FEDERAL DEMOCRATIC REPUBLIC OF NEPAL
DEPARTMENT OF IRRIGATION
MINISTRY OF IRRIGATION

FEDERAL DEMOCRATIC REPUBLIC OF NEPAL

DATA COLLECTION SURVEY ON PROMOTING OPERATION AND MAINTENANCE OF IRRIGATION SCHEME IN TERAI

FINAL REPORT

October 2016

Japan International Cooperation Agency

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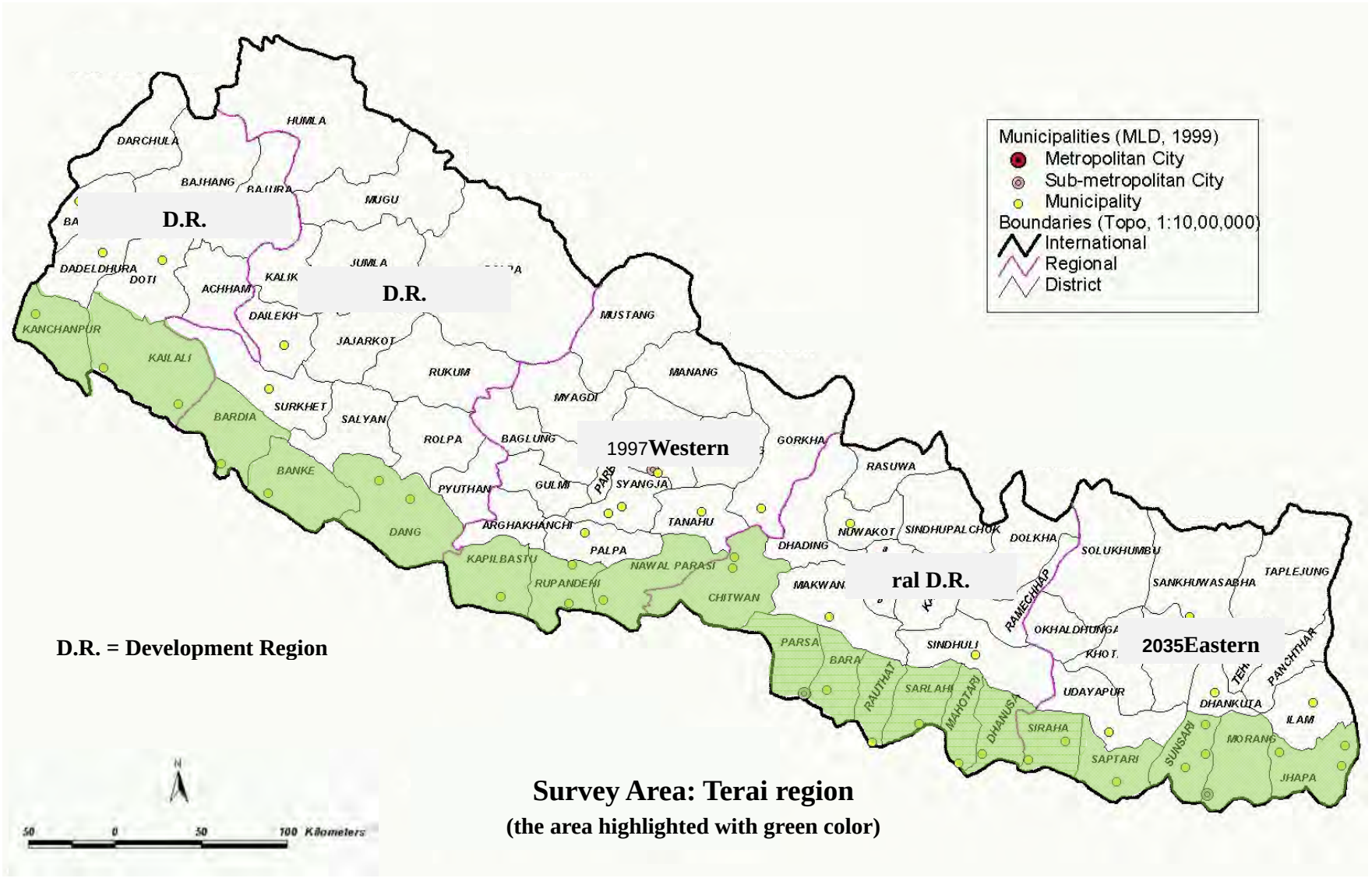

D.R. = Development Region

Survey Area: Terai region

(the area highlighted with green color)

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Acronyms & Abbreviations

ADB	Asian Development Bank
ADS	Agriculture Development Strategy
AMIS	Agency-managed Irrigation System
AO	Association Organizer
APP	Agriculture Perspective Plan
AVRSCS	Armed Violence Reduction and Strengthening Community Security
CBS	Central Bureau of Statistics, National Planning Commission Secretariat
CMIASP	Community Managed Irrigated Agriculture Sector Project
CMIASP-AF	Community Managed Irrigated Agriculture Sector Project - Additional Financing
DADO	District Agricultural Development Office, DOA
DDC	District Development Committee
DOA	Department of Agriculture, Ministry of Agricultural Development
DOI	Department of Irrigation, Ministry of Irrigation
DTW	Deep Tube Well
DPTC	Disaster Prevention Technical Center
DWIDM	Department of Water Induced Disaster Management
ET	Evapotranspiration
FAO	Food and Agriculture Organization of the United Nations
FGWID	Field Groundwater Irrigation Division
FIMD	Field Irrigation Management Division
FMIS	Farmer-managed Irrigation System
GDP	Gross Domestic Product
GESI	Gender Equality and Social Inclusion
GOJ	Government of Japan
GON	Government of Nepal
GWID	Groundwater Irrigation Division, DOI
IDD	Irrigation Development Division, DOI
IDSD	Irrigation Development Sub-division, DOI
IMD	Irrigation Management Division, DOI
IMT	Irrigation Management Transfer
ISP	Irrigation Sector Project

ISF	Irrigation Service Fee
IWRMP	Integrated Water Resources Management Project
IWRMP-AF	Integrated Water Resources Management Project -Additional Financing
JICA	Japan International Cooperation Agency
JICA-TCP	JICA's Technical Cooperation Project
JMIS	Jointly-managed Irrigation System
MOAD	Ministry of Agricultural Development
MOFALD	Ministry of Federal Affairs and Local Development
MOF	Ministry of Finance
MOI	Ministry of Irrigation
NISP	Nepal Irrigation Sector Project
NWP	National Water Plan
O&M	Operation and Maintenance
PIM	Participatory Irrigation Management
PNA	Peacebuilding Needs and Impact Assessment
SDE	Senior Divisional Engineer
SISP	Second Irrigation Sector Project
STW	Shallow Tube Well
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VDC	Village Development Committee
WB	World Bank
WECS	Water and Energy Commission Secretariat
WIDMP	Water Induced Disaster Management Program
WUA	Water Users' Association
WUG	Water Users' Group

Rs.	Rupee	Currency in Nepal (Rs.1=Yen 0.9604, as of Sept. 2016)

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Chapter 1 Background and Objectives of the Survey

1-1 Background of the Survey

Agriculture is one of the major industries of the Federal Democratic Republic of Nepal (Nepal). The percentage contribution of the Agriculture and Forestry Sector to the Gross Domestic Product (GDP) for the year 2013/2014 was 32.6%[1] and 65.6[2]% of the domestic labor population, respectively (aged between 15 and 60 years old). The stability and development of the agricultural sector in which the majority of the labor population has been involved is one of the priority issues that the Government of Nepal (GON) has been addressing, and well-functioning irrigation facilities are indispensable for such sectoral development.

The GON has continuously constructed irrigation facilities for a long time, with support from donors. Not only budget and technology provided by GON but also fund collected from water users as irrigation service fee (ISF) has been required to maintain such facilities. Thus, the collection of ISF is critical for the irrigation system management. In addition, it has been recognized the need for capacity development of water users' associations (WUAs) in the organizational development and in the technique for operation and maintenance (O&M)[3].

The view of GON on the irrigation development and management mentioned above is reflected in national policies, including the Agricultural Development Strategy (ADS) 2015-2035, which was approved by GON in September 2014. The ADS states the importance of the rehabilitation of the existing irrigation systems, the capacity development of WUAs, the expansion of irrigated area in the existing irrigation systems and the development of year-round irrigation systems. Such strategies are planned to be implemented, particularly, in the plain of Terai region where irrigated areas spread all over.

Nepal is divided into three regions from the points of view of geography and climate features: Terai region (60 - 300m above sea level), Hill region (300 - 4,000m above sea level) and Mountain region (4,000m and higher above sea level). The agriculture is mainly practiced in Terai and Hill regions. The former is the producing region of cereals, while the latter is that of vegetables, fruits and livestock products such as milk, through effective uses of small and narrow farming areas. Terai region consists of the plain of grain belt stretching from east to west in Nepal.

Very high percentages of major food crops to the national total production are produced in Terai region. The production amounts of rice, wheat and vegetables in Terai region accounts for 78.6%, 64.1% and 58.1% to the national total production, respectively[4]. Nepal has attained the self-sufficiency in crops in general since 2010/11: however, looking at rice, which is one of the staple foods for the Nepalese, it has not attained the self-sufficiency because the amount of imported rice keeps increasing for the last five years[5]. So as to attain the self-sufficiency of their staple foods, it is essential for Nepal to increase the rice production in Terai region, and this is feasible only when the maintenance of the existing irrigation systems in the region is

[1] Statistical Year Book of Nepalese Agriculture 2013/2014, Ministry of Agricultural Development (MOAD)

[2] Statistical Year Book of Nepalese Agriculture 2013/2014, MOAD

[3] The term of "O&M" is utilized in Nepal to stand for only the maintenance of facilities to keep them functional. Here and after, the term of "operation" will be utilized to stand for specifically the operation of facilities such as gates to distribute and deliver irrigation water to farmlands.

[4] Statistical Year Book of Nepalese Agriculture 2013/2014, MOAD

[5] Preparatory Survey on JICA's Cooperation Program for Agriculture and Rural Development in Nepal -Food Production and Agriculture in Terai- (2013)

given appropriately.

GON planned increases of food crop production and of farm income as agricultural development strategy for Terai region in the "Agricultural Perspective Plan (APP) 1995/96－2014/15". APP adopted, as means to implement such a strategy, the expansion of year-round irrigated area, the construction/rehabilitation of rural roads, an improvement of agricultural technology and extension services, and the strengthening of project implementation mechanism with the participation of beneficiaries and/or rural communities in addition to government agencies. Thus, the promotion of year-round irrigation in Terai region has formed an important part of national policies and may contribute to an increase in food crop production.

1-2 Objectives of the Survey

Based on the background mentioned in the previous section, GON has made requests to the Government of Japan (GOJ) for a Technical Cooperation Project of the Japan International Cooperation Agency (JICA-TCP) to develop capacity for O&M of irrigation systems in Terai region in 2011. After some discussions between the two governments, the Data Collection Survey on Food Production and Agriculture in Terai region (2012) and the Preparatory Survey on JICA's Cooperation Program for Agriculture and Rural Development in Nepal -Food Production and Agriculture in Terai- (2013) were conducted. Then, this time, the Data Collection Survey on Promoting Operation and Maintenance (O&M) of Irrigation Scheme in Terai (hereafter referred to as "the Survey") has been carried out.

The objectives of the Survey are (a) to examine the current state of irrigation projects in Terai region and (b) to examine Japan's cooperation strategy and its framework for technical cooperation projects, putting emphasis on the current state of O&M by both the Department of Irrigation (DOI) of the Ministry of Irrigation (MOI) and WUAs.

1-3 Target Region of the Survey

The new constitution was promulgated in 2015 and it divides Nepal into seven provinces. However, the five Development Regions, Eastern, Central, Western, Mid-Western and Far-Western, are still used as administrative unit practically. Terai region is not a development region and is, as seen in the previous section, one of the three regions established in Nepal based on geographical and climatic features: Terai (plain): Hill and Mountain. The five development regions are arrayed from east to west, while the three regions of Terai (plain), Hill and Mountain lie from south to north. In this report, Terai region refers to the geographical and climatic one mentioned above and not an administrative unit, except for the case particularly noted.

Terai region is composed of twenty districts as follows.

Table 1-3-1 Development Regions and Districts in the Survey Area, Terai region

Development Regions	Districts	Number
Eastern	Jhapa, Morang, Sunsari, Saptari and Siraha	5
Central	Dhanusha, Mahottari, Sarlahi, Rautahat, Bara, Parsa and Chitwan	7
Western	Nawalparasi, Rupandehi and Kapilbastu	3
Mid-Western	Dang, Banke and Baldiya	3
Far-Western	Kailali and Kanchanpur	2
Total		20

Source: Central Bureau of Statistics. 2014. Population Atlas of Nepal 2014

According to DOI, there is no distinctive difference among the five Development Regions in terms of irrigation and agriculture development plans.

1-4 Scope of the Survey

There are two antecedent surveys to this time Survey, regarding the requested JICA-TCP:

- Data Collection Survey on Food Production and Agriculture in Terai region (2012); and
- Preparatory Survey on JICA's Cooperation Program for Agriculture and Rural Development in Nepal -Food Production and Agriculture in Terai- (from January to August, 2013).

GON submitted the application for a JICA-TCP for the irrigation sector three times to GOJ, in 2011, 2012 and 2015. The following table shows outlines of the application and the antecedent surveys in chronological order.

Table 1-4-1 Outline of the Applications Related to this Survey Made by GON

Year/Topic	Application in 2011	Application in 2012	Application in 2015
Project Title	Enhancing Food Productivity by Farmer's Managed Small Irrigation Project (FMSIP) in Terai region	Irrigated Agriculture Strengthening Project	Project for Promoting O&M of Irrigation Systems in Terai Plain
Year	2012-2017	2013-2018	2016-2021
Target Area	3 Districts each from the 5 Development Regions (15 Districts)	Districts of Jhapa, Morang, Dhanusha and Mahottari (4 Districts)	20 Districts in Terai region
Overall Goal	Stable food production by the promotion of small scale irrigation	Promotion of irrigation and an increase in farmers' income	The O&M system that the project applied is adopted in other areas out of the targeted areas.
Project Purpose	Organizational development of WUAs and capacity development of government officers at the field level who are working for the agriculture sector.	Development of model irrigation schemes to be operated and maintained by WUA	The Irrigation systems are well managed and maintained in the target areas.
Activities	Construction of 65 small irrigation schemes, organizational development of WUAs, training to field engineers/officers (no mention of the water management within the command areas at the tertiary and lower level canals under the WUA's management)	Organizational development of WUAs, training to farmers on agricultural technology (assistance to the development of inventory and manuals on the water management within the command areas at the tertiary and lower level canals under the WUA's management	Organizational Development of WUAs and capacity development of DOI/IDD in O&M, establishment of model O&M systems, Strengthening the coordination and cooperation among stakeholders (assistance to the development of inventory and manuals on the water management within the command areas at the tertiary and lower level canals under the WUA's management)
Input	Dispatch of Experts, project operation costs, training costs (Costs for the construction of model irrigation facilities are counted as input from Japan)	Dispatch of Experts, project operation cost (no description on costs for the construction of model irrigation facilities)	Dispatch of Experts, project operation cost (no description on costs for the construction of model irrigation facilities)

Year/Topic	Application in 2011	Application in 2012	Application in 2015
Related Survey	Data Collection Survey on Food Production and Agriculture in Terai region (2012)	Preparatory Survey on JICA's Cooperation Program for Agriculture and Rural Development in Nepal -Food Production and Agriculture in Terai- (2013)	Data Collection Survey on Promoting Operation and Maintenance of Irrigation Scheme in Terai (2016)

Note: DOI: Department of Irrigation, IDD: Irrigation Development Division, WUA: Water Users' Association

Relationship between the Survey and the above two antecedent surveys are summarized as follows:

Table 1-4-2 Summary and Comparison of the Third Applications and Antecedent Two Surveys in the Past

TOPIC	2012 Survey	2013 Survey	This time Survey	Remarks of this time Survey
Target area	Not specified	Districts of Jhapa, Morang, Dhanusha and Mahottari (4 Districts)	Entire Terai Plain (20 Districts)	Field visits: 14 irrigation systems in 13 out of the 20 districts in total were visited. Number of Invited irrigation systems to the Workshop: 6 Targets for the Questionnaire survey[6]: FIMD：13 offices IDD/IDSD：20 offices FGWID：11 offices
Contents of TCP (overall)	Farm mechanization, seed improvement, extension services, marketing, irrigation policies, micro-finance (credit)	Extension services, micro-finance, farm mechanization, income analysis, agronomy	O&M of irrigation systems	Possibility of the inclusion of Farming components shall be further discussed
Contents of TCP (irrigation)	The construction of new facilities shall be considered for western area (due to the low coverage of irrigation), Rehabilitation of existing facilities (such as FMIS) shall be considered for eastern and central areas		Expansion of year-round irrigated area	Construction/ rehabilitation of facilities shall be undertaken by GON

Note: FIMD: Field Irrigation Management Division, IDD: Irrigation Development Division, IDSD: Irrigation Development Sub-division, FGWID: Field Groundwater Irrigation Division, FMIS: Farmer-Managed Irrigation System.
Source: Survey team

On the basis of results of the two antecedent surveys, the issues to be investigated through this time Survey were defined as follows, with the major focus of the Survey on revealing the current situation of the existing irrigation facilities in Terai region.

