro YUMOTO	Technical Staff, Irrigation Department, Nippon Koei Co., Ltd.

I-3-2 Activities of the Team

Date	Activities
7th Sep.	Moved to Bangkok from Tokyo.
8th	Moved to Kathmandu from Bangkok and discussed its schedule with the Leader, Liaison and JICA Resident Representative.
9th	Discussed Irrigated Model Farm Scheme with both sides.
10th	Called on the Secretary of Ministry of Food and Agriculture, and visited the Embassy of Japan.
11th	Moved to Janakpur from Kathmandu.
12th	Discussed the selection of the sites (5) with Japanese experts and Nepalese officials, and made a trip to Iswarpur and Goshala.
13th	Made a trip to Saphy.
14th	Matoba (member), Hiratsuka and Esaki (experts) jointed to the Team.
15th	Surveyed.
16th	Surveyed.
17th	Surveyed.
18th	Moved to Kathmandu from Janakpur.
19th	Reported the result made by the Team to the Secretary.
20th	Holiday.
21st	Reported the result of the survey to the Embassy of Japan.
22nd	Moved to Bangkok from Kathmandu.
23rd	Observed the Irrigation Project in Thailand.
24th	- do -
25th	Back to Tokyo from Bangkok.

Note: The Design Group continued its survey until October 15.

CHAPTER II

BACKGROUND

CHAPTER II BACKGROUND

II-1 Situation of Janakpur Zone

Janakpur Zone is located, facing China in the north and India in the south. Topographically, the Zone is divided into the Terai Plain in the southern half and the mountains in the northern half. Consequently, the topographic difference causes socio-economic characteristics within the Zone.

Janakpur Zone belongs to the Central Zone of the kingdom and is located at its central-eastern part. It has 6 districts, namely, Dolakha, Ramechhap, Sindhli, Sarlahi, Mahottari, and Dhanusa and the latter 3 districts are in the Terai. It has approximately 1,200,000 inhabitants: 350,000 in hills and the rest in the Terai. In this Zone, there are two main rivers: the Bagmati River and the Kamla River.

Being close to Indian territory, this zone is economically active and is very important. It is very ideal tract for agricultural development. It produces enough food grains both for domestic consumption and for export. Main crops are rice, wheat, pulses, jute, tobacco and vegetables.

II-2 Agriculture in the Terai Plain

The Terai Plain stretches out from the east to the west with width ranging from 25 km to 32 km. It runs about 800 km long parallel to the Churia Hills. It is located at the height of 100 m to 200 m above the sea level. Nearly 48% of the population in the country lives in this zone.

In Janakpur, the characteristics in both the Terai and hills are mentioned in Table-8. As far as the ratio of cultivated-land is concerned, it is 64% in the Terai far more than the national average i.e. 14% but it is 6.7% in hills. Therefore, in the Terai 1 ha-farm can feed 11.5 persons but in hill 3.4 persons. The main food crops in this area are rice, wheat, maize and millet and cash crops are oilseed and tobacco.

Table-8 General Condition of Janakpur Zone

Area \ Item	District name	Area (10^3Ha) (1)	Cultivated land (10^3Ha) (2)	Ratio of cultivated land (%)	Number of village	Population (person) (3)	No. of household (4)	Persons per household (3)/(4)	Cultivated land/household (2)/(4)	Persons per area (3)/(1)	Persons per cultivated land (3)/(2)	Cultivated land/capital (2)/(3)
	Dolakha	198	6.0	3.0	38	130,022	25,306	5.1	0.24	0.7	21.7	0.05
Hill	Ramechhap	137	12.5	9.1	38	157,349	29,092	5.4	0.43	1.2	12.6	0.08
	Sindhuli	259	14.0	5.4	36	147,409	24,871	5.9	0.56	0.6	10.5	0.09
	Sub-total	396	26.5	6.7	74	304,758	53,963	5.6	0.49	0.8	11.5	0.09
Terai	Sarlahi	138	48.6	35.2	61	175,543	33,595	5.2	1.45	1.3	3.6	0.28
	Mahottari	125	95.8	76.6	55	324,831	62,249	5.2	1.54	2.6	3.4	0.29
	Dhanusa	119	100.2	84.2	68	330,601	64,454	5.1	1.55	2.8	3.3	0.29
	Sub-total	382	244.6	64.0	184	830,975	160,298	5.2	1.53	2.2	3.4	0.29
Grand total		778	271.1	34.8	258	1,135,733	214,261	5.3	1.27	1.4	4.2	0.24

Notes: Source Area: Agricultural Statistics of Nepal 1972
Population & household: Population Census 1971
Number of village: Taken from the FY of 77/78

Dolakha district is not included in the total.

The crop production in this area has not been increased in the past ten years, except wheat. Instead, the production of paddy has been decreased so far. This is because agriculture in the Terai is very much dependent upon rainfall, and it spoils farmers' will to go on field practices. It is very important not to rely on rainfall too much in order to improve farming.

Fortunately in this area it is found that there are abundant water sources beneath the Terai Plain and it is expected that it will bring more prosperity to this area.

II-3 Ground Water

Water resources in the Terai Plain are surface water and ground water. The former is, however, dried up during dry season of November to April while the latter is available throughout a year and is found in a relatively shallow layer. Self-flowing ground water is also available in the limited area and in such area, IAP is being promoted by JADP. Prior to the implementation of STWP, potential and depth on the ground water in the Terai Plain was studied in July, 1980 by Mr. M. Aiba[1/] who prepared "Report for Technical Guidance on the Shallow Ground Water Development and the Future Activities of IAP".

The hydro-geological circumstances in Janakpur Zone has been made partly clear from the studies on the ground water in the Sunkosi-Terai Project by FAO and those by JADP. The topography was divided into the following classes by FAO.

(1) Flood plain

(2) Alluvial fan
  (2)-1 Lower terrace
  (2)-2 Middle terrace
  (2)-3 Higher terrace

The alluvial fan vastly extends in the Terai Plain along the south of Churia Hill and of which the middle terrace spreads widely over Janakpur Zone. More than 30 deep tube-wells of FAO and JADP provide the geological information about this area. From the correlation of geological sections of deep tube-wells, shallow aquifer exists within 40 m from the ground surface as shown in Figure-2.

1/ : Ministry of Agriculture, Forestry and Fisheries, Japan.

Typical fan deposite of gravel and sand are predominant in almost geological sections in the northern part of the area and toward the south, the deposits get to be fine. So that, clay, silt and fine and medium sand come to be predominant in the southern part.

Ground water occurrence may be almost unconfined water in the north. As about 10 meters unpermeable layer of clay occurs as uppermost confining bed, ground water takes place weakly confined water in the south.

The thickness of shallow aquifer is presumed to be from 10 to 30 meters in the northern to central parts and about 5 meters in the south. The ground water tables of shallow wells made of bricks are shown in Figure 2.

It gets to be steeply deep toward north from 3 to over 20 meters from the ground surface in the area of above the contour line of 120 meters of ground height, on the other hand, it is remaining from 1 to 4 meters in the area of an elevation of below 120 meters.