[6] Questionnaires were sent to FIMD offices for JMIS, and IDD/IDSD offices for FMIS.

Table 1-4-3 Items for This Time Survey and their Details

Items	Details
Present condition of the existing irrigation facilities	Information collection of individual systems which were not fully covered by the antecedent surveys ((1) sources of irrigation water, (2) conditions (good, rehabilitated, requiring a rehabilitation, with signals for the need for future rehabilitation, partially no functioning, etc.) and problems of the headworks as well as the main, secondary and tertiary canals
Implementation set-up (Distribution of roles)	－ Progress in the IMT process (agreement of the distribution of roles b/w GON and WUA in JMISs) － Demarcation of roles in the maintenance/development/rehabilitation of the irrigation facilities between the GON and WUAs (The 2013 survey mentions that the 2013 Irrigation Policy defines the cost sharing between the GON and WUAs in the construction, rehabilitation and repair of the irrigation facilities. This time survey reveals actual practices on the ground of the cost sharing.
Ability and willingness of farmers to pay costs of O&M	－ Interviews and questionnaire survey with representatives from WUAs (Number of WUAs, ISF collection status, WUA participation in the irrigation projects and O&M activities) (There is no detailed description on the actual situation of WUAs in the reports of the antecedent surveys.)

Notes: IMT: Irrigation Management Transfer, JMIS: Joint-management Irrigation System, IMD: Irrigation Management Division, IDD: Irrigation Development Division, WUA: Water Users' Association

Source: Survey team

1-5 Methodology of the Survey

1-5-1 Survey Period

The field survey was conducted for 90 days from 19th of June to 16th of September, 2016 in Nepal.

1-5-2 Survey Methodology

(1) Data and information on irrigation and irrigated agriculture in Terai region were mainly collected through questionnaires to the following 44 offices:

- 13 Field Irrigation Management Divisions (FIMDs)
- 20 Irrigation Development Divisions/Sub-divisions (IDDs/IDSDs)
- 11 Field Groundwater Irrigation Divisions (FGWIDs)

(Refer to Chapter 3 and Annexes for details of the questionnaires and their results.)

(2) The field survey of respective irrigation systems was carried out by visiting and interviewing DOI staff and WUA members (Refer to Chapter 4 for details of the field survey).

(3) Problem Analysis was carried out in the workshop held on 14th of August, 2016 at the DOI central office in Kathmandu (Refer to Chapter 5 for details of the workshop).

Chapter 2 National Policy and Development Plan of the Irrigation and Agriculture Sectors

2-1 Overview of the Country

2-1-1 Geography

Nepal is a landlocked country which lies thinly from west to east along the main part of the Himalayan Mountains. It faces the Tibet Autonomous Region of the People's Republic of China (China) in north, and the Republic of India (India) in south, east and west. The land area of the country is almost 14,720,000 ha (147,181 km^2. Approximately 885 km long from west to east and 193 km long from south to north), which is less than two fifth of Japan, and one point eight times large of Hokkaido.

83% of its land area belongs to Mountain and Hill regions, while the remaining 17% is Terai region which is the plain stretches along the international border with India in the southern Nepal (Figure 2-1-1). The majority of farmers in Mountain and Hill regions live on subsistence agriculture, but the production has been reducing recently due to land degrading and/or farm retirement. Meanwhile, owing to the sub-tropical climate and fertile soil, Terai region is the most productive granary in the country.

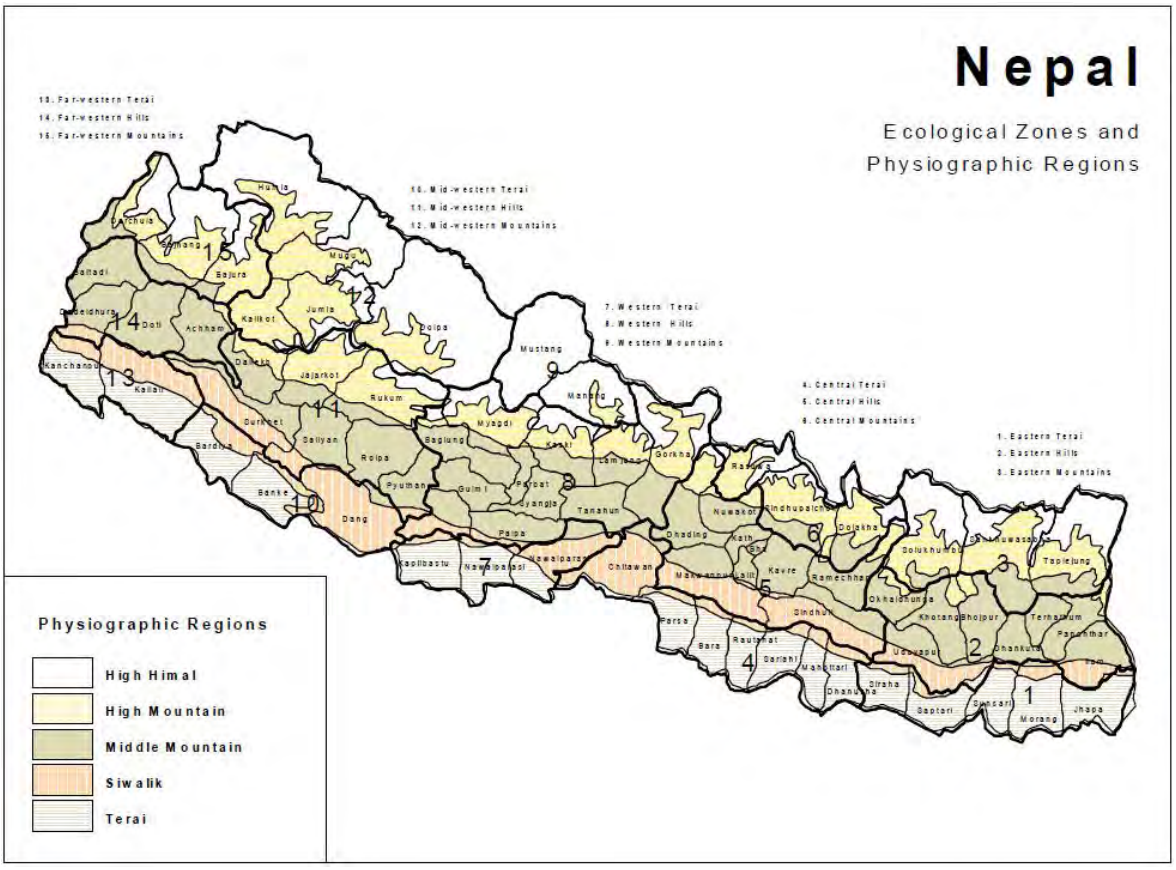


Figure 2-1-1 Ecological Zones and Geography of Nepal

Source: ADS published by MOAD

Looking at the land use of Nepal from 1991 to 2012, it is obvious that population increase has been affecting it (Figure 2-1-2). In this period, as the total population increased, other land uses than agriculture

and forest also increased. Meanwhile, the forest area has inversely decreased by approximately 1 million hectare and the agricultural land area seems to have remained as almost the same during these12 years. This fact indicates that the forest area has been converted into the agricultural land area and areas for other land uses, such as housing and commercial uses, however, the decline of forest area has not resulted in an increase of agricultural land area, and it would be difficult to increase agricultural land area from now onwards. Consequently, it is necessary to improve the land productivity of the existing agricultural lands in order to increase agricultural production. The expansion of the irrigated area and the promotion of year-round irrigation in the existing agricultural lands can be one of the possible measures to improve the land productivity.

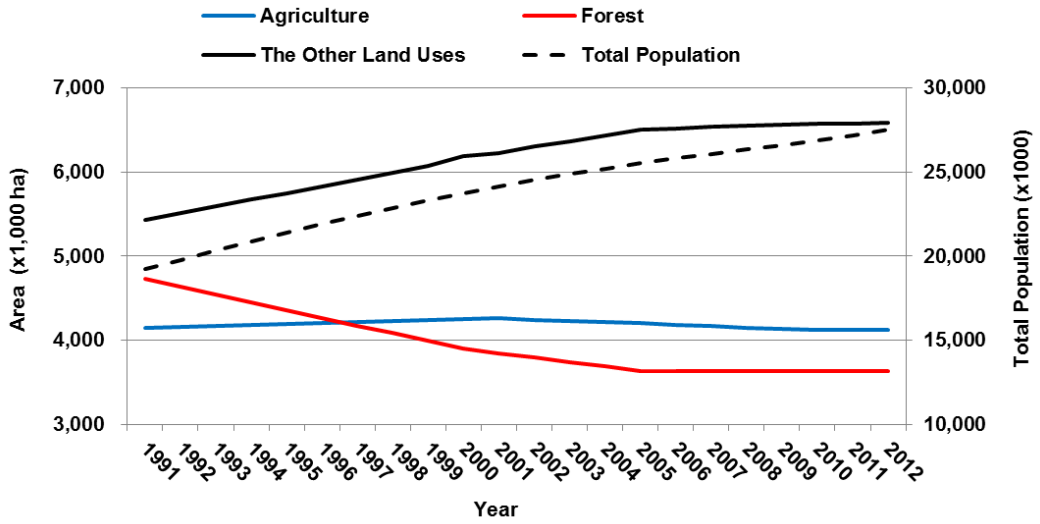


Figure 2-1-2 Trend of the land use in Nepal

Source: Total population from World Bank, the others from FAOSTAT

2-1-2 Climate

The land area of Nepal lies between 27°and 30°N in latitude, and in Japan the Ogasawara Islands and the Amami-oshima Island are located at almost the same °N in latitude. Although the entire country belongs to the sub-tropical climate zone, a variety of climate features can be seen within the country because of a wide range of elevation: from less than 100m in Terai region to the highest peak in the world, Mount Everest (8,848 meters above sea level). Such different climate conditions and elevations can divide Nepal into the following 3 regions:

(a) Terai region (from 60 to 300m high) under the subtropical climate;
(b) Hill region (from 300 to 4,000m high) under the temperate climate; and
(c) Mountain region (more than 4,000m high) under the alpine and cold climate.

The above three regions form continuous geographical features from south to north, and are located on the Himalayan mountain-building belt which lies on from the Indian Ocean to the northern Tibet high land. Himalayan oogenesis uplifted the geological formations of these regions made of sedimentary rocks. The mountain region, which has steep slopes called the Himalayan geological group, has extremely cold and arid climate. The Hill region is formulated with rocks of the Cretaceous-to-Tertiary Periods, and the Himalayan oogenesis left lots of cracks inside of the foundations. Therefore, landslides in mountain

slopes frequently happen and a huge amount of soils and stones are conveyed to downstream areas[7].

The skirts of Hill region are called Siwalik, which is composed of sedimentary rocks from the Tertiary period to the Pleistocene times. The foundation of the skirts is vulnerable to rainfall and causes slope/land slide every year. The Terai region is composed of alluvial soils conveyed from the Hill region[8]. As mentioned above, the geological features of Mountain and Hill regions (upper streams of Terai) are that they easily cause land slide and soil erosion. Accordingly, rain causes a lot of sediments in river water which flows down to Terai region during the monsoon season. Thus, irrigation systems in Terai regions are required to remove sediments as part of the important maintenance activities; the sediments are conveyed from Mountain and Hill regions by flood.

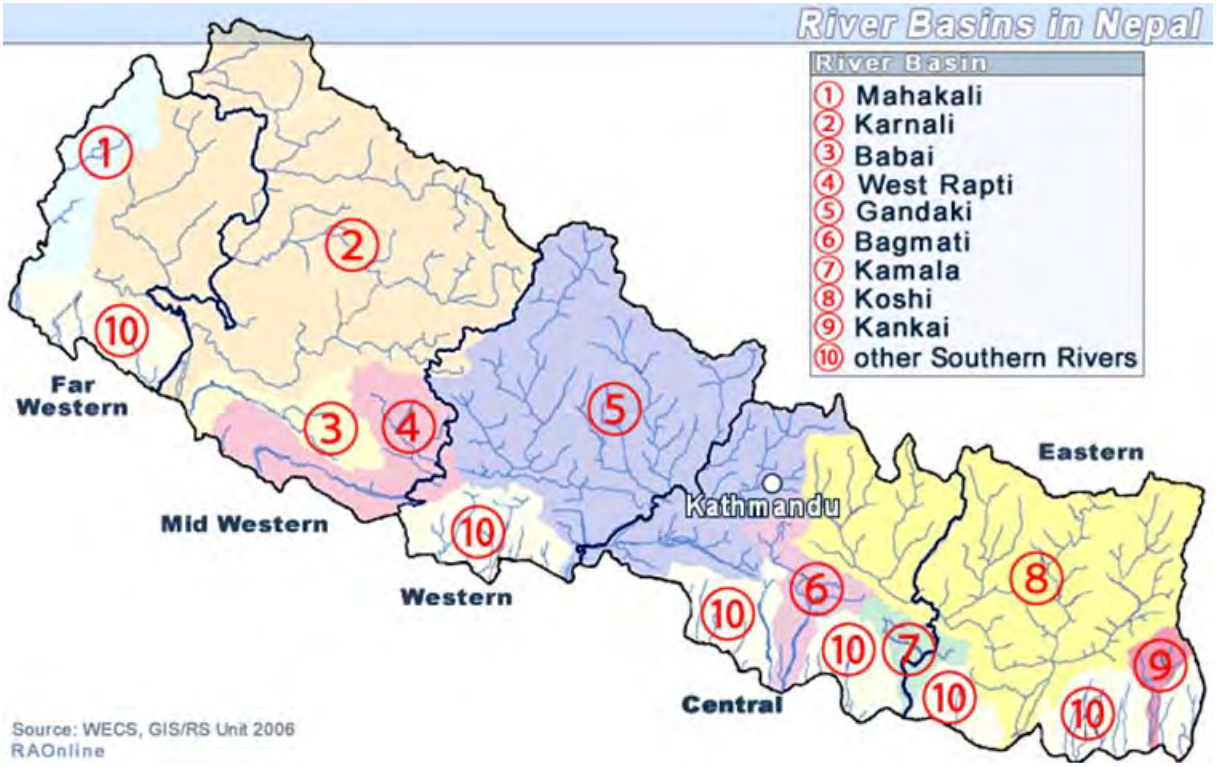


Figure 2-1-3 Rivers and their Basins in Nepal

Source: Website: RAOnline Nepal, http://www.raonline.ch/pages/np/npmaps01i.html, accessed in October 2016

There are 3 large river basins: Karnali (② in Figure 2-1-3), Gandaki (⑤) and Koshi (⑧), and also other small and medium river basins. Not to mention, the larger river basins have larger geologically vulnerable area against rainfall than smaller ones, because the larger river basins have larger Siwalik geological area. Therefore, large river stream includes more sediments than small and medium river streams. This implies that surface water irrigation systems in small river basins have less sediment in canals than those in large river basins.

[7] T. Yamamoto, et al. 1998. "The Movement of Sediments and River Improvement in Nepal" Journal of Japan Society of Civil Engineering, pp.309-314

[8] T. Yamamoto, et al. 1998. "The Movement of Sediments and River Improvement in Nepal" Journal of Japan Society of Civil Engineering, pp.309-314

2-1-3 Society and Economy

The International Monetary Fund (IMF) shows Nepalese economy, current national finance and their projection as follows (from Figure 2-1-4 to Figure 2-1-11).

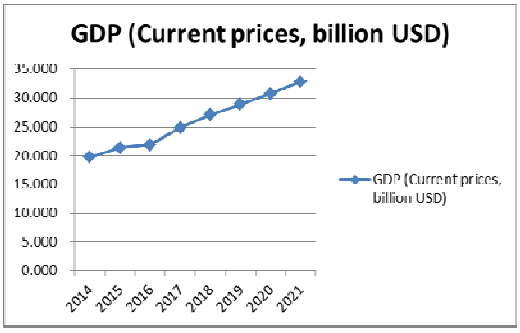


Figure 2-1-4 GDP

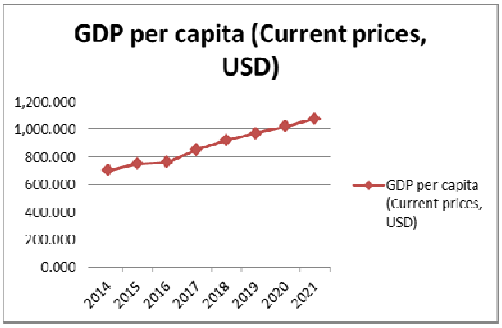


Figure 2-1-5 GDP per capita

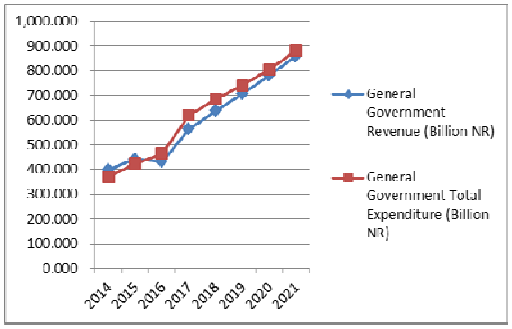


Figure 2-1-6 General Government Revenue and Total Expenditure

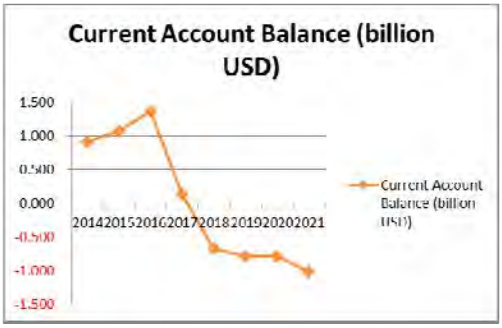


Figure 2-1-7 Current Account Balance

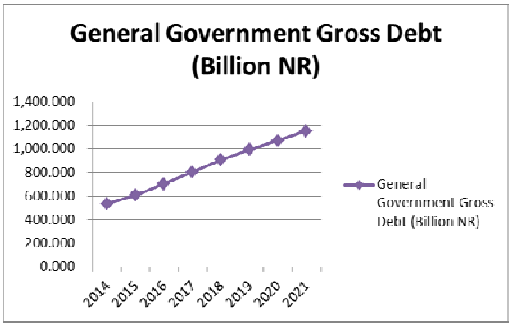


Figure 2-1-8 General Government Gross Debt

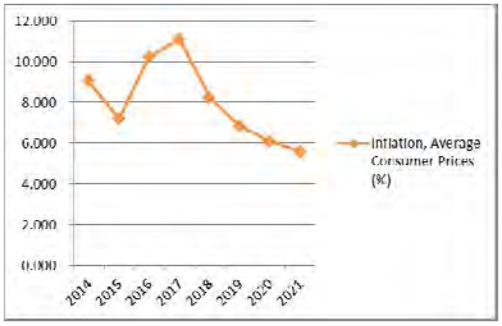


Figure 2-1-9 Inflation, Average Consumer Prices

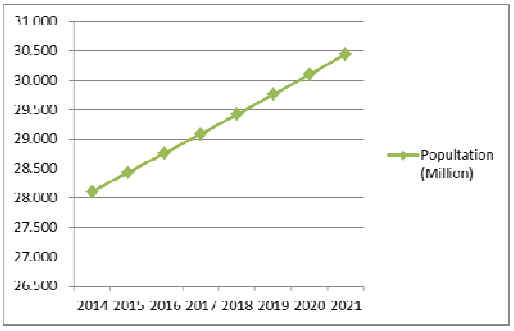


Figure 2-1-10 Population

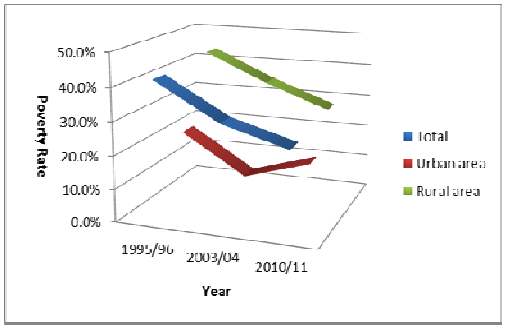


Figure 2-1-11 Poverty rates

Source of all the figures on this page: IMF. 2016. World Economic Outlook Databases April, 2016

The population is projected to keep increasing by 1.35% per year. GDP and GDP per capita also keep increasing. The inflation rate goes up once, but it will come down. However, it is predicted that the GON's current-account balance gets worse, causing the increased national debt. As for the poverty, it had showed the downward trend as a whole, but it is important to keep an eye on the trend continuously because the poverty rate in urban areas turned to the upward trend in 2010/11.

Table 2-1-1 shows basic statistics of Nepal.

Table 2-1-1 Basic Statistic data of Nepal

Item		Data / Value	Source
GDP（2015）		20,880,546 Thousand US Dollars	The World Bank (WB)
GDP per capita（2015）		732.3 US Dollars	
Exports of Goods and Services: Percentage of GDP (2015)		11.7%	
Imports of Goods and Services: Percentage of GDP (2015)		41.6%	
External Debt Stocks (% of Gross National Income) (2014)		20.0%	
Poverty Headcount Ratio at $1.90 a Day (2011 PPP) (% of population) (2010)		15%	
Poverty Headcount Ratio at $3.10 a Day (2011 PPP) (% of population) (2010)		48.4%	
Average precipitation in depth (mm per year) (2014)		1,500mm	
Life Expectancy at Birth (2014)	Total	69,6 years	
	Male	68.2 years	
	Female	71.1 years	
Population		26,494,504	National Population and Housing Census 2011
Sex Ratio (Number of males per 100 females)		91.6/100	
Population Density		180/km^2	
Working Age Population (Population between 15 and 59 years old)		57% (15,091,848)	
Annual Average Growth Rate of the Population		1.35	
Population Distribution	Terai region	50.27% (13,318,705)	
	Hill region	43% (11,394,007)	
	Mountain region	6.73% (1,781,792)	
Urban and Rural Populations	Urban Area (Population of the 58 Municipalities)	17%	
	Rural Area	83%	
Number of Individual Households		5,423,297 households	
Average Household Size		4.88 persons	
Female-headed Households		25.73%	
Source of Drinking Water	Tap / Piped Water	47.78%	
	Tube Well / Hand Pump	35%	
	Spout	5.74%	
	Uncovered Well	4.71%	
	Covered Well	2.45%	
Source of Lighting	Electricity	67.26%	
	Kerosene	18.28%	
	Solar	7.44%	
	Biogas	0.28%	
Caste / Ethnicity		125 Castes / Ethnicity	
Mother Tongue		123 Languages	
Literacy Rate	Total	65.9%	
	Male	75.1%	
	Female	57.4%	

Item		Data / Value	Source
Religion	Hindu	81.3%	
	Buddhism	9.0%	
	Islam	4.4%	
	Kirat	3.1%	
	Christianity	1.4%	
	Prakriti	0.5%	
	Others	0.3%	
Availability of the access to the Internet at the Household Level	Total	3.33%	
	Urban Area	12.11%	
	Rural Area	1.24%	
Availability of Mobile Phones at the Household Level	Total	64.63%	
	Urban Area	84.07%	
	Rural Area	59.98%	
Availability of Landline Telephone at the Household Level	Total	7.37%	
	Urban Area	22.66%	
	Rural Area	3.72%	

It should be noted that the population of Terai region accounts for 50% of the national population. Accordingly, the region is the key area for the development of the Nepal. Meanwhile, the male-female ratio of the region is approximately 90 to 100 (men is less than women), and the ratio of female householders is 25.7%, which seems very high. This is probably due to men's migrant working abroad. Therefore, the women's participation in irrigated agriculture is important.

The literacy rate has large difference between men and women. The literacy rate of males is 75%, while that of females is as low as 57%. The average rate of 66% covers the low rate of females, and it seems that the cause for the difference in the literacy rates between males and females attributes to gender discrimination. That is, sons are prioritized to be educated in the poor household rather than daughters. In the strong patriarchal system culture of Nepal, parents tend to think that educating daughters is wasting money since the daughter marries into another family. The number one reason that boys cannot go to school is "There is no school." that is approximately 25%, while that of girls is "their parents do not want to make them educated." that is approximately 40%[9].

As for information and telecommunication, the dissemination rate of fixed-line phone at the national level is only 7%, but that of cellphone is 65%. The dissemination of cellphone rate is 60% even in rural areas. Meanwhile, the national rate of access to the internet is as low as 3%. Thus, the cellphone will be very useful for information sharing and communication in the irrigated areas.

2-1-4 Food Balance

The proportion of the household suffering from food shortage to all the households in Nepal was 51% in 1995/96, and it drastically decreased to 16% in 2010/11. However, food deficit was seen in 32 districts out of the 75 in total, according to the agricultural production data from 2011/12 to 2013/14 (MOAD, 2016): Nepal: Zero Hunger Challenge National Action Plan (2016-2025)). Areas where the most serious food shortage occurred were the Hill and Mountain regions in Far- and Mid-Western Development Regions (ADS. p.32). The climate of these regions is relatively dry. Besides, the traffic system has not been well developed and farmers' access to the market is limited. Therefore, subsistence agriculture is

[9] Journal of Gender Studies, Ochanomizu Univ. Vol.11 (2008) "Gender Equality in Education: Experiences of Nepal to Achieve EFA Goal 5"

prevailing and farmers do not produce surplus foods. This is the background of the cause for the delay in agricultural infrastructure development in these development regions.

Meanwhile, in seven districts in Terai region from Eastern to Central Development Regions, food deficit due to unbalance between cereal production and demand within those districts has been reported. The unbalance may be attributed to a yield reduction due to river flooding over agricultural lands during the monsoon season, although it is not confirmed. Otherwise, it may be attributed to higher population densities in Eastern and Central Development Regions than in other development regions in the western part of Terai, although it is not confirmed, neither.

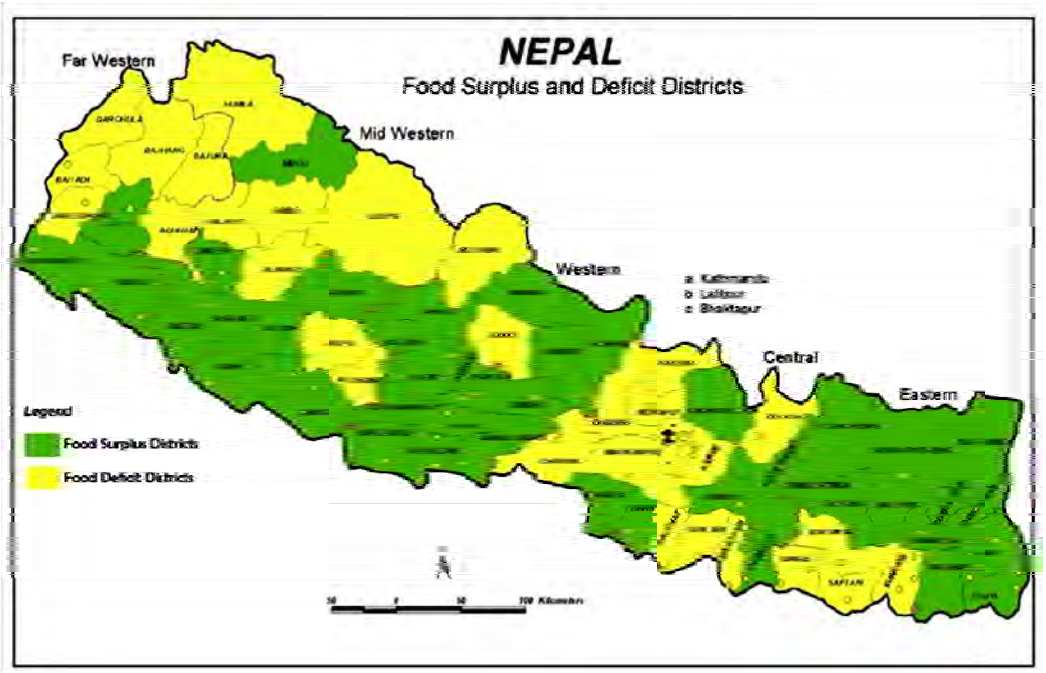


Figure 2-10-12 Food Surplus and Deficit Districts in Nepal

Source: MOAD, 2016: Nepal: Zero Hunger Challenge National Action Plan (2016-2025)

MOAD analyzed major causes for the above food deficit as: (a) expensive food prices; (b) food production which cannot catch up with the population increase, and (c) aftermath of the earthquakes. As for food production, it is pointed out that the segmentation of agricultural lands among the poor has resulted in a reduction of the productivity and efficiency of farming.

GON aims at eradicating famine in the next 10 years, and has adopted the following 10 policies with priority to cope with food deficit comprehensively.

As for rural infrastructure development amongst the 10 policies, particularly, MOAD shall accelerate the implementation of the rural infrastructure development stated in ADS[10] in order to eradicate famine (MOAD, 2016: Nepal: Zero Hunger Challenge National Action Plan:

(i) Enhanced food production and productivity;
(ii) Increased investment in agriculture;
(iii) Rural infrastructure development;

[10] ADS spells out that rural roads, storage facilities, irrigation facilities (construction, rehabilitation, and expansion), improvement of water management capacity of government agencies and farmers are the priority issues in the rural infrastructure sector.

(iv) Local consumption of local agricultural products;
(v) Agri-business promotion;
(vi) Creation of employment opportunities;
(vii) Promotion for youth to start farming;
(viii) Providing smallholders and landless farmers with agricultural inputs;
(ix) Safety net support for the socially vulnerable; and
(x) Food governance strengthening.

2-1-5 Basic Infrastructure

Infrastructure damaged by the earthquakes in 2015 is still under reconstruction with priority.

The total length of the strategic network of roads[11] to date in the country is 12,500km, and that of rural roads[12] is 53,000km. The road density of the country is 0.44km/km^2. As part of efforts to attain the Sustainable Development Goals (SDGs), GON is to be engaged in the social infrastructure development, aiming at attaining 5km/km^2 of road density, 100% access to telephones, and 10-fold electric-power generation by 2030[13].

2-2 Positioning of the Irrigation and Irrigated Agriculture Sectors in the National Plan

The National Planning Commission (NPC), which is led by the Prime Minister as the head of the Executive branch of GON, is in charge of planning and coordinating national development. Nepal intends to get out of the category of least developed countries by 2022 and join the middle income countries, by attaining more than US$2,500 of GNI (Gross National Income) per capita by 2030. Currently, the NPC is leading the formulation of Vision 2030, which is the long-term national development plan to realize the above intent. It is supposed that irrigation development and irrigated agriculture are addressed as a principal measure for the rural poor to increase income in Vision 2030.