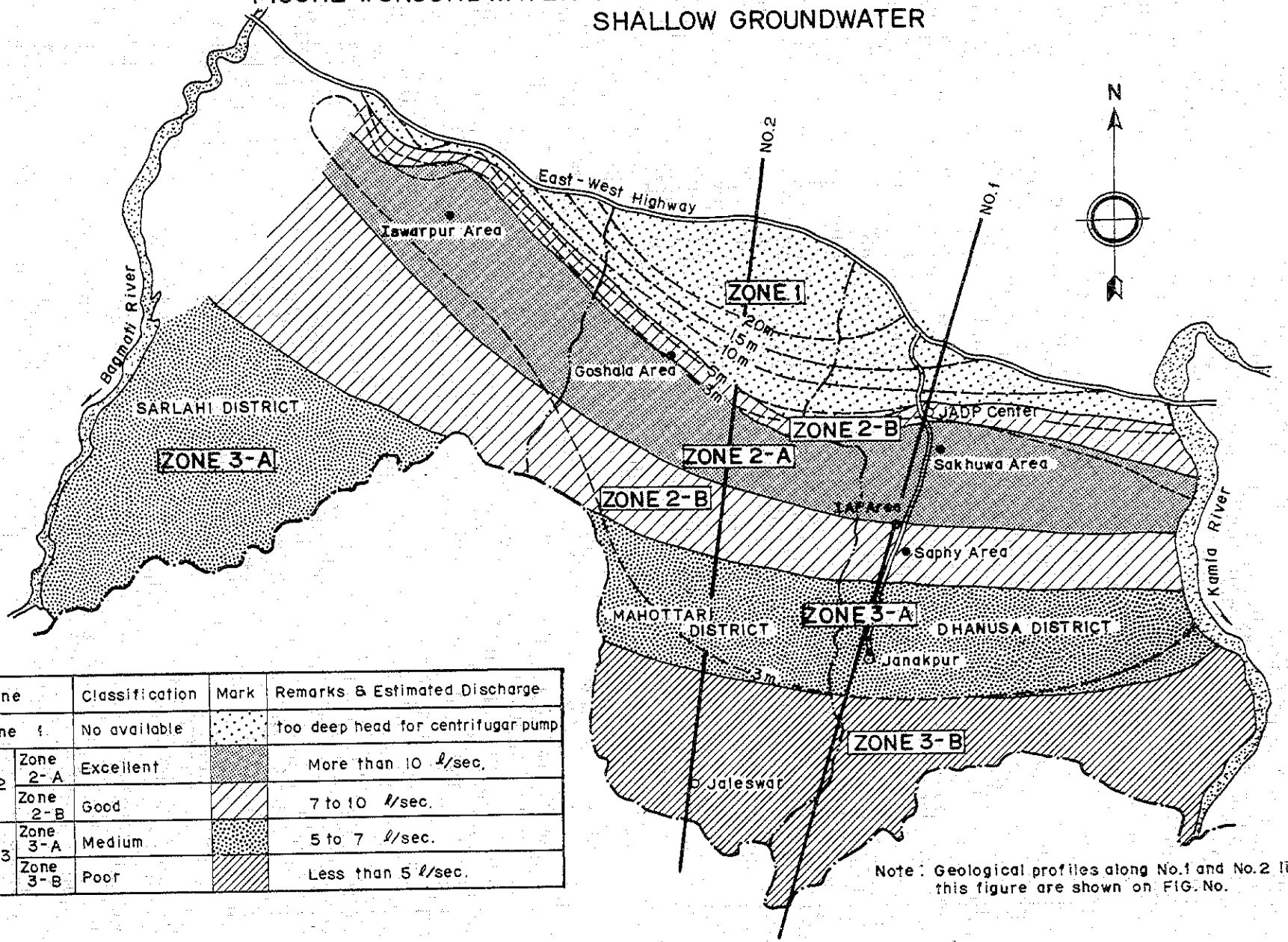
Thus, this area can be classified into several zones from both geology and ground water table for the convenience of planning of ground water development, as shown Figure-1.

The study on the situation of groundwater can divide this area into three zones of Zone-1, Zone-2 and Zone-3 as shown in Figure-1 according to the available amount of shallow ground water.

Zone-1 is no available for irrigation because of too deep ground water table for setting centrifugal pump. Zone-1 is composed of typical fan deposits of gravel and sand, but takes place more than 5 meters depth of ground water table and 20 m in maximum depth. It will show large seasonal fluctuation of water level from 3 m to 8 m.

Zone-2 is the most promising for shallow ground water development. For the convenience of considering expectable discharge, Zone-2 is further divided into Zone-2A and Zone-2B. Zone-2A may be estimated more than 10 ℓ/s of discharge and Zone-2B from 7 to 10 ℓ/s. Zone-2 is composed of mainly gravel and sand with thin silty and clayly layer and 1 m to 3 m of ground water table which has small seasonal fluctuation.