ADS which was approved in 2014, is the long-term development strategy for the agriculture sector and is currently under implementation. This strategy addresses not only agriculture but also irrigation, by integrating related policies such as the 2010 draft doctrine of Integrated Water Resources Management and the 2013 Irrigation Policy.

2-3 Legal System of the Irrigation Sector

2-3-1 National Code: Muluki Ain

Muluki Ain was promulgated in 1854. It ensures riparian rights and prior use rights of water. However, it does not specify “ownership of water”.

The above old version of Muluki Ain 1854 was replaced by the new Muluki Ain in 1963. The new version contains both substantive and procedural laws covering criminal and civil matters. Chapter 8 of Section 3, “Land Cultivation (*Jagga Abad Garneko*)” sets out the priority use of water in irrigation, and also regulates traditional farmer managed irrigation systems.

[11] Main and branch roads administrated by the Department of Road
[12] Rural and farm roads administrated by the Department of Local Infrastructure Development and Agriculture Roads
[13] National Planning Commission. 2014. "Sustainable Development Goals 2016-2030 National (Preliminary) Report”

2-3-2 Water Resource Act 1992

It is an umbrella act governing water resource management and declares the order of priority in water use. The water use for drinking and domestic purposes has the first priority, followed by the water use for irrigation.

It stipulates the formation of "Water User Association", and requires water users obtain licenses. However, no license is required in case of: (a) drinking and any other domestic use on individual or collective basis; (b) irrigation of one's own land on individual or collective basis; (c) operation of running water-mill or water-grinder as cottage industry; (d) personal use of boat as local transportation; and (e) the personal use of water resources available within specific land by the land owner.

2-3-3 Water Resource Regulation 1993

This regulation was made in accordance with Article 24 of the aforementioned Water Resource Act 1992. It stipulates the establishment of the District Water Resource Committees as authority to issue licenses for the water use in general. The submission of an Environmental Impact Assessment is the pre-requisite to apply for the license for water resource utilization and survey. This regulation also regulates dispute settlement mechanisms in relation to water charges.

2-3-4 Irrigation Regulation

(1) Irrigation Regulation 1989

This regulation was institutionalized through the accumulation of studies and experiences of the participatory water management pilot projects, such as the Irrigation Water Management Project (United States Agency for International Development: USAID, 1985), the Irrigation Line of Credit (World Bank: WB, 1988), the Irrigation Sector Project (Asian Development bank: ADB, 1988), and the Irrigation Sector Support Project (United Nations Development Programme: UNDP/WB/ADB, 1989). This regulation provides the legal framework to water user organizations, and was referred to in the development of the Water Resources Act 1992.

(2) Irrigation Regulation 2000

The regulation was developed based on Section 24 of the Water Resources Act 1992 as amendment of the Irrigation Regulation 1989. The WUA for irrigation is recognized under this regulation and the WUA shall be registered to an irrigation office of respective districts in order to utilize the irrigation system developed/rehabilitated by GON. Due to this regulation, the traditional water users' groups (WUGs) had to convert into the water users' association (WUAs) with legal personality, and are required to register to GON.

The WUAs have responsibility to utilize, distribute, maintain, operate and manage the irrigation system handed over by GON. GON may fully or partially transfer an entire irrigation system to a registered WUA.

Those irrigation systems, which are too large for a WUA to provide O&M, can be jointly-managed by GON and WUA based on a written agreement. In case of the Joint Management Irrigation System, each WUA can individually make an agreement with GON and begin the joint management.

(3) Irrigation Regulation 2004

This regulation is the amendment to the Irrigation Regulation 2000. The items newly added are: (a) the establishment of exclusive fund for O&M, which can be disbursed for manual desilting, canal reshaping at small scale, greasing, wage for gate operators, etc., and (b) the deposit of at least 10% of the total ISF collected by WUAs to such an exclusive fund. In addition, the WUA has to pay 10% of the total amount of ISF to GON as their income tax. Costs for the O&M are much larger than the total revenue from the ISF collection for most of the WUAs. Therefore, WUAs have no other choice but to postpone maintenance works, and they often rely on government assistance.

2-4 National Policy and Development Plan/Strategy of Irrigation Sector

2-4-1 Irrigation Policy

(1) Irrigation Policy 1992

This policy supports the Irrigation Management Transfer (IMT) from GON to WUAs, ISF collection by WUAs, and the demand-based rehabilitation of the Farmer-Managed Irrigation Systems (FMISs). All irrigation policies after the issuance of this policy consistently require the implementation of the IMT.

(2) Irrigation Policy 1997

The aforementioned Irrigation Policy 1992 was amended in 1997 by reviewing the sections on the irrigation sector development, resources mobilization, and economic analysis of the former policy. The new policy intends to promote new technology and to maximize the participation of private and non-governmental sectors. The new policy also reiterates the importance of demand-driven irrigation development.

(3) Irrigation Policy 2003

The aforementioned Irrigation Policy 1997 was amended again in 2003. The new version put an emphasis on decentralization and WUAs' autonomous management of irrigation systems in order to enhance the implementation of the Agricultural Perspective Plan 1995/96-2014/15. The primary focus remained in the extension of irrigation services to all types of irrigation systems.

(4) Irrigation Policy 2013

The aforementioned Irrigation Policy 2003 was again amended in 2013. The new policy provides a vision to provide sustainable and reliable year-round irrigation services, so as to increase agricultural production and productivity. In addition, the new policy puts an emphasis on the sustainable development of the irrigation sector, by maximizing the utilization of available water resources, effective water management and institutional reform through empowerment of human resources.

2-4-2 Development Plan/ Strategy

(1) Agriculture Perspective Plan (APP) 1995/96-2014/15

It was a long-term plan for 20 years and the most comprehensive plan for agricultural and rural development with the objectives of poverty alleviation and food security through accelerating agricultural growth. It targeted to increase the agricultural gross domestic product to 4.9% per annum and to reduce the incidence of poverty to 14% in rural areas by 2015. Six strategies adopted by this

plan are as follows:

(i) Accelerated economic growth through technology guided agricultural development;
(ii) Agricultural growth creating production demand with multiplier effects on all sectors of the national economy;
(iii) Higher employment growth as mechanism of attaining social objectives;
(iv) Public policy and investment focusing on a small number of priorities building on past investment in human capital, and physical infrastructure and institutions;
(v) A package approach to development, specific to Terai, Hills and Mountain regions, that would recognize the powerful complementarities of public and private investments in order to ensure their coordination; and
(vi) Broader participation of key stakeholders that ensures regional balance and involvement of women.

The first priority in the irrigation sector was the expansion of year-round irrigated area, followed by the enhancement of women's participation in WUAs and training in O&M of irrigation systems. APP 1995/96-2014/15 showed Terai region as promising candidate area for the "green revolution" in Nepal, and stated the following 3 strategies for the region to increase food crop production:

(i) Rural infrastructure development, including irrigation facilities
(ii) Promotion of agricultural technology and of investment
(iii) Organizational development of related government institutions

(2) National Water Plan 2005

Water and Energy Commission Secretariat (WECS) prepared National Water Plan (NWP) in 2005 so that the activities identified by the Water Resources Strategy 2002 can be implemented[14]. NWP 2005 aims to contribute to the overall national goals of economic development, poverty alleviation, food security, public health and safety, decent standards of living for the people, and protection of the natural environment in a balanced manner. NWP 2005 also has targets regarding the irrigation sector.

Table 2-4-1 indicates the targets of the irrigation sector set in the National Water Plan 2005. The plan defines the target irrigated areas at 2007, 2017 and 2027, respectively. The current situation as of 2016 confirmed through interviews with relevant officers and literature reviews is also shown in the same table as progress. The percentage of the year-round irrigated area to the total irrigated area as of 2016 (18%) was estimated based on the past achievement in 2010. According to DOI, the target value set in the National Water Plan 2005 for this proportion is relatively high and it assumes that the actual proportion still remains as only around 18%.

Table 2-4-1 Targets for the irrigation sector set by the National Water Plan 2005

Indicators	2007	Progress as of 2016	2017	2027
Percentage of year-round irrigated area to the	49%	18%	64%	67%

[14] Water Resources Strategy 2002 focused on the following areas: (i) Integration of irrigation planning and management in agricultural development; (ii) Improved management of existing irrigation systems, and improved planning and implementation of new irrigation systems; (iii) Development of year-round irrigation in order to support the intensification and diversification of agriculture; (iv) Strengthening of capacity in planning, implementation and management of irrigation; (v) Redistribution of arable land in order to improve irrigation efficiency and agricultural productivity; and (vi) Improved groundwater development and management.

Indicators	2007	Progress as of 2016	2017	2027
total irrigated area		(Source: ADS)		
Percentage of the irrigated area to the total land area with potential for irrigation	71%	79% (Source: DOI)	81%	97%
Irrigation efficiency	35%	less than 40% (at least 170,000ha) (Source: ADS)	45%	50%

Source: National Water Plan 2005

(3) Agriculture Development Strategy (ADS) 2015 - 2035

This Strategy[15] is a long term agricultural development strategy for 20 years, developed as succeeding strategy upon the completion of APP. It has been implemented since November 20, 2015 by GON (DOI. Irrigation Newsletter No. 98, Mid November 2015 – Mid March 2016). The Ministry of Agricultural Development (MOAD) was in charge of the development of the strategy in consultation with the related government agencies and concerned donors. The ADS 2015 – 2035 is a comprehensive strategy aiming at the reinvigoration of entire rural economies based on agriculture, instead of focusing narrowly on agriculture.

Based on the existing administrative systems, MOAD takes the lead in the implementation of the same strategy and coordinates other government agencies at different levels as well as donors and private organizations. In addition to the consolidated funds of GON, financing from donors and private organizations are also expected as resources for implementing activities of ADS. In particular, the establishment and utilization of the ADS Implementation Trust Fund (ATF) with contributions from donors are planned.

Projects and activities for the Irrigation Sector are planned to form a comprehensive package of infrastructure and capacity development for irrigation development, which is prepared for one of the 13 outputs required to produce one of the four Outcomes of the ADS: Higher Productivity[16]. The followings are the 8 strategies in the irrigation sector for the selected output 2.5 “Irrigated Area expanded equitably and viably, and improved Irrigation Efficiency and Management”.

1) Expand irrigated area by most feasible means
   a. Completing surface water irrigation systems under construction at present,
   b. Pilot construction of medium scale ponds / groundwater-recharge basins,
   c. Repairing damaged surface water irrigation facilities,
   d. Repairing damaged shallow tube wells (STWs),
   e. Construction of new STWs, and
   f. Developing non-conventional irrigation systems.

2) Increase effective area of existing schemes
   a. Irrigation efficiency improvement,

[15] ADS replaces APP and it is consistent with other present related laws and policies. Although necessary legal backing for the implementation of the proposed JICA-TCP is already available, the ADS recognizes the need for new legislative documents for the implementation of itself (For instance, to establish funding sources for O&M activities, a legislation to enhance the ISF payment is proposed in the strategy paper as seen on the next page, 2-4-2 (3), 6) b.).

[16] ADS consists of the 4 expected outcomes: Output 1: Improved Governance, Output 2: Higher Productivity, Output 3; Profitable Commercialization, and Output 4: Increased Competitiveness.

b. Command area expansion,
c. Improvement of water allocation and cropping plan: provision of agriculture extension services,
d. Construction of permanent headworks and improvement of main canals managed by farmers, and
e. Construction of STWs in areas irrigated by minor canals where water shortage occurs.

3) Increase irrigation intensity
   a. Improve catchment management.
   b. Construct inter-basin transfer schemes.

4) Improve irrigation facilities and the water management within the command areas (the tertiary and lower level canals) under the WUA's management
   a. Reform and strengthen the existing Irrigation Management Division (IMD).
   b. Provide adequate levels of budget, either from national resources or the collection of adequate ISF.
   c. Build capacity of WUAs and provide advice and possibly funding to farmers.

5) Implement Irrigation Management Transfer (IMT) of the management of the 32 government irrigation systems to WUAs
   a. Joint management (government agency / WUA) for large systems with greater responsibility progressively transferred to the WUA.
   b. Full responsibility and ownership transferred to WUAs or federations of WUAs for the medium scale irrigation systems, whose irrigated area is ranging from 5,000 to 10,000ha.
   c. Prepare and implement an IMT pilot project[17] for two medium to large irrigation systems, including the formation of farmer-owned Irrigation Management Company or Cooperative and studies on international experience of IMT as components.
   d. Harmonizing and streamlining legal structures required for ownership transfer to WUAs.

6) Establish funding for O&M
   a. Introduce incentives into the system (e.g. government budget support proportional to ISF collection).
   b. Introduce legislation to require a receipt for ISF payment to be attached land tax payment.
   c. Enforce the existing requirement that ISF payments be brought up to date, before a land sale can be registered.
   d. Define and charge ISFs per crop in short-term and per volume of water in the long term.

7) Implement integrated water resource management.
   a. Finalize the Integrated Water Resources Management (IWRM) policy drafted in 2010.
   b. Introduce the IWRM through the country, with management based on hydraulic boundary, starting in areas where there is inter-sectoral competition or conflict over water.

8) Build capacity of Women Farmers in Irrigated Agriculture and Water Resources Management as one of measures to enhance Gender Equality and Social Inclusion (GESI).

[17] This means a "pilot project" for the implementation of the ADS, and not a pilot project of any specific actual project.

As mentioned above, the irrigation regulations 2004 has been brought to effect based on the Water Resources Act promulgated in 1992. In addition, the foundation of national policies lies in the Irrigation Policy 2013, and to implement this policy, a comprehensive strategy, ADS, which addresses different sectors related to agriculture and rural development, such as agriculture, water resources, as irrigation sectors, was developed and put into practices. Figure 2-4-1 shows mutual relationships of these acts, regulations, policies and strategies.

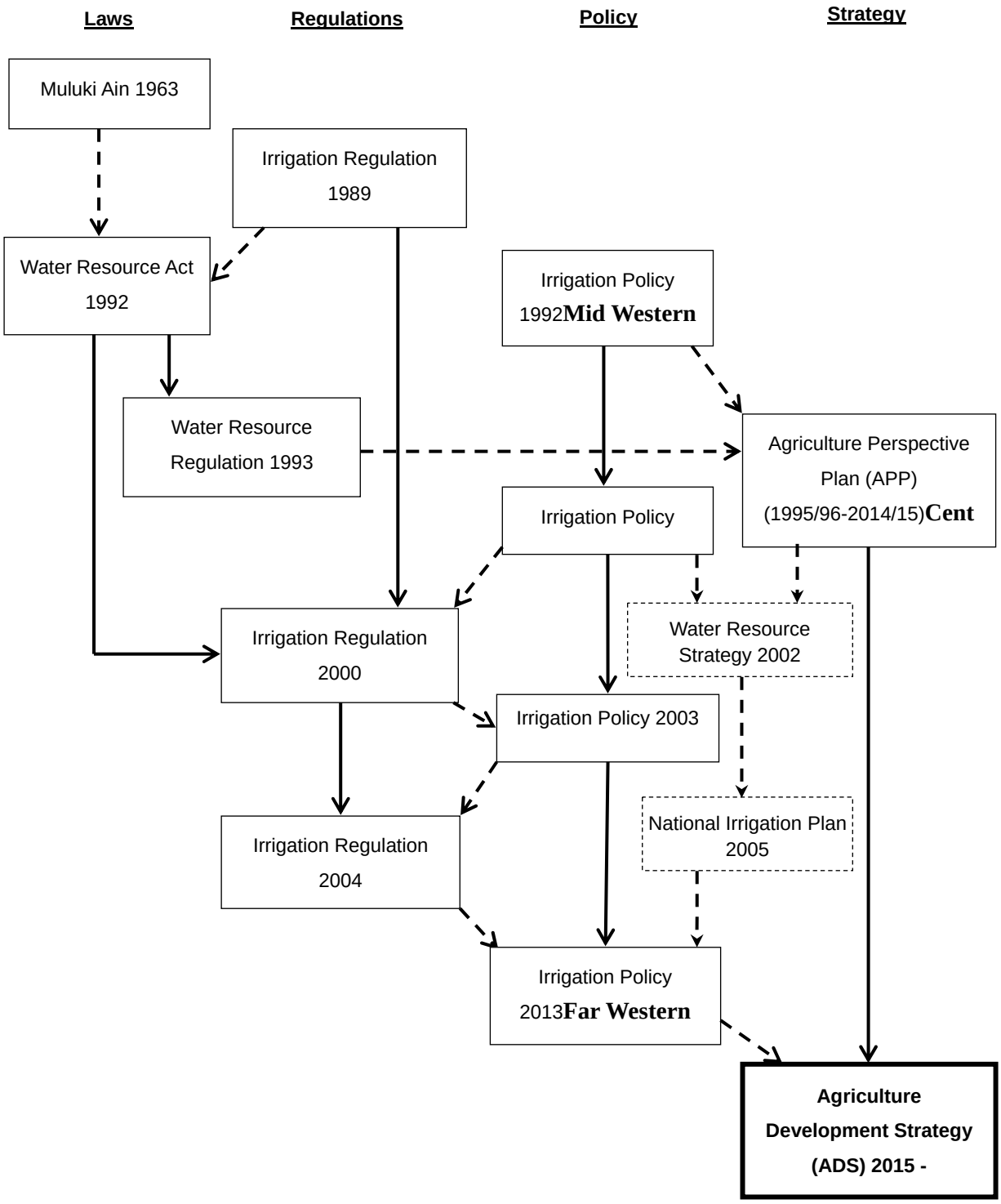


Figure 2-4-1 Relationships of Laws, Regulations, Policies and Strategy in Irrigation Sector

Source: Survey team

2-4-3 Progress of Irrigation Development

The following tables show the progress of irrigation development of Nepal and Terai region. The irrigated area of Terai region has accounted for 76%, 67%, 69% and 73% to the total irrigated area of the country in 1981/82, 1991/92, 2001/02 and 2011/12, respectively. Thus, 70% of the irrigated area of Nepal is intensively spread over Terai region and this implies that the region meets those conditions important for successful irrigation.

Table 2-4-2 Decennial transition of the irrigated area (Unit: ha)

Year	1981/82	1991/92	2001/02	2011/12
Nepal	583,900	882,400	1,168,300	1,313,406
Terai	444,900	595,100	801,300	953,740
(Percentage of the area in Terai to the total area of Nepal)	(76.2%)	(67.4%)	(68.6%)	(72.6%)

Table 2-4-3 Percentages of the irrigated area to the total agricultural land area

Year	1981/82	1991/92	2001/02	2011/12
Nepal	23.7%	34.0%	44.0%	52.0%
Terai	31.7%	43.3%	57.4%	74.2%

Sources for Table 2-4-2 and Table 2-4-3 above: Agriculture Monograph and CBS. National Sample Census of Agriculture (District) 2011/12 and National Sample Census of Agriculture 2011/2012

As seen earlier, there is little possibility of the expansion of the agriculture land in Nepal, and therefore, to strengthen the cropping intensity on the existing agricultural land together with the provision of appropriate irrigation facilities is necessary in order to increase agricultural production and to improve productivity. Tables above show that the irrigated area has been expanded continuously. However, the year-round irrigated area has not been expanded.

ADS discusses that the total year-round irrigated areas of Nepal in 2010 was 234,000ha and they accounted for 18% of the irrigable areas of the country. According to the Nepal National Committee for the International Commission on Irrigation and Drainage (ICID), the percentage of year-round irrigated area to the total irrigated area in Terai region in 1997 was 36.6% (288,000ha). DOI admitted that such percentages still remain as almost the same today, though the irrigated area is slightly increased in both Terai region and in the country as a whole.

As an outcome of the policy implementation, irrigated area has consistently increased. However, the year-round irrigated area has not increased. This fact implies that the sluggishness of the expansion of year-round irrigated area could become a bottleneck to achieve increased agricultural production and improved productivity. In other words, the expansion of the year-round irrigated area is the challenge to be actively addressed by GON from now on.

2-4-4 Improvement of Irrigation Efficiency

The irrigation efficiency is classified into two categories: conveyance efficiency and application efficiency. The former is determined by the proportion of water loss occurred while water travels from a headwork to farming plots. The loss is caused not only due to seepage and evaporation but also due to malfunctioning canal structures and inadequate gate operations. The latter is determined by the proportion of water loss occurred when farmers apply water onto crops in their plots. The loss is caused mainly due to over-irrigation, which may result in deep percolation below the effective root level of crops. Such water

loss by deep percolation can be reduced if farming plots are leveled, since water can pervade uniformly over the plots without concentrating on the lowest areas.

ADS aims at improving the irrigation efficiency. To improve the conveyance efficiency, canal lining, proper allocation of irrigation facilities to secure their functions as well as proper operation of facilities for water management are needed. Lining reduces the seepage loss and water is distributed properly by well allocated irrigation facilities. Controlling water flow by properly operating water management facilities makes accurate water distribution possible. On the other hand, ADS pursues the improvement of the application efficiency by the establishment of water distribution network through capacity development of WUA members, leveling of farming plots, on-farm water management, and so forth.

2-5 Ministry of Irrigation

2-5-1 Mandates

Abundant water resource in Nepal is utilized not only for irrigation but also for hydraulic power generation, urban and rural water supply, and industrial uses, and therefore, it is invaluable natural resource for Nepal's economic development. The authority for the water use and management in the irrigation sector is MOI. MOI is in charge of the preparation of policies and plans and their implementation in the irrigation sector, and at the same time, is responsible for the attainment of targets of the irrigation sector among the national targets.

As per the Work Division (Second Amendment) Rules, 2009 of GON, this ministry has the following duties:

(1) Development and implementation of policies/plans for conservation, regulation and utilization of water resource for irrigation;
(2) Conducting and Promotion of surveys, researches and feasibility studies of irrigation development;
(3) Construction, operation and maintenance of irrigation facilities;
(4) Human resource development and capacity building;
(5) Activities related to Flood and Flood Control;
(6) Study, research, feasibility study, construction, operation and maintenance of each irrigation facility;
(7) Promotion of the participation of private sector in the irrigation development;
(8) Conducting survey and research on water resource development and undertaking of such development;
(9) Groundwater Resources;
(10) Construction, conservation, integrated operation of irrigation facilities in rural areas as part of Irrigation Development of the country;
(11) National and international seminars and workshops;
(12) Facilitation of bilateral and multilateral dialogues, agreements and mutual understandings regarding irrigation;
(13) Cooperation among institutions related to irrigation development;
(14) Matters related to tax imposed on the use of irrigation;
(15) Prevention of natural disasters related to water;

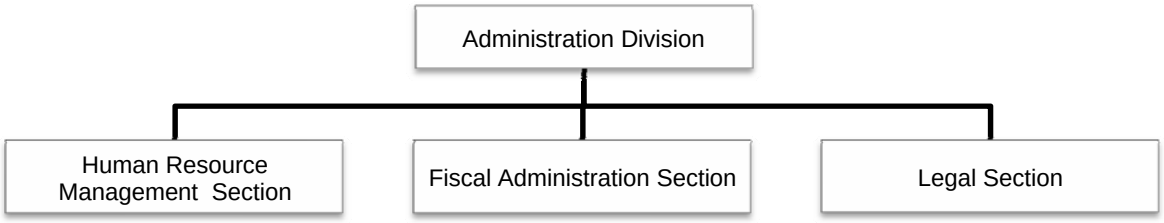
(16) Surveys and researches on disasters related to water;
(17) Coordination with International institutions and organizations on disasters related to water;
(18) Development and Implementation of policies and plans on disasters related to water;
(19) Qualification setting for the recruitment, transfer and promotion of technical service officers who work for the following groups
- Meteorology Group
- Irrigation Sub-group

The Secretary is the administrative head of the Ministry and there are established three Divisions and two Departments which are directly answerable to the Secretary. The Administration Division, Planning & Program Division and Policy & Foreign Coordination Division are the three Divisions which assume the roles of the ministry's secretaries and most of their activities are carried out at the central level. On the other hand, the two Departments, DOI and the Department of Water Induced Disaster Management (DWIDM), have their activities at the local level. The outline of these Divisions and Departments are described in 2-5-2 and 2-5-3 below.

2-5-2 Divisions

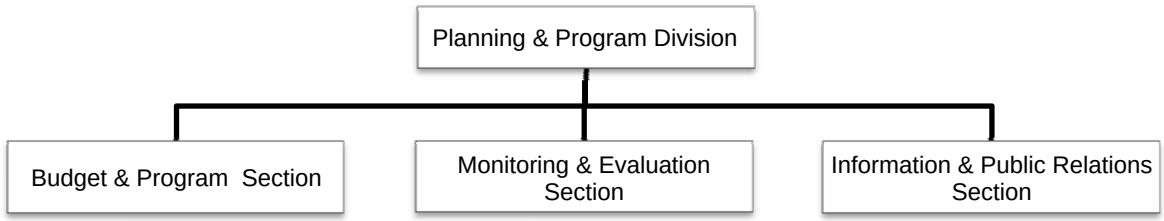
(1) Administration Division

This Division consists of the following three Sections.



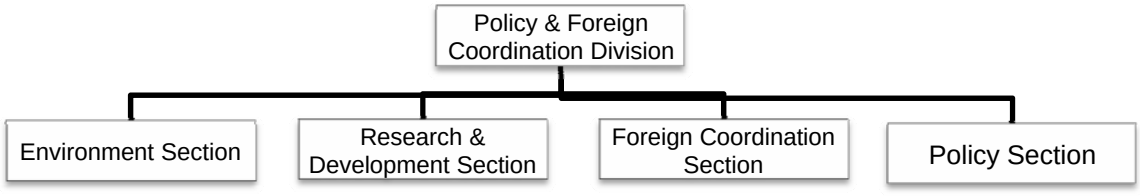
(2) Planning & Program Division

The Division consists of the following three Sections.



(3) Policy & Foreign Coordination Division

The Division consists of the following four Sections.



2-5-3 Departments

(1) DOI

DOI is a governmental agency, with the mandate to plan, develop, maintain, operate, and manage socially adoptable and environmentally sustainable irrigation and drainage systems. The agency works for surface water irrigation systems irrespective of their scales ranging from small to large scale, as well as groundwater irrigation systems irrespective of their ownership ranging from individually owned to community owned. The primary goal of DOI is to increase the irrigated area in the country as large as possible, through the provision of year-round irrigation facilities. The overall goal is to contribute to an increase of GDP and an improvement of the living standards of beneficiary farmers, by meeting basic conditions to improve the farming land productivity through the expansion of the irrigated area.

(2) DWIDM

Nepal has a high potential that various types of water-induced disasters such as flood, soil erosion, landslides, debris flow, bank erosion, etc. are induced easily due to its rugged topography and weak geological formation with active fault. The expansion of such disasters may turn into serious threat to sustainable development of the country by doing harms on roads, houses, hydraulic power generation facilities, irrigation facilities and water purifying plants.

In order to prevent such water induced disasters in Nepal, the Disaster Prevention Technical Centre (DPTC) was established based on an agreement between GON and GOJ signed in October 1991. The support from JICA to DPTC was provided for seven and half years and GON has been implementing the Water Induced Disaster Management Program (WIDMP) since July 2000, so as to institutionalize the achievements of DPTC with support from JICA. DWIDP has been implementing WIDMP through its seven divisions and five sub-divisions.

2-6 Department of Irrigation (DOI)

DOI belongs to MOI and is the governmental department responsible for irrigation development. Figure 2-6-1 shows its organization structure. The Director General is the head of Department and under the Director General, there are 5 divisions headed by Deputy Director Generals. In addition, 5 Regional Irrigation Directorates, Groundwater Irrigation Directorate and Irrigation Management Directorate are set as branch offices directly answerable to the Director General. Directors of central level projects and programs are appointed by the Director General.

The Irrigation Management Division (IMD) is in charge of O&M, on-farm water management and IMT at the DOI central office. The Irrigation Management Directorate and the 13 Field-level Irrigation Management Divisions (FIMDs) as well as the Irrigation Development Divisions/Sub-divisions (IDDs/IDSDs) under each of the five Regional Irrigation Directorates are in charge of such duties at the local level. In addition, the Groundwater Irrigation Directorate and the 11 Field-level Groundwater Irrigation divisions (FGWID) construct tube wells and give maintenance to them.

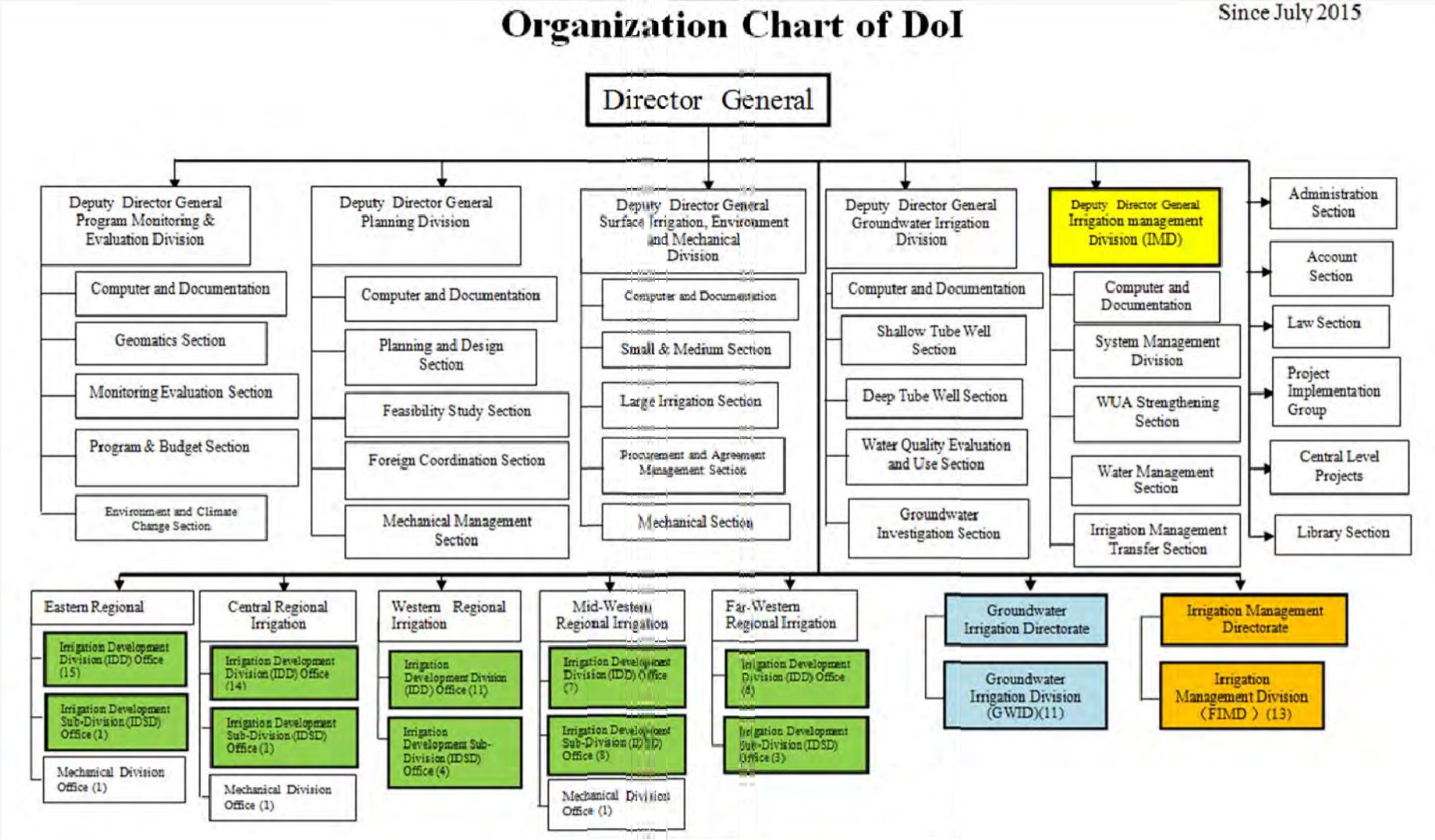
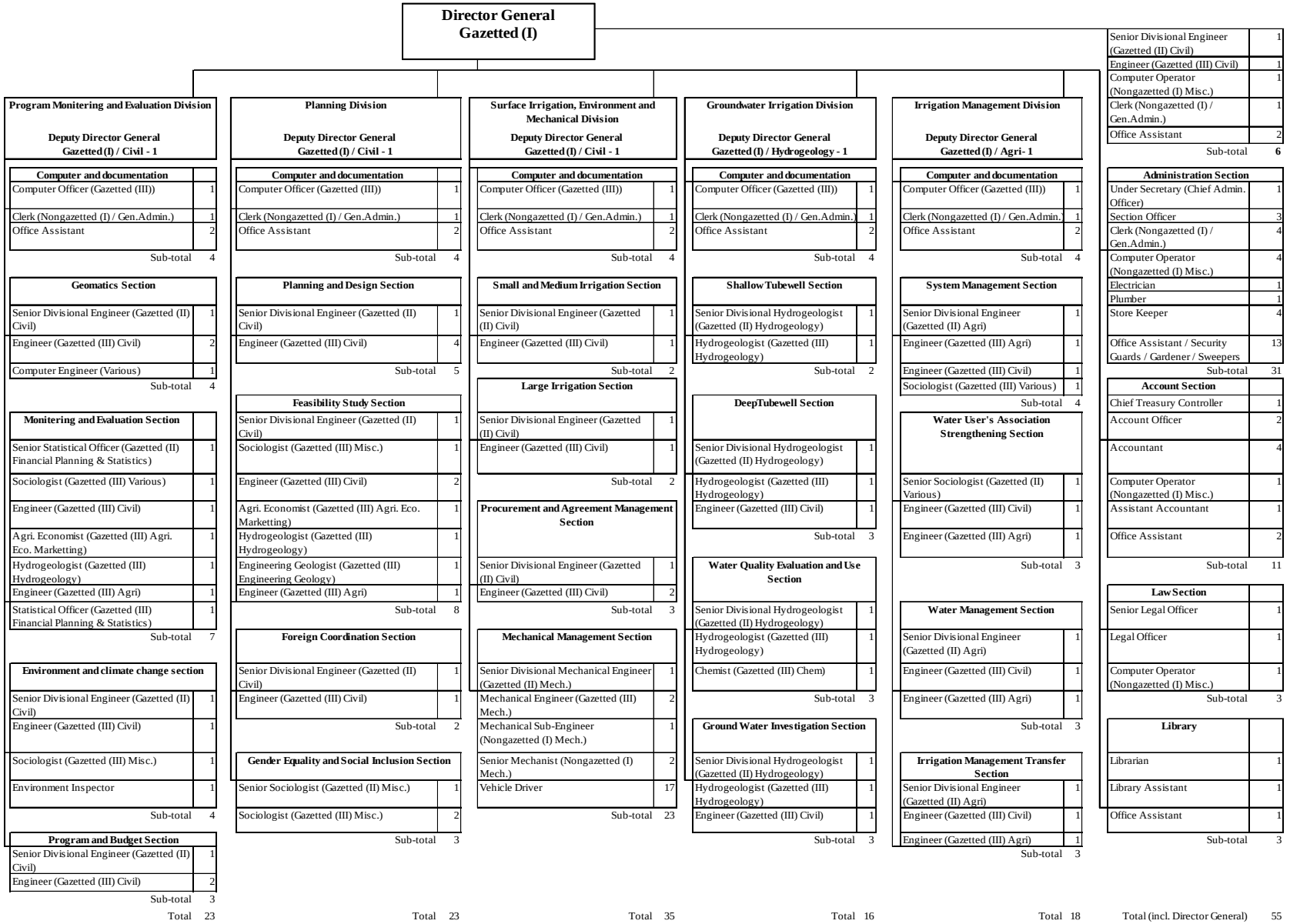