FIGURE-1. GROUNDWATER POTENTIAL & ISODEPTH CONTOURS OF SHALLOW GROUNDWATER

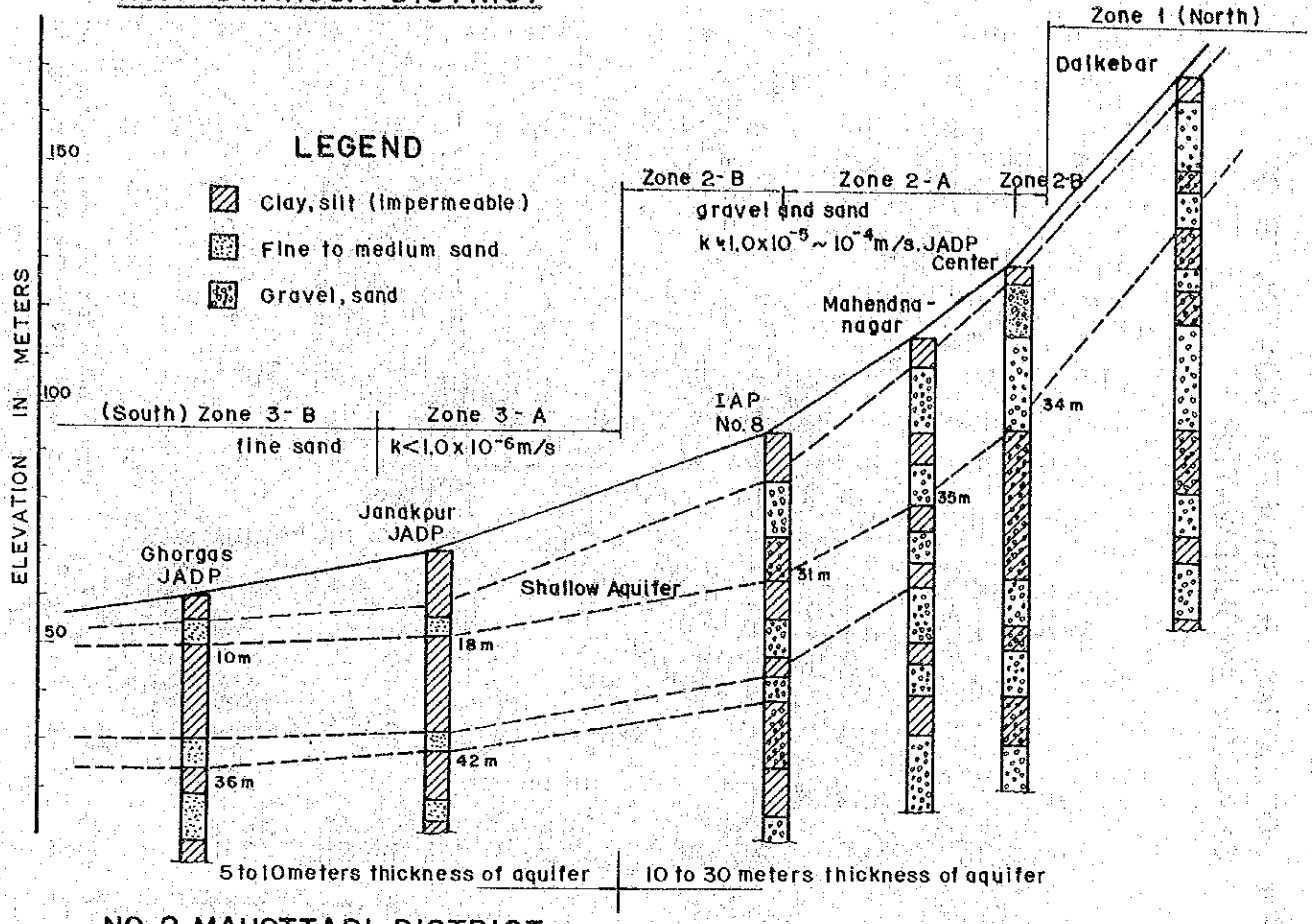


Zone		Classification	Mark	Remarks & Estimated Discharge
Zone 1		No available		too deep head for centrifugar pump
Zone 2	Zone 2-A	Excellent		More than 10 ℓ/sec.
	Zone 2-B	Good		7 to 10 ℓ/sec.
Zone 3	Zone 3-A	Medium		5 to 7 ℓ/sec.
	Zone 3-B	Poor		Less than 5 ℓ/sec.

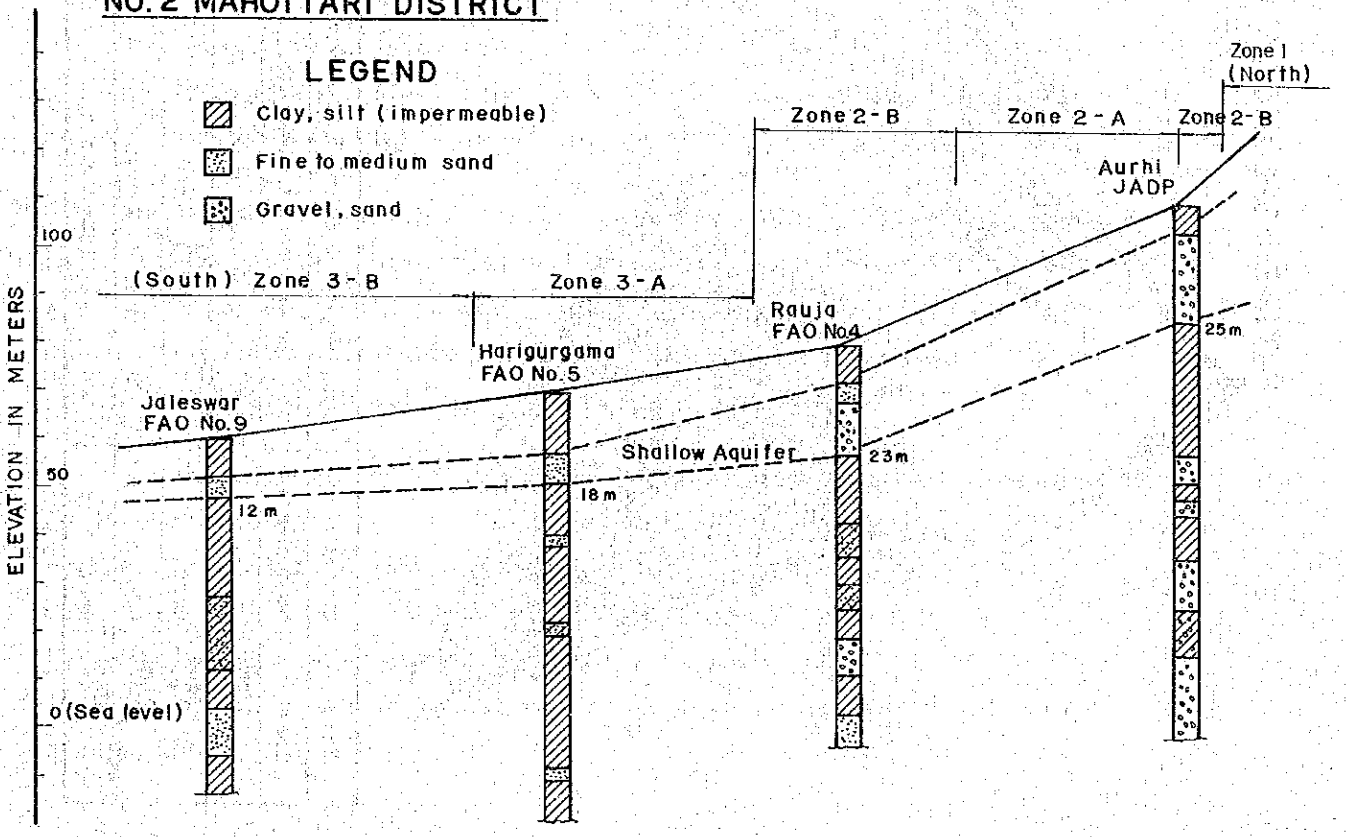
Note : Geological profiles along No.1 and No.2 lines on this figure are shown on FIG. No.

FIGURE-2. GEOLOGICAL PLOFILES

NO.1 DHANUSA DISTRICT



NO.2 MAHOTTARI DISTRICT



Zone-3 is slightly suitable in some area and almost impossible in some area, judging from economic consideration. Zone-3 can also be divided into Zone-3A and Zone-3B. Zone-3A may be expected from 5 to 7 ℓ/s of discharge and Zone-3B less than 5 ℓ/s.

In Zone-3, clay, silt and fine sand are predominant, so that good aquifer does not almost exist within 40 meters depth from the ground surface. The ground water table exists in 3 to 5 meters from the ground surface.

The Irrigated Model Farms for extension are all located in Zone-2. As to confirm the above classification and to get more detailed information on hydro-geology, Mr. Aiba suggested to carry out drilling survey in properly selected plots in this region.