Figure 2-6-1 Organization Structure of DOI

Organization Chart of Department of Irrigation



(Source: DOI)

Figure 2-6-2 Staff Allocation to the DOI Central Office

DOI officers affirmed in the interviews that DOI has accumulated skills in the irrigation facility construction, since the main duties of the Department have been planning, designing, and constructing of irrigation facilities for a long time. Accordingly, it is assumed that the DOI engineers have enough capacity to plan and design small scale irrigation systems, and for the construction of large-scale facilities, they have rich experience in the supervision, as DOI, usually, outsources the construction of large scale facilities.

DOI is aware of the importance of O&M of the irrigation facilities, and has been developing the capacity of their engineers in O&M. All the existing positions within DOI are shown in Figure 2-6-2 and the training materials to the DOI officers are listed in Annex-6.

With regard to the human resource capacity, currently 87 persons are assigned to the 27 positions for civil engineer shown in the establishment for FIMDs, according to the obtained information. Meanwhile, there are currently 20 persons are assigned to the 24 positions for agricultural engineers defined in the establishment.

2-6-1 Irrigation Management Division (IMD)

The IMD is the division responsible for the management of Jointly-Managed Irrigation Systems (JMISs), which are large and major scale irrigation systems developed by DOI. Separately, there are IDD and IDSD as responsible offices for the management of medium and small scale irrigation systems. IMD supports IDD and IDSD in O&M of medium and small scale irrigation systems under specific projects such as the Integrated Water Resources Management Project – Additional Financing – (IWRMP-AF) and the Community Managed Irrigated Agriculture Sector Project – Additional Financing – (CMIASP-AF).

The large scale irrigation systems under the management of IMD are called “Main Irrigation Systems”, which DOI has selected because of their scale (irrigated area) and difficulties in O&M. There are 25 Main Systems in Terai region, which are jointly managed by WUAs and 13 FIMDs and the IDD of Rupandehi. The following table shows the general information on the 25 Main Irrigation Systems and the irrigated areas vary from system to system. The smallest irrigated area is 1,800ha while the largest is 68,000ha: more than 37 times as large as the smallest one. The average irrigated area of the 25 systems is 12,800ha.

Table 2-6-1 Main Irrigation Systems in Terai region

S/N	IMD Name	District	S/N	Irrigation System	Command Area (ha)
1	Kankai	Jhapa	(1)	Kankai	8,000
2	Sunsari Morang	Sunsari	(2)	Sunsari Morang	68,000
			(3)	Chanda Mohana	1,800
3	Koshi Pump Chandra Nahar	Saptari	(4)	Chandra Nahar	10,000
			(5)	Koshi West Canal (Distribution System)	10,500
			(6)	Koshi Pump Canal	13,180
4	Kamala	Dhanusha	(7)	Kamala	25,000
			(8)	Hardinath	2,000
5	Bagmati	Sarlahi	(9)	Mansumara	5,200
			(10)	Bagmati	37,600
			(11)	Jhanj	2,000
6	Narayani	Parsa	(12)	Narayani	28,700
			(13)	Narayani Tube Well	2,800
7	Narayani Lift-Khageri	Chitwan	(14)	Narayani Lift	4,750
			(15)	Khageri	3,900
8	Gandak	Nawalparasi	(16)	Nepal Gandak Western Canal	10,300
9	Bhairawa Lumbini Groundwater	Rupandehi	(17)	Bhairahawa Lumbini Bhumigath Jalshorat	20,309
10	Banganga	Kapilbastu	(18)	Banganga	6,350
11	Praganna	Dang	(19)	Praganna Kulo	6,684
12	Babai Rajapur	Bardiya	(20)	Babai	27,000
			(21)	Rajapur	14,870
13	Mahakali	Mahakali	(22)	Pathraiya	2,000
			(23)	Mohana	2,000
			(24)	Mahakali	11,600
	IDDO Rupandehi	Rupandehi	(25)	Machawar Lift	5,600
	13 Field IMDs & 1 IDDO			25 Irrigation Systems	330,143

Source: IMD and FIMD

The total budget of IMD for the fiscal year of 2016/17 is shown in Table below. The amount includes not only the budget for O&M but also that for construction (rehabilitation).

Table 2-6-2 Budget of IMD (Fiscal Year of 2016/17)

Item	Amount (Unit: Nepal Rs.) *1	Remark
Irrigation System Management and Training Programs	8,927,000 (8,605,628)	
O&M*2	852,232,000 (821,648,048)	The amount for all the O&M activities to be undertaken by IMD.
Rehabilitation of Large Scale Irrigation Systems and IMT Projects*3	646,094,000 (622,834,616)	
TOTAL	**1,507,353,000** **(1,453,088,292)**	

*1 The amounts in Japanese Yen (Rs. 1 = Yen 0.9604) are shown in the parenthesis. The information on the budget adequacy for duties as well as on the availability of financial support from donors was not obtained.
*2 This item includes the budget of the 13 FIMDs for O&M activities such as cleaning of canals and repairs of small scale canals, which is amounting to Rs. 263,331,000.
*3 This item includes the budget of the 13 FIMDs for the repair and rehabilitation of facilities (LISP), which is amounting to Rs. 634,585,000.

Source: Ministry of Finance. Estimate of expenditures, Budget Details - Red Book

Table below shows the annual budget for the FIMDs. As the Kankai irrigation system has a schedule of large scale rehabilitation (re-plastering weir) in this coming spring, the costs for such rehabilitation is budgeted under the item of construction. The budget for the Bagmati and Babai Irrigation Systems is zero, since the budget required for these two irrigation systems is going to be allocated as part of the budget of the project at the central level, as shown in Table 2-6-3. Therefore, such budget cannot be incorporated into the budget of FIMDs.

Table 2-6-3 Budgets of Field IMDs for Fiscal Year 2016/17

Unit: Nepal Rupees, and the figure in parenthesis is the amount converted into Japanese Yen (Rs. 1 = Yen 0.9604)

No.	FIMD in charge	District	Name of Irrigation System	O&M (AMIS)	Construction	TOTAL
1	Kankai	Jhapa	Kankai	19,600,000 (18,894,400)	52,446,000 (50,557,944)	72,046,000 (69,452,344)
2	Sunsari Morang	Sunsari	Sunsari Morang	2,734,000 (2,635,576)	0 (0)	2,734,000 (2,635,576)
			Chanda Mohana	8,055,000 (7,765,020)	0 (0)	8,055,000 (7,765,020)
			Total of FIMD	10,789,000 (10,400,596)	0 (0)	10,789,000 (10,400,596)
3	Koshi Pump Chandra Nahar	Saptari	Chandra Nahar	8,042,000 (7,752,488)	90,000,000 (0)	98,042,000 (94,512,488)
			Koshi West Canal (Distribution System)	4,255,000 (4,101,820)	47,500,000 (0)	51,755,000 (49,891,820)
			Koshi Pump Canal	25,968,000 (25,033,152)	47,700,000 (0)	73,668,000 (71,015,952)
			Total of FIMD	38,265,000 (36,887,460)	185,200,000 (0)	223,465,000 (215,420,260)
4	Kamala	Dhanusha	Kamala	18,545,000 (17,877,380)	0 (0)	18,545,000 (17,877,380)
			Hardinath	4,240,000 (4,087,360)	185,456,000 (178,779,584)	189,696,000 (182,866,944)
			Total of FIMD	22,785,000 (21,964,740)	185,456,000 (178,779,584)	208,241,000 (200,744,324)
5	Bagmati	Sarlahi	Mansumara	3,900,000 (3,759,600)	0 (0)	3,900,000 (3,759,600)
			Bagmati	0 (0)	0 (0)	0 (0)
			Jhanj	5,236,000 (5,047,504)	0 (0)	5,236,000 (5,047,504)
			Total of FIMD	9,136,000 (8,807,104)	0 (0)	9,136,000 (8,807,104)
6	Narayani	Parsa	Narayani	2,050,000 (1,976,200)	0 (0)	2,050,000 (1,976,200)
			Narayani Tube Well	8,582,000 (8,273,048)	68,742,000 (66,267,288)	77,324,000 (74,540,336)
			Total of FIMD	10,632,000 (10,249,248)	68,742,000 (66,267,288)	79,374,000 (76,516,536)

No.	FIMD in charge	District	Name of Irrigation System	O&M (AMIS)	Construction	TOTAL
7	Narayani Lift-Khageri	Chitwan	Narayani Lift	6,857,000 (6,610,148)	70,447,000 (67,910,908)	77,304,000 (74,521,056)
			Khageri	37,491,000 (36,141,324)	0 (0)	37,491,000 (36,141,324)
			Total of FIMD	44,348,000 (42,751,472)	70,447,000 (67,910,908)	114,795,000 (110,662,380)
8	Gandak	Nawalparasi	Nepal Gandak Western Canal	10,768,000 (10,380,352)	41,147,000 (39,665,708)	51,915,000 (50,046,060)
9	Bhairawa Lumbini Groundwater	Rupandehi	Bhairahawa Lumbini Bhumigath Jalshorat	9,955,000 (9,596,620)	0 (0)	9,955,000 (9,596,620)
10	Banganga	Kapilbastu	Banganga	17,715,000 (17,077,260)	31,147,000 (30,025,708)	48,862,000 (47,102,968)
11	Praganna	Dang	Praganna Kulo	20,540,000 (19,800,560)	0 (0)	20,540,000 (19,800,560)
12	Babai Rajapur	Bardiya	Babai	0 (0)	0 (0)	0 (0)
			Rajapur	21,715,000 (20,933,260)	0 (0)	21,715,000 (20,933,260)
			Total of FIMD	21,715,000 (20,933,260)	0 (0)	21,715,000 (20,933,260)
13	Mahakali	Mahakali	Pathraiya	6,671,000 (6,430,844)	0 (0)	6,671,000 (6,430,844)
			Mohana	1,717,000 (1,655,188)	0 (0)	1,717,000 (1,655,188)
			Mahakali	18,695,000 (18,021,980)	0 (0)	18,695,000 (18,021,980)
			Total of FIMD	27,083,000 (26,108,012)	0 (0)	27,083,000 (26,108,012)
TOTAL	**13 FIMDs**		**24 Irrigation Systems**	**263,331,000 (253,851,084)**	**634,585,000 (611,739,940)**	**897,916,000 (865,591,024)**

*AMIS: Agency Managed Irrigation System

Source: Ministry of Finance. Estimate of expenditures, Budget Details - Red Book

Table 2-6-4 Budgets allocated to the Bagmati and Babai Irrigation Systems from Project at the Central Level

Unit: Nepal Rupees, and the figure in parenthesis is the amount converted into Japanese Yen (Rs. 1 = Yen 0.9604)

Irrigation System	O&M	Construction	TOTAL
Bagmati	101,655,000 (97,995,420)	296,718,000 (286,036,152)	398,373,000 (384,031,572)
Babai	8,000,000 (7,712,000)	658,300,000 (634,601,200)	666,300,000 (642,313,200)
TOTAL	109,655,000 (105,707,420)	955,018,000 (920,637,352)	1,064,673,000 (1,026,344,772)

Source: DOI

2-6-2 Field Level Irrigation Management Division (FIMD)

In July 2015, DOI newly established the Irrigation Management Directorate and the 13 FIMDs in Terai region. The Irrigation Management Directorate guides, monitors and evaluates the FIMDs. Twenty-four out

of the 25 Main Systems are managed by the 13 FIMDs, and the remaining one (Machawar Lift Irrigation System) is under the IDD of Rupandehi District (Table 2-6-1). Each FIMD manages 1 to 3 Main Systems in cooperation with WUAs. All these Main Systems are the targets of IMT and GON is bringing forward the transfer process in accordance with the ADS as well as the Irrigation Policy 2013.

FIMD chiefs are the skilled Senior Divisional Engineers (SDEs), which is the second highest rank of the DOI engineers. In addition, undergraduate engineers (civil engineers and/or agricultural engineers); engineers with diploma (sub-engineers) and association organizers who are undergraduates, are assigned to the FIMDs. The actual number of staff assigned to each FIMD is listed in Annex 3, while the proposed establishment numbers and organizational structure are shown in Annex 1.