II-4 Extension Services

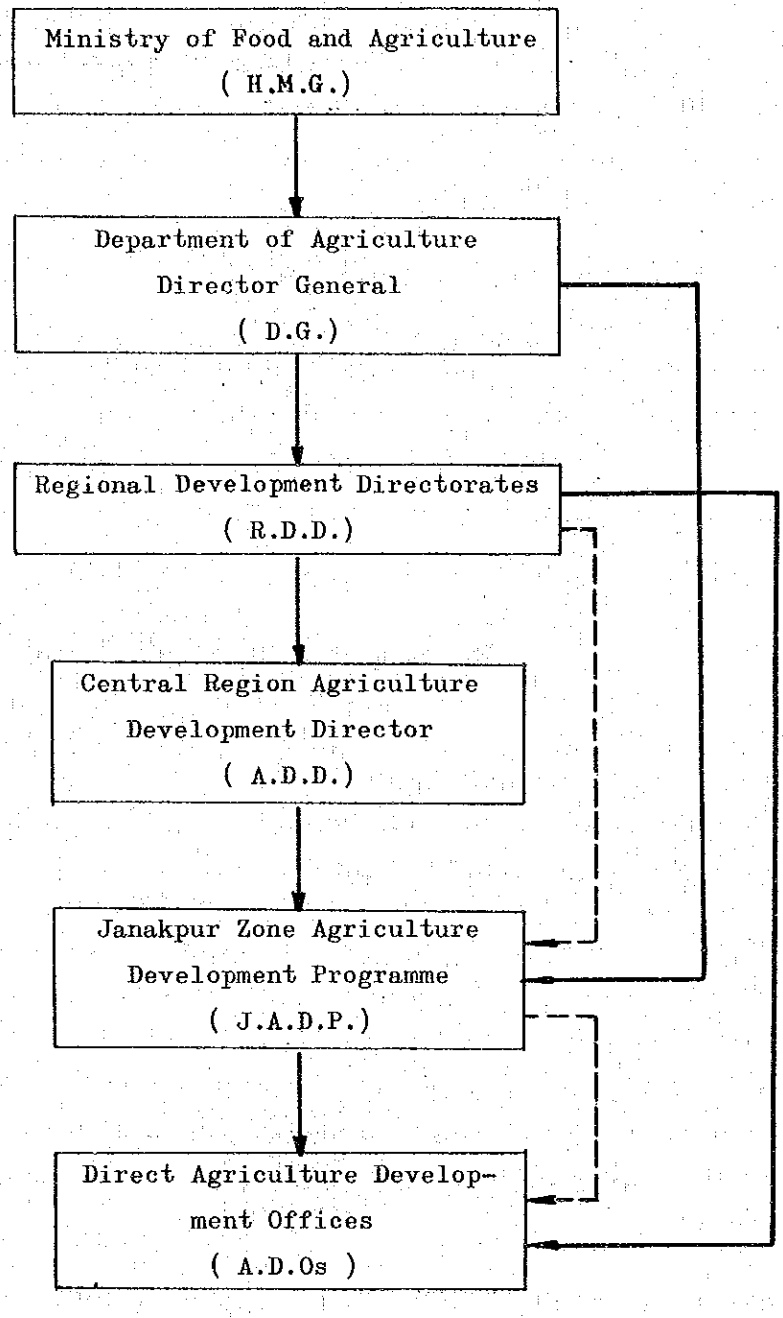
The following organization chart shows the machinery of extension services in Nepal. JADP stands just under the Regional Development Directorate (RDD) in the machinery but in practice it is under the supervision of the Director General of Department of Agriculture.

JADP covers the extension networks in the Zone. ADOs are spread over each district and theoretically they stand just under JADP, but practically they are controlled directly by RDD.

In a district there is one ADO (Agricultural Development Officer) and down to a village (Panchayat). There are JT and JTA which are practical extension agents consulting with farmers. Under these agents, there are Agricultural Assistants (AA) who are assigned as assistant workers to the extension agents, and usually they are chosen among farmers. In the Irrigated Model Farm Scheme, the model farms were chosen by the ADO.

From now on, it should be important for JADP to build up the frame-work of effective extension services like training of farmers as well as extension workers themselves, development of extension resources, fostering of local communities and planning.

Figure 3 Organization Chart



II-5 Activities of AIC and ADBN

AIC was established in 1966. It is a governmental organization which provides agricultural input materials like small-scaled pumps, fertilizers, chemicals, implements, improved seeds, etc at reasonable prices.

In detail, the activities are as follows:

(1) Provision of fertilizers and chemicals like pesticides etc.;

(2) Provision of improved cereal varieties;

(3) Provision of small-scaled pumps and farm implements; and

(4) Purchase of improved seeds from government-owned or contracted farms, and selection, sterilization and delivery of them.

In the nationally wide system of delivery of these materials, the bottem structure in the village-level is likely to be very firm. The Sajha Society can be seen in the Terai and it is so active that it has its own warehouses to keep farm materials. It carries out several activities: firstly to lend a production and a living loan; secondly, purchases farm outputs and sells inputs; thirdly, to purchase and to sell living necessity; lastly, to deal with savings.

In STWP, the pump-sets brought from Japan, will be delivered to the Sajha through AIC, and they will be kept in its warehouses. Then they will be handed over to farmers.

ADBN is, to some extent, a governmental bank because its capital is shared largely by the government (86.34%, 1970/71), and the rest of it is shared by commercial banks, cooperatives and individuals.

The list of interest rates by items shows in Table-9, and ADBN can lend even production loan to individual farmers. The rate is dependent upon whoever individuals or cooperatives. In this table, it is found that the pump-sets will be lent at 11% to be purchased.

Table-9 Agricultural Development Bank, Nepal

Interest Rates on Loans

Purpose	Interest % per Annum
1. For Co-operatives and Sajha Institutions	
a) Special Projects	4
b) Cardamom, Horticulture, Tea and Cotton Cultivation	4
c) Livestock, Poultry, Fishery, Sericulture and Bee-keeping	7
d) Agro-based Industries	7
e) Other Agricultural Loans	10
2. For other Institutions and Individuals	
a) Special Projects	6
b) Cardamom, Horticulture, Tea and Cotton Cultivation	8
c) Livestock, Poultry, Fishery, Sericulture and Bee-keeping	11
d) Agro-based Industries	11
e) Other-Agricultural Loans	14 (maximum)
3. Overdue Loans	As Fixed by ADB

Notes: 1. For the construction of farm level storage and establishment of Gobar Gass Plant.

2. For fixed Capital only.

Source: Agricultural Development Bank, Nepal.

CHAPTER III

STWP

CHAPTER III STWP

III-1 Outline of STWP

As mentioned before, STWP organizes several schemes, and it is an integrated programme.

The Board Meeting, which decides important matters on JADP, already determined establishment of the Central Committee and the Executive Committee respectively. Both committees consist of members related to STWP including staff from ADBN, AIC, JADP and Ministry of Food and Agriculture.

The following matters should be immediately decided at either committee:

(1) A price of pumpset and a condition of a loan;

(2) Forming of framework and selection of the target farmers;

(3) Extension activities of shallow tube-well irrigation;

(4) Confirmation of each sector concerned;

(5) Working-out of its practical schedule;

(6) Establishment of the cooperative working systems between Japanese experts and counterparts.

The Embassy of Japan in Kathmandu signed the Exchange of Notes on grant aid for STWP on the 22nd, November, 1979. The following machinery and equipment in Table-10 were or will be sent to Janakpur by the end of next January. The amount of these machinery and equipment reached 500,000,000 yen on the CIF Janakpur basis.

Especially, the machinery and equipment include drilling rig and measuring instrument so that this programme would be promoted very effectively with the more strength of its mobility. In the long-term plan of JADP, totally 1,000 pumpsets including 400 for this year will be sent to Janakpur.

Table-10 Machinery and Equipment under Food Production

Items	Quantity	CIF Janakpur (¥)
Truck mounted drilling rig	5	220,610,750
Pumpsets and pipes	400 sets	201,399,250
Measuring instrument	1 set	2,980,000
Cleaning vehicles	3	40,100,000
Communication jeeps	3	7,460,000
Camping equipment	1 set	5,760,000
Mud powder	74 tons	21,690,000
Total		500,000,000

In this programme, ADBN is dealing with loan services. Its condition for providing loans to farmers is same as it of the Fourth Agricultural Credit Project as shown in Table 11, but it may be worried that a Japanese pump at the price of about NRS 13,000 will exceed the limit of the loan of ADBN. The limit is NRS 7,000.

The interest rate is so high i.e. 11% a year that farmers will face difficulty in investing it. Table-11 shows the conditions of a shallow tube-well and a pumpset.

As far as extension services are concerned, JAPD deals with them. The participants to be trained by JADP are JT and JTA as well as farmers who will get pumps. The irrigated model farms as the main resources for extension were designed in the next chapter.

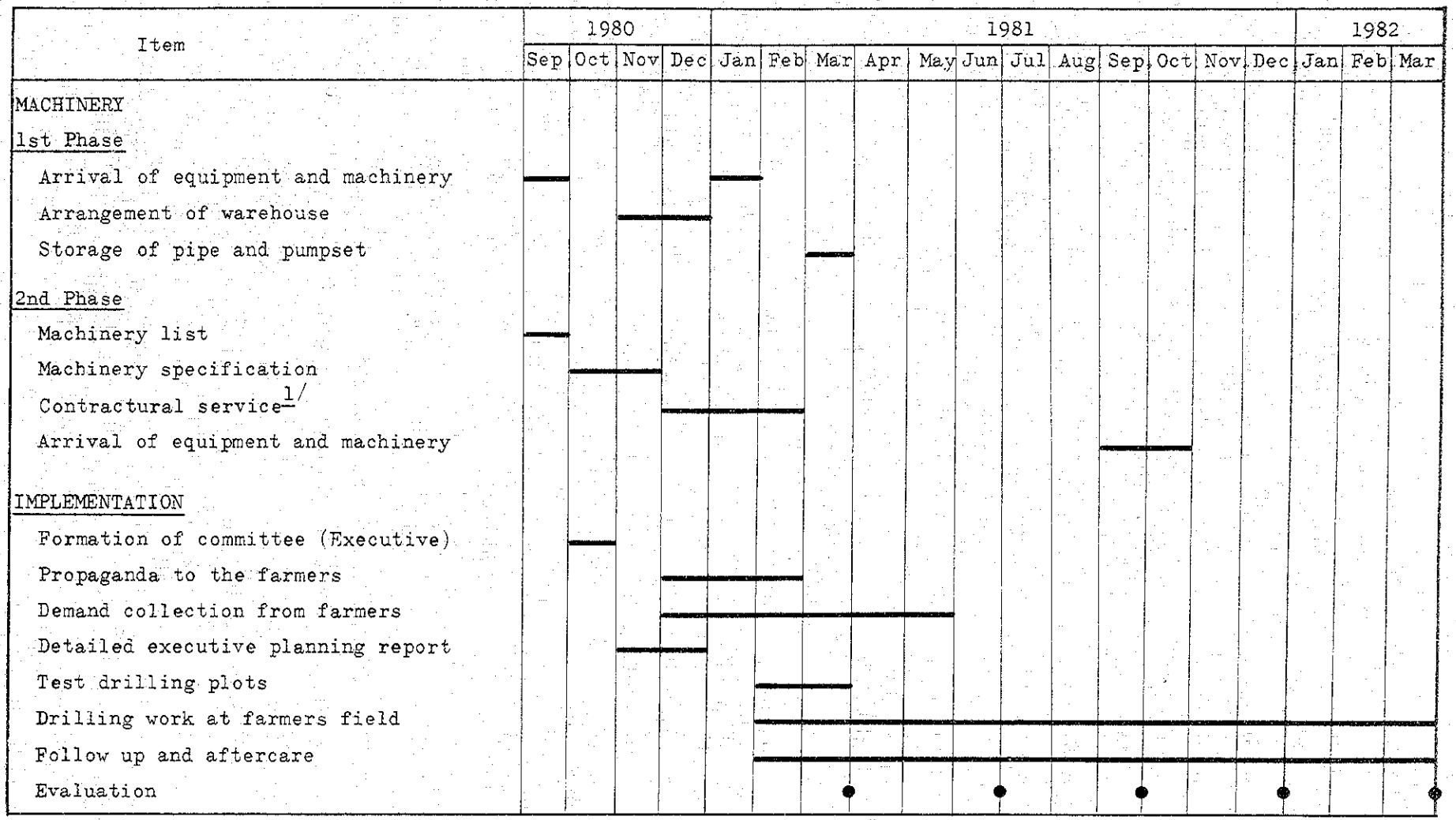
The schedule of STWP made by JADP is shown in Table-12.

Table-11 Conditions of a Loan from ADBN for STWP

Condition	Shallow tube-well	Pumpset
Eligibility	A farmer with more than 1.5 ha to be irrigated by this.	A farmer with more than 0.67 ha to be irrigated by this.
Unit cost	NRS 16,600 excluding contingency NRS 7,000 for pumpset NRS 9,600 for shallow tube-well	NRS 7,000 excluding contingency and spare parts
Limit of loan	Pumpset 100% NRS. 7,000 Shallow tube-well 85% NRS 8,160	NRS 7,000
Interest rate a year	11%	11%
Term of loan	Not exceeding 7 years	Not exceeding 5 years
Annual installment	NRS 3,217	NRS 1,894
Security	Fixed assets (land & building)	Fixed assets (land & building)
Remarks	Buying pumpset & well the same time	—

Source: The Forth Agricultural Credit Project.

Table-12 The Schedule of Concerning Work and Procedure



1/ : This has a effect on the arrival of machinery. It is desirable to be finished.

III-2 Financial Analysis

III-2-1 Existing Problems

Existing problems facing STWP are as follows:

(1) Farmers will pay water costs;

(2) The fuel costs are very high and increasing;

(3) Farmers are not used to cooperative water management if a pump is shared by several farmers. So far, any successful water management system has not been established yet;

(4) It is possible that if farmers are frangemented, all the farms would not be irrigated by a single pump;

(5) In Nepal, rice price is low or compared with fuel cost, or fuel cost is higher;

(6) Small farmers can not afford to participate in this programme;

(7) Irrigation technique has not been established by crops and by individual regions separately;

(8) The framework of extension services for the STWP has not been made yet, and

(9) The interest rate of a loan provided by ADBN is very high for small-scaled farmers.

III-2-2 Financial Analysis

A farmer's introduction of a pumpset and necessary materials in the Terai should be very big investment, and the operation & maintenance cost for diesel would be a very heavy burden for him.