2-6-3 Irrigation Development Division / Sub-division (IDD/IDSD)

IDDs and IDSDs are placed under the Regional Irrigation Directorates located in each of the five Development Regions of Nepal: Far-Western, Mid-Western, Western, Central and Eastern. Currently, either IDD or IDSD is established in each District of the country, and there are 20 IDDs or IDSDs placed in Terai region. IDDs and IDSDs are in charge of the development and O&M of small and medium scale surface water irrigation systems, namely, FMISs. The figure below shows the organization of the IDD in Rautahat District. Though the organization structure varies from district to district, the positions (SDE, Engineers, and Sub-Engineers) and the number of staff assigned to IDD are similar. IDSD has the same functions as IDD does, but its scale (the number of staffing) is smaller than IDD. Association Organizers (AOs) are sociologists, who are engaged in the establishment and development of WUAs. The organizational structure and budget of each of the IDDs are attached in Annex 1.

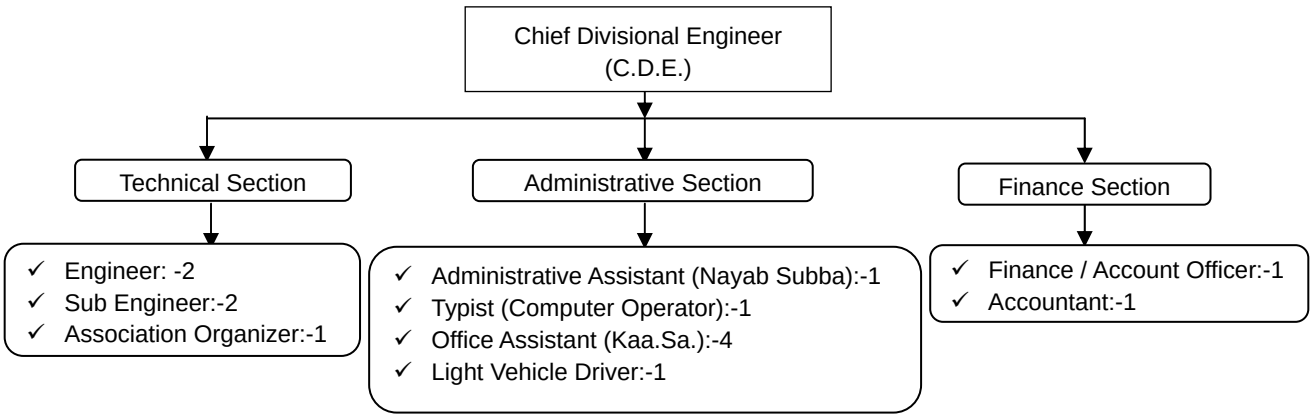


Figure 2-6-3 Organization of IDD, Rautahat District

Source: IDD in Rautahat district

2-6-4 Groundwater Irrigation Divisions

There are 11 Groundwater Irrigation Divisions (GWIDs) established in Terai region and they are manned with hydrogeologists, engineers and sociologists, although the total number of staff is limited (See Annex-1, Proposed establishment, for details of the staff allocation). GWIDs build deep and shallow tube wells for groundwater irrigation systems. In case of the irrigation system with the conjunctive use of surface and ground water, GWID takes care of the part of groundwater within such systems.

2-7 Other Related Institutions

2-7-1 Ministry of Agricultural Development

MOAD, when participating in an irrigation project, takes care of the agricultural component (Figure 2-7-1). More concretely, MOAD may be in charge of practices of crop water management, water-saving rice-growing techniques, cropping patterns, production of improved seeds, agricultural mechanization, soil management, support for marketing, improvement on access to markets, cropping plan, soil fertility analysis and management, and the utilization of small agricultural machines and equipment, among others within the command areas (the tertiary and lower level canals) under the WUA's management.

Meanwhile, DOI is in charge of supporting water management in the command areas under the management of WUAs, such as calculation of irrigation requirement for the distribution of water and the training of on-farm irrigation method. After the completion of the IMT, WUAs remain responsible for the water management of the command areas under their management, while beneficiary farmers assume the responsibility for irrigation water use and crop production on their individual farming plots.

IMD of DOI is playing a pivotal role in projects for the irrigation sector, which are under the implementation with support from WB and ADB and the participation of MOAD. As part of the implementation structure, a Project Appraisal Committee chaired by the Director General of DOI is to be set above IMD, and likewise, a Project Steering Committee chaired by the Secretary of MOI, above the Project Appraisal Committee (Figure 2-7-2).

The Secretary of MOI chairs the Project Steering Committee, while the Director Generals of DOI and DOA should be assigned to the same committee as members. Representatives from other related government agencies, such as the Ministry of Federal Affairs and Local Development and the Ministry of Finance, are usually assigned as members as well. The Project Steering Committee meets twice a year to monitor progress of the project, to provide necessary instruction to the project, and to coordinate among different government agencies for the implementation of the project.

The Director General of DOI chairs the Project Appraisal Committee, while all the Deputy Director Generals of Division of DOI and the head of the Directorate of Agricultural Extension (DAE) compose the Committee as members. The DAE is a program directorate of DOA and in charge of the agricultural extension. The Project Director and Project Leaders also attend the meetings of the Project Appraisal Committee. The appraisal meeting of the Committee is held usually twice a year, prior to the meeting of the Project Steering Committee, in order to confirm progress, outputs and problems of the project, and to examine challenges and possible countermeasures based on such a confirmation.

In order to implement the agricultural component, a Project Implementation Unit is established inside DAE at the central level as PIU/DAE, and the Regional Agricultural Directorates (RADs) and the District Agricultural Development Offices (DADOs) of the project are also involved in the implementation at their respective levels. With the purpose of the coordination between DOI and DOA/DAE at the central, between IMD and RAD, or between RID and RAD at the regional level and between FIMD and DADO, or between IDD/IDSD and DADO at the district level, a coordination committee (CC) is set up at the respective levels. The coordination meeting is usually held on a quarterly basis, with the participation of representatives from the District Development Committees (DDCs) so as to share the information. In case

where two districts are involved in the irrigation project or system such as JMIS (e.g. Bagmati Irrigation System), the CC should be established in each district.

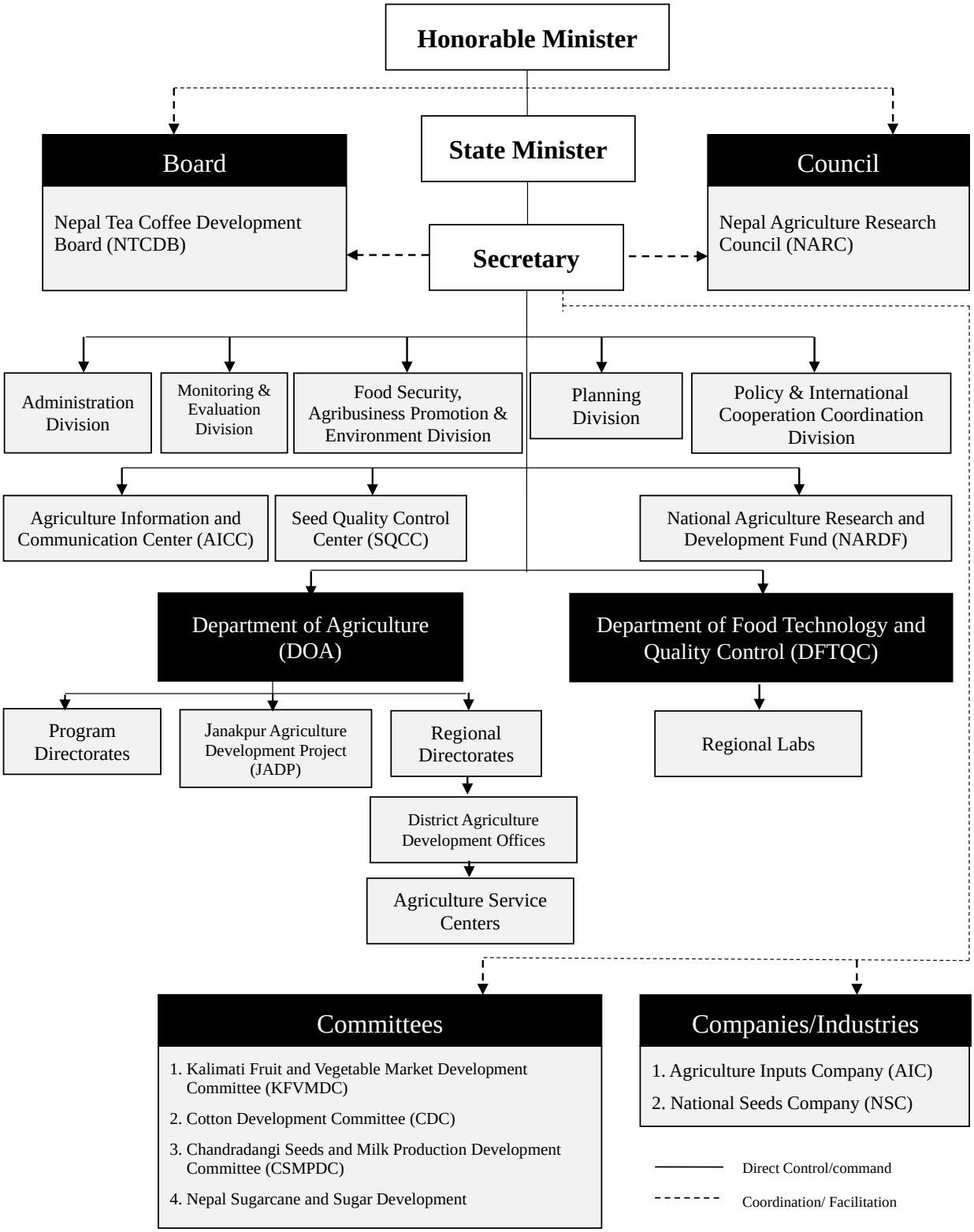
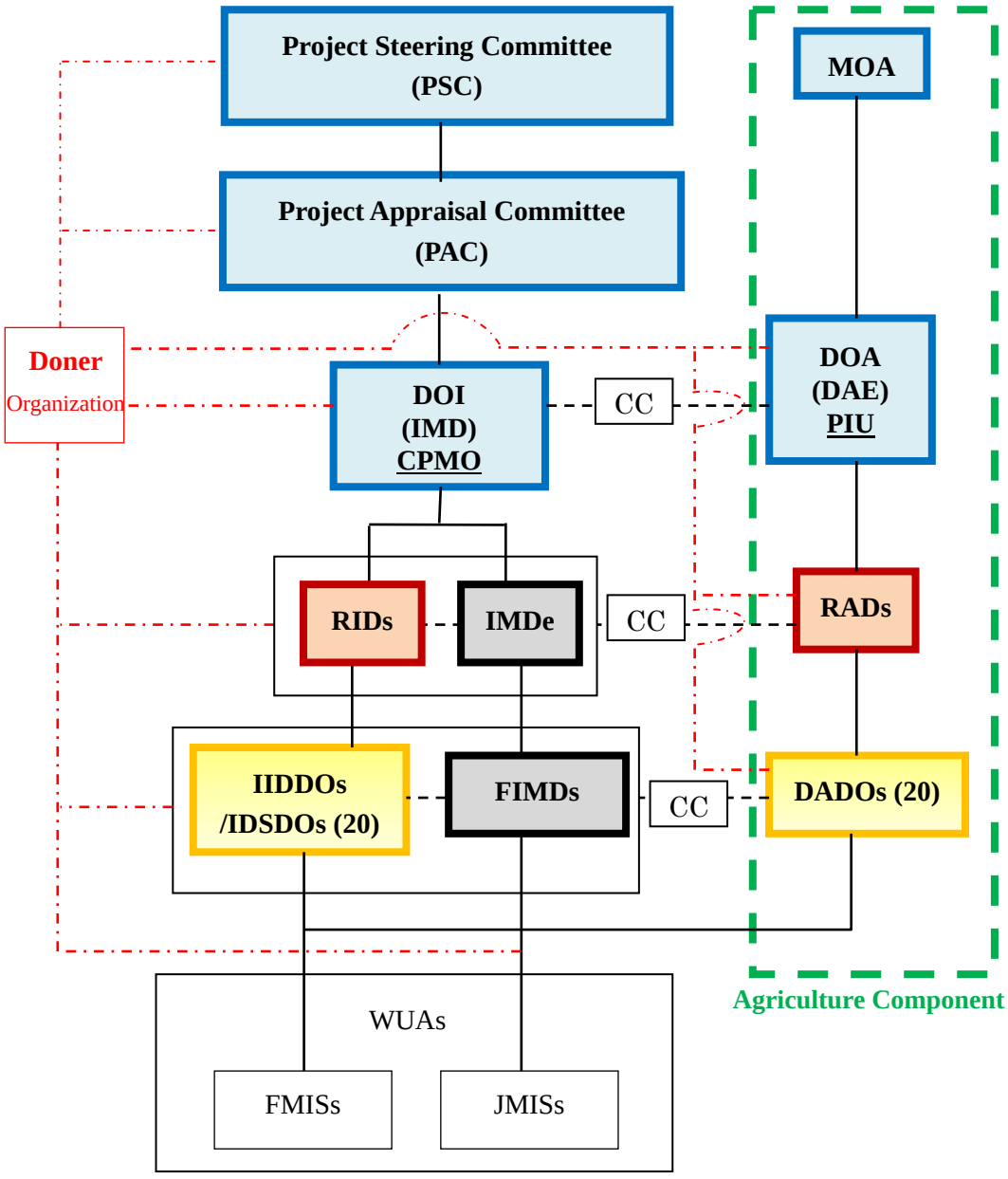


Figure 2-7-1 Organization Chart of MOAD

Source: MOAD



CPMO = Central Project Management Office
PIU = Project Implementation Unit
MOI = Ministry of Irrigation
MOAD = Ministry of Agricultural Development
DOI = Department of Irrigation
IMD-= Irrigation Management Division
DOA = Department of Agriculture
DAE = Directorate of Agricultural Extension

RID = Regional Irrigation Directorate
IMDe = Irrigation Management Directorate
RAD = Regional Agricultural Directorate
IDD/IDSD = Irrigation Development Division/Sub-division
FIMD = Field Irrigation Management Division
DADO = District Agricultural Development Office
CC = Coordination Committee

Central Level
Regional Level
District Level
Local Offices in Terai, which manage large-Scale Irrigation Systems.

Figure 2-7-2 Possible Implementation Structure for an Irrigation Project to be Implemented in Collaboration with MOAD

Source: Drawn by the Survey team based on the cases of other projects supported by WB and ADB

2-7-2 District Development Committee and Village Development Committee

It is known that the District Development Committees (DDCs) and the Village Development Committees (VDCs) are taking part in the irrigation development. These local government institutions are established in each District and Village under the Ministry of Federal Affairs and Local Development. They are supposed to have updated information on the irrigation development projects and their progress.

It is possible for WUAs to request financial assistance to DDCs or VDCs: however, in a hearing survey conducted on the matter, the respondents admitted that there had been few cases that the local government had provided assistance in response to such requests. In wake of special cases, such as natural disasters, DDCs and VDCs may provide emergency support. Based on this background, WUAs usually request for both technical and financial supports to IDDs, IDSDs or FIMDs. Nevertheless, the information on those projects to be implemented in response to the requests from WUAs shall be shared with DDCs and VDCs through the implementation periods.

Chapter 3 Current State of Irrigation in Terai region

3-1 Overview of Terai region

3-1-1 Climate and Geology

The Terai region spreads in the southern part of Nepal covering from the west boarder to the east boarder and lies in north of the Gangetic Plain of India. It has 17% of the total land area of the country, including the area with the lowest elevate in the country: 70 meters above sea level. It enjoys the abundant amount of the sun light and rain fall of the sub-tropical climate with fertile soil, and there are a large number of irrigation systems with surface and ground water. The majority of the food crops for national consumption are produced in this region.