This analysis does not focuse on evaluation of the whole programme but that of a farmer's level. It is remarkable that diesel has been increased double in last two years, and it will definitely be crucial. Therefore, it is necessary to carry out sensitivity analysis in which the diesel costs are a variable factor.

In ascertaining financial feasibility of providing shallow tube-wells and pumpsets under the programme the following assumptions, factors and situations were taken into consideration:

(1) The Irrigated Model Farm Scheme has been set up four shallow tube-well model farms in Terai, Janakpur Zone. Financial analysis on two model farms was done in their current conditions.

(2) Whatever the tube-wells and pumpsets will be provided on rental basis or not, the costs of well and pumpset were taken at assuming prices which were discussed with the JADP, i.e. NRS 3,000 and NRS 13,000 and cost towards purchase of spare parts for pumpset at 10% rate every three years was also included in the investment cost.

(3) The life of shallow tube-well is taken at 10 years which is inclusive of casing pipe and strainer. That of a pump is 7 years. They are authorized by ADBN.

(4) In the operation and maintenance cost, fuel consumption was taken at 1.5 kg/hr according to the test data of Yanmar Diesel Co., Ltd. The current cost of diesel is NRS 4.6 per one kg. Moreover, lubricants are used at 10% of it. Therefore, the cost of operation of pump is NRS 7.59 per an hour.

(5) In the production cost, the costs of cultivation and gross income have been taken at current price level.

(6) The present value of individual components was computed at 11% annuity factor over their life.

(7) The labour charge was taken at NRS 6 per a day.

The contents of the case-study are as follows:

Number	Farm	Type	Command area
No. 0	Example of ADBN 1/	General 2/	5.0 ha
No. 1	Standard in Terai 3/	General	5.0 ha
No. 2	Model Farm, Iswarpur	General	7.4 ha
No. 3	Model Farm, Sakhuwa	Intensive 4/	4.7 ha

Notes: 1/: The Fourth Agricultural Credit Project by ADBN.
2/: It is adopted to local conditions.
3/: JADP
4/: Land consolidation will be done in this plot.

No. 1 was designed by the agronomist of JADP and cropping patterns both at present and with project except No. 0 are shown in Figure-6.

Farms of No. 2 and No. 3 will be constructed for Irrigated Model Farms at the expenses of JICA. These fields have been carefully selected by JADP with helps of ADOs, bearing in mind that the sites should be:

(1) Located in the ground water potential zone which is defined as Zone-2 in Mr. Aiba's report ;

(2) Located along a village road or main road for demonstration effects;

(3) Grouped together in a place for water management;

(4) Approached easily from a main road for cost saving of transportation of construction materials and equipment; and

(5) Free from the improvement of drainage conditions in down-stream area for the sake of cost-saving.

In the above table, the two figures of No. 2 and No. 3 acreages are different from them to be constructed for the model farms.

Appendix-D shows basic data concerning water requirement, production cost and expected production amount by crops on the 1 ha - basis. They are bases of computation for both financial and sensitivity analyses. From water requirement, total hours a year to use a pump can be got and then the quantity of diesel oil can be obtained. Next, the amounts of necessary inputs, labours and harvest are estimated according to experiences, and finally cost and benefit can be calculated.

B/C ratioes were obtained through two methods. One is the same method as ADBN used in the Fourth Agricultural Credit Project and this is called 'Annual-based Method' in this report. The equation of this method is as follows:

$$B \div \left\{ \frac{Iw}{\sum_{n=1}^{10} \frac{1}{(1+r)^n}} + \frac{Ip}{\sum_{n=1}^{7} \frac{1}{(1+r)^n}} + \frac{Is}{\sum_{n=1}^{3} \frac{1}{(1+r)^n}} + C \right\}$$

where,

B : Gross benefit

Iw: Investment cost for a tube-well

Ip: Investment cost for a pumpset

Is: Investment cost for spare-parts

r : Yearly interest rate i.e. 11%

n : Integer, 1 to 10

i.e. 10 for a tube-well, 7 for a pumpset and 3 for spare-parts. These numbers show terms of redemption for each item.

C : Costs including O & M cost & production cost.

This method means that yearly gross benefit is divided by yearly gross cost including annuity expense of investment cost.

The another one is called 'Discounted Method'. The life of the project is 7 years i.e. the term of redemption for a pump

This following equation shows this method:

$$\sum_{n=1}^{7} \frac{\Delta Bn}{(1+r)^n} + \sum_{n=1}^{7} \frac{In + \Delta Cn}{(1+r)^n}$$

where,

ΔBn: Incremental benefit in the n th year

In: Investment cost in the n th year

ΔCn: Incremental cost in the n th year

The incremental cost includes operation & maintenance cost and production cost.

In the discounted method, costs and benefits are picked out as tabled below:

Cost/Benefit	Item	Contents
Cost	Investment cost	In No.0, NRS 9,596 for a well, NRS 7,000 for a pumpset 1/ In No.1,2,3, NRS 3,000 for a well NRS 13,000 for a pumpset For Spare-parts, NRS 700 in No.0, NRS 1,300 in the rest
	Operation and maintenance cost	Diesel cost and lubricants
	Incremental production cost	Seeds, fertilizers and labours on the incremental basis
Benefit	Incremental benefit	Incremental harvest

Note: 1/: This is made in India. Either type has either advantage or disadvantage. Indian pumps have easy access to spare parts and are cheap. On the contrary, Japanese ones are more expensive but after-selling services will be better and speedier by JADP.

The following table shows B/C ratioes for both methods by cases. The flows of economics of analysis led to this table are in Appendix-B for discounted method and in Appendix-C for the annual-based method.

Case	Annual-based method	Discounted method
No. 0	1.29[1/]	1.055
No. 1	1.31	1.242
No. 2	1.23	1.085
No. 3	1.38	1.183

Note: 1/: The ADBN result, The Fourth Agricultural Credit Project.

All cases have more than one so that they can be satisfied at the present price situation. In No.2, although the figure of 1.23 is rather high in the annual-based method, the ratio of 1.085 of the discounted method is low. This is because the present cropping pattern is high i.e. 214%, and in the annual-based method gross benefit was taken but in the discounted method incremental benefit was taken into calculation. (It may be the same as in the case of No.0, but there was no data concerning this point.)

III-2-3 Sensitivity Analysis

As a means of risk allowance, sensitivity analysis was done allowing the one most likely to occur: an increase in diesel cost for pumpsets. Its situation is getting worse in Nepal due to the world-wide situation of supplying oil.

The following graph of Figure-4 shows the regressions of both petrol and diesel prices in the past five years in Nepal. These prices vary from place to place in this country, but because of the very small differences by regions, they did not affect this sensitivity analysis seriously.

The trend of the diesel-price increases can explain the following equation through the least square method.

$$y = 1.3143\ e^{0.2284x} \qquad (r = 0.913)$$

where,

y: Diesel price per a kilo in NRS

x: Year but x = 1 in 1976

Then, the increasing rate of it can be obtained as follows:

$$\frac{\Delta y}{y} = \frac{dy/dx}{y/dx} = \frac{y'}{y/dx} = 0.2284 \qquad (\because dx = 1)$$

For sensitivity analysis, four cases: 3%, 5%, 10% and 22.84% yearly increasing rates of diesel price in No.0 to No.3 were chosen and the following table shows different B/C ratioes of the discounted method.

Table-13 Diesel-cost Increases a Year and B/C Ratioes

Case	(Present) 1.00	Increasing Rate of Diesel Cost 1.03	1.05	1.10	1.2284
No.0	1.056	1.021	0.997	0.936	0.766
No.1	1.242	1.182	1.142	1.042	0.794
No.2	1.085	1.016	0.971	0.862	0.615
No.3	1.183	1.125	1.085	0.994	0.746

The increasing maintenance & operation cost caused by these increasing rates of diesel were also compounded every year for the 7 year-project life. Table-13 can be visualized in Figure-5.

In the Figure, these lines are not straight, strictly speaking, the angles show contents of farm management or farming practices of each case. The break-even points stand where the lines are crossing the line of y = 1 i.e. B/C ratio is 1. These points are respectively 4.9% yearly increase for No.0, 11.5% for No.1, 3.7% for No.2, and 9.5% for No.3. If the annual increase is 22.84% i.e. the past trend, the B/C ratioes will be respectively, 0.766, 0.794, 0.615, 0.746, so all are far below 1.

Figure-4 Price Regression of Petrol and Diesel

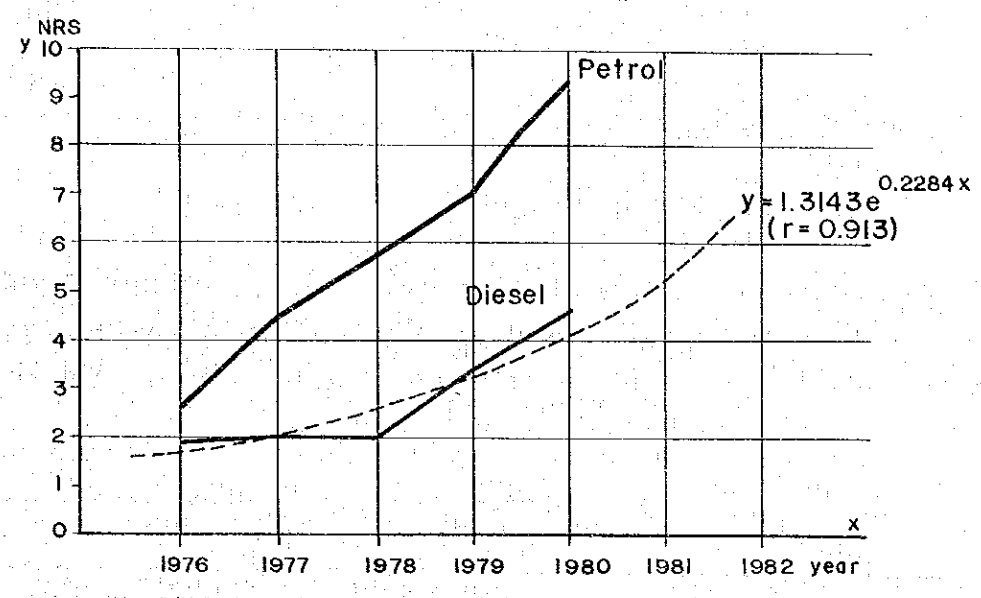
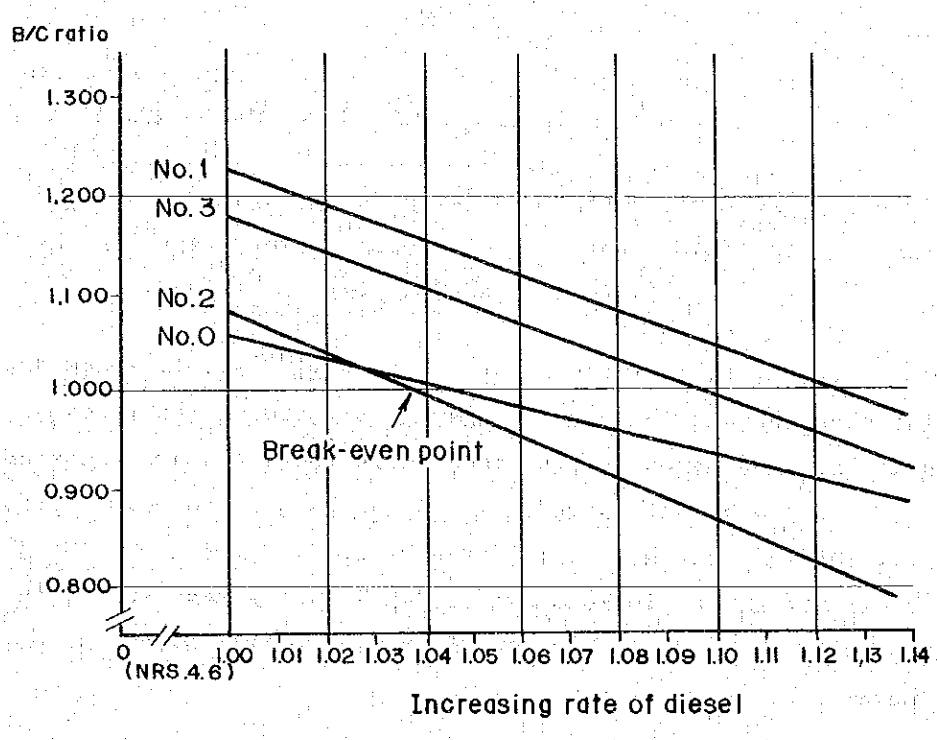


Figure-5 Relation between B/C Ratio and Diesel Cost



In the figure, it is remarkable that the line of No.0 is the most gentle among four. This is because No.0 is not seriously affected by the increase of diesel compared with the rest. In a word, in the case of No.0 the pump operation hours are the less.

III-2-4 Conclusion and Recommendation

Through financial and sensitivity analysises, it came to be judged that diesel price is very high in terms of farm outputs and vice versa. The comparison was made between Nepalese price situation and international one in the following table.

Country	Rice price per kg (A)	Diesel price per kg (B)	(A)/(B)
Nepal	NRS 1.5	NRS 4.6	33%
International	U.S.$ 0.3535 1/	¥ 104 2/	75%

Note: 1/: Average price of Thai rice in FOB in 1978

2/: Retail price in Tokyo in September, 1980.
This may be international price. US$1 equals ¥220.

The ratio, (A)/(B) of Nepal is 33% and is not optimistic at all in comparison with the international ratio of 75%. In Nepal, a rice bowl of 3 kg can be exchanged to diesel of only 1 kg.

Therefore, the following administrative measures may be taken:

(1) To slide farm-output prices to increasing price of input to secure farm economy; and

(2) To subsidy and to stabilize the supply of diesel.

In practice, the following measures should be taken at the farm-level:

(1) To introduce more profitable crops like tobacco and wheat into the present cropping pattern to raise farm income;

(2) To carry out 'water-saving cultivation practice' for the sake of saving costly water and maximizing its effect; and

(3) To sell water to neighbouring farmers in order both to get water charges for pump-owned farmers and to extend benefit to others.

In financial analysis, it is likely to estimate as much quantity of water as possible to maximize farm outputs for at least 3 cases: No.1, 2, 3, but it would not be realistic at all. 'Water-saving cultivation practice' above means to find the point of marginal productivity of costly water and to economize it.

At last, turning eyes to estimated pump-operation hours by cases, they are as follows:

No.0:	1,000 hours	(5.0 ha)
No.1:	2,017 hours	(5.0 ha)
No.2:	3,797 hours	(7.4 ha)
No.3:	1,769 hours	(4.7 ha)

As mentioned before, No.0 was estimated by ADBN and the rest by JADP. The JADP's one: No.1 is more double than No.0. Therefore, JADP should rethink of the pump's operation hours.

Additionally, according to the recent survey of existing farmers who use pumps in their farms, the operation hours are very few and they operate when they face crucial situations.

It may be so ambitious that JADP envisages 300% of cropping pattern with paddy yield of 3 metric tons per ha and wheat yield of 2.5 metric tons per ha. It will definitely require high level of technology.

III-3 Water Management

IAP has been a sort of pilot test for an irrigation project in the Terai Plain in terms of techniques as well as socio-economics. IAP is providing much data of these terms which are worth reviewing for future expansion and progress of irrigation projects either from ground water or from surface water.

Water management is very important where water is scarce and population is densed like the Terai Plain.

III-3-1 Irrigation Plan of the IAP Area

IAP comprises of 9 artesian wells which vary from 130 m to 200 m deep. The quantity of water from these wells is 124 ℓ/s far less than the expected amount of 153 ℓ/s. It is obviously deficit because the irrigation discharge per unit is supposed to be 1 ℓ/s/ha, equivalent to 8.6 mm daily water requirement in depth, with the command area of 420 ha. Moreover, the quantity is fluctuated season to season and it trends to be diminishing year to year. Therefore, it has come to be judged that the water should be used in an effective manner not to waste water as what it is and that water-saving cultivation should be introduced.

The main objective of the IAP irrigation plan should be to irrigate in rotation within the blocks and intermittently within the IAP area in order to supplement the shortage, in the way where the area is divided into 10 blocks. In the plan for irrigation, to meet demand and supply of water, the blocks are interdependently connected one and another. In the connection of this matter, Mr. Mikami, the former expert on irrigation of JADP, says in his report, 'The each well (block) is planned to be connected by the main canals, and the grade is planned to be so gentle: 1/3,000 that adverse currents are supposed to make proper allocation of water in the case of fluctuation of water amount of the each well and also each branch canal is planned to command approximately 30 ha.'

If this plan is embodied, the following points should be borne in mind:

(1) To work out the actual water management plan, taking account the socio-economic factors in the IAP area as a result of detailed surveys;

(2) To set up and foster water management organizations;

(3) To give trainings to those who participate in this programme; and

(4) To strengthen extension networks and services.

III-3-2 Basic Survey for Water Management Plan

Before the water management plan is worked out, the present situation of the IAP area should be cleared. And the following survey items are advised to be carried out:

(1) Preparation of Maps

Following maps should be prepared before construction in order to make the actual command area clarified:

i. Topographic maps;

ii. Cadastral maps;

iii. Water distribution diagrams; and

iv. Location of facilities.

(2) Distribution and method of intake

In the water distribution diagrams, flow charts and both of inflow and outflow from plot to plot should be drawn.

(3) Measurement of water in main canals

The water-levels and the discharge amount should be measured at the each diversion point of canals for several times, during rainy seasons, dry seasons, harrowing, transplanting, rooting, and flooding stages respectively. These data will show both losses in canals and at management-level.

(4) Drainage

The water-level and the difference between plots and ditches should be measured at entrances of drainage ditches and tails of them for several times during the same respective periods as the above.

(5) Blocks and terminal drainage ditches

Shapes and coverages of each block, locations of paths and their width, locations of terminal and irrigation canals, and their width and their depth should be surveyed and be put in the maps mentioned in (1).

(6) Depth of required water and submerged water

Frequent surveys on depth of water during flooding stages should be carried out, taking account of the soil conditions and the terminal irrigation and drainage systems.

The average depth of water requirement in the sub-tropical zone with yearly percipitation of over 1,000 mm is adopted to be 1.0 ℓ/s/ha.

Since the present one is planned to be 0.36 ℓ/s/ha, which comes from 153 ha/420 ha, cropping rotation has been planned to be introduced, but in practice it will be very difficult. As a result, some ditches evidently have been deteriorating.

Therefore, the surveys on water requirement are so important for planning water management systems.

(7) Management

So far, there are no stoplogs or flash boards in the diversions. They are supposed to adjust the water amount. Although it is economical and simple to use soil in the fields for its adjustment, it may not correctly keep a certain level of water.

(8) Soil survey

This should be carried out along with the survey on (6). The soil survey done so far must be sufficient.

(9) Field management

In the IAP area, the farmers freely grow crops within the present framework until the irrigation works will be completed. However, the situation of cropping and the intension of the farmers should be surveyed towards the benefit of the whole IAP area.

(10) Farmers' situation

Since water management is jointly carried out not only by JADP but also by the beneficiary: farmers, it is very important important to find out farmers' economic and social situations. The further study on them should be done.

III-3-3 Water Management Plan

The previous chapter suggests to save costly water pumped-up, and the water management plan should be worked out in full consideration of this factor and the above-mentioned survey data. This plan should include the expected amount of water, the adjusting methods, the time for distribution of water, the assignment of operators, the allocation of the cost occurred like diesel cost, the relation between JADP and the beneficiary, etc. Additionally, following measures should be taken:

(1) In order to keep more ground-water in the aquifer, valves should be put on the wells and be closed when water is not needed, not to waste water. Sequent use of the wells should be avoided and rotation cropping system should be introduced;

(2) In order of domestic use of water for villagers, taps should be installed on the wells;

(3) It is better to take off sands in the strainers in order to get more water effectively; and

(4) The survey on the amount of water from each well should be continued to be carried out to know the future availavility.

Since irrigation should be done timely in accordance with the growing stages of paddy, the varities have to be the same within the command area, to collectively conduct proper water management.

However, at present it is difficult to force it to the IAP farmers. Therefore, initially JADP ought to introduce collective water management within a certain coverage of plots step by step. Further, it is desired that the coverage should be enlarged and finally the collective and united water management organizations with a certain scale will be borne.

In order of smooth conduct of collective water management, it is very much necessary to install measuring devices in diversion points and gates to adjust the water amount. Simultaneously, how to handle these devices should be included in the training programmes of JADP and be taught.

III-3-4 Water Management Organizations

The IAP's irrigation plan is trying to conquer the absolute shortage of artesian-well water. Accordingly, the block were planned to be connected by the canals and cropping rotation and intermittent irrigation are being introduced block by block.

When the deep tube-wells were such, a committee with 5 members was established for individual well. Namely, chairman 1 person, water management 2, crop development 1, plant protection 1. However, although it has not worked well, it is inevitably needed to set up and to foster such cooperative organizations under the supervision of JADP.

It is proposed that inter-sectional organization including the Agronomy Section, the Extension Section, and the Irrigation Section ought to be set up within JADP to elaborate the plan and to execute it, and JADP should be responsible for organizing trainings and extension to farmers.