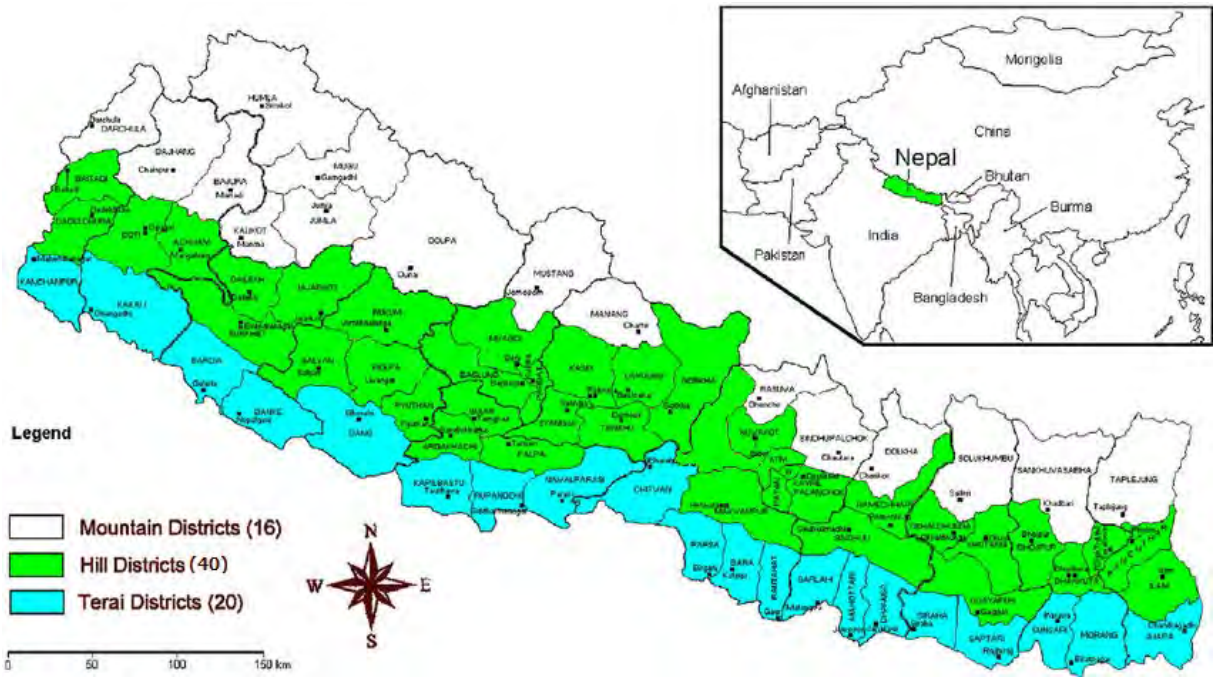


Figure 3-1-1 20 Districts of Terai region (highlighted with light blue)

Source: Drawn by the Survey team based on the Research Gate Website (https://www.researchgate.net/figure/227417012_fig1_Fig-1-Political-map-of-Nepal-showing-study-district-and-other-districts-by-ecological [Accessed on 15/08/2016])

Terraced paddy field is one of the typical scenery of Nepal, however, it has become more and more difficult to maintain those fields, due to decreased labor force and reduced collaborative agriculture works in the hilly area of Nepal. The area has recently experienced a rapid population decrease due to a drastic increase of emigrants from rural areas to urban areas or foreign countries. This tendency has caused an increase in the abandoned farmland area, a decrease in the soil productivity and an increase in the frequency of soil erosion and landslide in Hill and Mountain regions of Nepal. In addition, long-lasted conflicts, in conjunction with a widening gap between the rich and the poor, made people tired and lose their identity of community.

The tendency of an increase of emigration is also seen in Terai region. More people have abandoned agriculture to work for manufacturing in near-by factories or to work in other countries, although the degree of depopulation is not significant. Unlike those terraced paddy fields whose water retention function has

reduced, paddy fields in the plain area tend to have little damage caused by soil erosion. This implies that Terai region has demonstrated its potential for the further development of irrigated agriculture, since the region meets the required geographical conditions; however, sediments brought by river stream from upstream should be removed incessantly.

As seen earlier, there are 20 Districts within Terai region, and each District is composed of villages and municipalities, which are the minimum administrative unit of Nepal. The VDCs are supposed to have general information on the irrigation facilities which exist within their village, and the DDCs are supposed to have such information at the district level.

Table 3-1-1 Districts in Terai region

No.	District	Population (National Population and Housing Census 2011)	No. of the VDCs	No. of the Municipalities	Administrative Zone	Development Region	State
1	Kanchanpur	451,248	4	8	Mahakali	Far-Western	State 7
2	Kailali	775,709	28	8	Seti		
3	Bardiya	426,576	18	5	Bheri	Mid-Western	State 5
4	Banke	491,313	33	2			
5	Dang	552,583	31	4	Rapti		
6	Kapilbastu	571,936	53	6	Lumbini	Western	
7	Rupandehi	880,196	48	6			
8	Nawalparasi[18]	643,508	56	7			
9	Chitwan	579,984	8	8	Narayani	Central	State 3
10	Parsa	601,017	66	2			State 2
11	Bara	687,708	68	6			
12	Rautahat	686,722	84	3			
13	Sarlahi	769,729	84	5	Janakpur		
14	Mahottari	627,580	66	3			
15	Dhanusha	754,777	71	6			
16	Siraha	637,328	63	6	Sagarmatha	Eastern	
17	Saptari	639,284	91	5			
18	Sunsari	763,487	39	5	Kosi		State 1
19	Morang	965,370	50	8			
20	Jhapa	812,650	33	8			
TOTAL		**13,318,705**	**994**	**111**	**9 (out of 14)**	**5 (out of 5)**	**5 (out of 7)**

Note; VDC stands for the Village Development Committee.

Sources: Local Governance and Community Development Programme – II, Ministry of Federal Affairs and Local Government (http://lgcdp.gov.np/GIS_national [Accessed on 16/08/2016]), and Wikipedia (https://ja.wikipedia.org/wiki/%E3%83%8D%E3%83%91%E3%83%BC%E3%83%AB%E3%81%AE%E8%A1%8C%E6%94%BF%E5%8C%BA%E7%94%BB [Accessed on 15/08/2016])

DOI manages the medium and small scale irrigation systems by district and development region, and it could not be confirmed through this Survey if DOI also manages the systems by administrative zone. DOI remains functioning with their local offices at the district and development region levels, and any near future restructuring of the Department has not yet been confirmed in accordance with the creation of provinces in 2015. It should be noted that there is the possibility of restructuring of irrigation works by province at some point. The following table illustrates the administrative system in Terai region. There are

[18] As results of the establishment of 7 States by the new Constitution, Nawalparasi District is spread over both the States 4 and 5.

25 irrigation systems at a large scale, which are called Main Irrigation Systems and are JMISs between DOI and the WUAs, in Terai region. Out of these 25, 24 systems are managed by the 13 FIMDs, while the remaining 1 is managed by IDD of Rupandehi District of Western Development Region.

3-1-2 Socio-economic Development

The "Nepal Human Development Report 2014" published by the NDP together with the United Nations Development Programme (UNDP) Nepal Office reveals gaps in the Human Development Index Value between Regions and Districts within the country as of 2011. The value of Terai region cannot be compete with that of the national capital, Kathmandu, or that of the western Hill region, but still it remains almost as same as the national average value: 0.490. However, looking at more closely the value per district, there are gaps among Districts in Terai region. Chitwan District marked the highest value, 0.551, while Rautahat District marked the lowest value, 0.386 (see Figure 3-1-2). Likely, regarding the Human Poverty Index Value of 2011, there are significant gaps among Districts in Terai region. Chitwan District marked the lowest value, 24.8, while Rautahat District marked the highest value, 46.4 (see Figure 3-1-3). As seen in Section 2-1-4 of Food Balance, Chitwan District of Central Development Region is one of the districts which have not met the self-sufficiency of food, reasons for which are considered as a rapid urbanization and population growth.

The degree of social bond or solidarity within administrative units or villages in Terai region is not strong, compared to that in Hill region. It is believed that this can be attributed to the background of the society of the region. People in Terai region originally came from different places after measures against Malaria mosquitos were taken by GON in the 1950s. On the other hand, the people in Terai region have formed communities based on the year of immigration, ethnicity or caste, and they have a strong identity of such social communities (Subedi, Das and Messerschmidt. "Tree and Land Tenure in the Eastern Terai, Nepal").

Although the caste system was officially abolished by the 1963 Constitution, the system is still subtly alive within the social structure of Nepal, significant gaps in the living standard remain between higher and lower castes. The opportunities for women and lower castes in education and jobs are still limited, and they are not granted equal access to public service delivery, compared to others.

Table 3-1-2 is a summary of the population and road network in Terai region as of 2011/2012. In the last rows of the table, the proportion of value of Terai region to that of the entire country is shown. 50% of the national population lives in Terai region, and the population density of the region is twice as high as the national average. This indicates that the total production of this region, including the agriculture production, is enough to sustain such a large population. In addition, the road density of Terai region (km/100km^2) is one point five times as high as the national average. This can be attributed to lower costs required for the construction compared to those in Hill and Mountain regions, high population density, and the strategic importance of the region for transit to India.

In order to look at the situation inside of Terai region, all the districts in the region are listed in Table 3-1-2 below in the geographical order from west to east. The population density of the districts in Eastern and Central Development Regions, except Chitwan District, is higher (ranging from 445 persons/km^2 to 652 persons/km^2) than that of the districts in Far-Western, Mid-Western and Western Development Regions, except Rupandehi District (ranging from 189 persons/km^2 to 328 persons/km^2). The road density shows a similar tendency, namely, the density in Eastern and Central Development Regions is higher than

that in Far-Western, Mid-Western and Western Development Regions. These facts indicate that the eastern part of Terai region is more developed than the western part.

Figure 3-1-2 Human Development Index Values across District, 2011

Source: National Planning Commission & UNDP Nepal. 2014

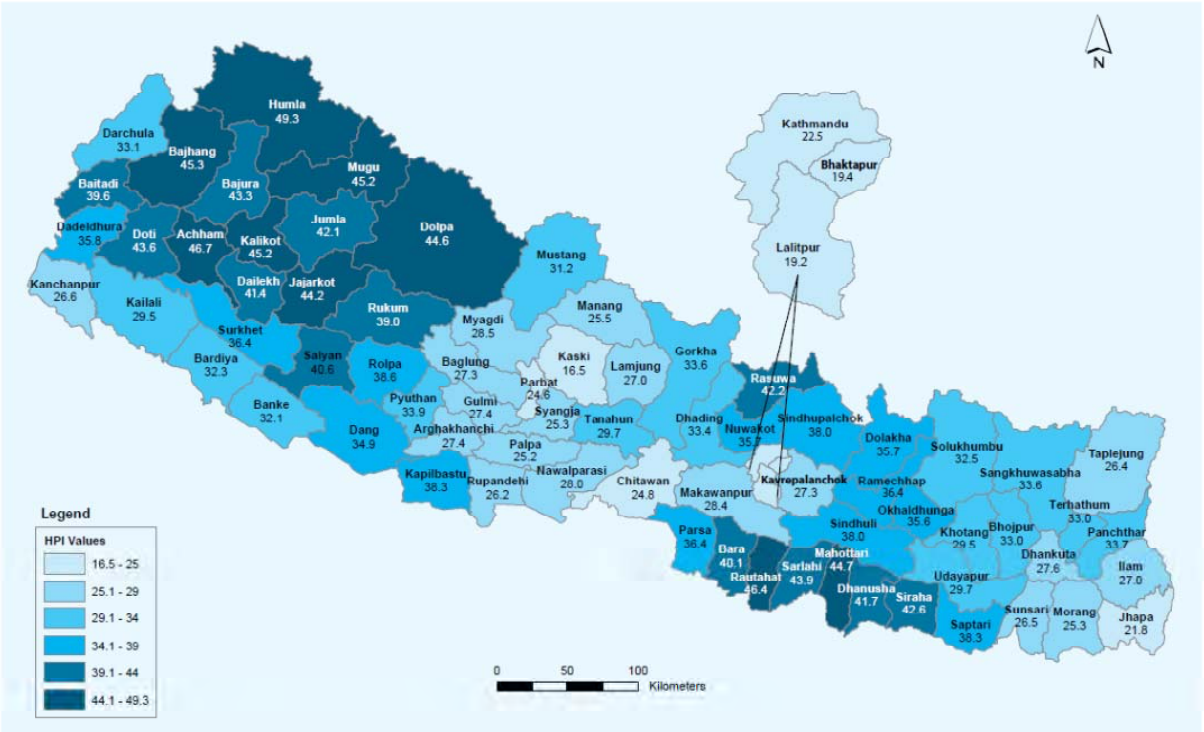


Figure 3-1-3 Human Poverty Index Value across Districts, 2011

Source: National Planning Commission & UNDP Nepal. 2014

Table 3-1-2 Population Density and Road Density in Terai region

No.	District	Population (National Population and Housing Census 2011)	Land Area (km^2)	Population Density (persons/ km^2)	Road Length (km)	Population per 1km of road	Road Density (km/ $100km^2$)
1	Kanchanpur	444,315	1,610	275.97	155	2,859	9.65
2	Kailali	770,279	3,235	238.11	310	2,488	9.57
3	Bardiya	426,946	2,025	210.84	211	2,019	10.44
4	Banke	493,017	2,337	210.96	226	2,178	9.69
5	Dang	557,852	2,955	188.78	366	1,523	12.39
6	Kapilbastu	570,612	1,738	328.32	223	2,559	12.83
7	Rupandehi	886,706	1,360	651.99	164	5,417	12.04
8	Nawalparasi	635,793	2,162	294.08	204	3,119	9.43
9	Chitwan	566,661	2,218	255.48	233	2,429	10.52
10	Parsa	601,701	1,353	444.72	53	11,392	3.90
11	Bara	701,037	1,190	589.11	167	4,189	14.06
12	Rautahat	696,221	1,126	618.31	88	7,927	7.80
13	Sarlahi	768,649	1,259	610.52	181	4,237	14.41
14	Mahottari	646,405	1,002	645.11	185	3,489	18.49
15	Dhanusha	768,404	1,180	651.19	195	3,938	16.54
16	Siraha	643,136	1,188	541.36	145	4,438	12.20
17	Saptari	646,250	1,363	474.14	247	2,622	18.09
18	Sunsari	751,125	1,257	597.55	191	3,932	15.20
19	Morang	964,709	1,855	520.06	216	4,462	11.66
20	Jhapa	810,636	1,606	504.75	197	4,123	12.24
Total or Average of Terai region (A)		**13,350,454**	**34,019**	**392.44**	**3,958**	**3,373**	**11.63**
Total or Average of Nepal (B)		**26,494,504**	**147,181**	**180.01**	**11,636**	**2,277**	**7.91**
(A) / (B)		**50%**	**23%**	**218%**	**34%**	**148%**	**147%**

Source: Department of Roads. Road Network Data (2011/2012)

3-1-3 Land Ownership

The problems around the land ownership in Terai region stem from the malfunction of clear rules around the issue, including the land registration system.

It is said that the land was traditionally distributed among the neighbors through discussion and verbal agreements, and even today, not many Nepali people are aware of the land registration system. There is a study which states that a half of the land owners in Nepal do not legally have the property right (Wily. L.A. 2008. "Land Reform in Nepal: Where is it Coming From and Where is it Going?" p.72), and there have been cases where the claimed landowners could not submit any official document which proves their property right on the land inherited from generation to generation, when they are involved in land conflicts.

Land conflicts can be caused when the owners of neighboring plots have different understandings of the plot border, or when one of them intentionally tries to expand his/her plots beyond the plot border. In addition, the case where an owner bribed the surveyor to manipulate the measurements, the case where a person registered unregistered plots of somebody else in his/her name, and the case that a former owner of the land did not take the necessary procedure to change the ownerships after selling his/her land, and finally

he/she pushed out the new owner from the land have been also reported[19]. Moreover, there were cases where those people who do not have land but have been contracted by owners for actual cultivation on the ground, start to claim the ownership of the entire or part of the land as remuneration for their long-time works.

In Nepal, the farmland reform took place in the 1950s, and the Land Act, which is the principal legislation for the reform, was enacted in 1964. The concerned act has been amended several times since then, and the fifth amendment was given to the act in 2002. The act with the fifth amendments is still valid today, although it has not been fully complied for various reasons[20], including the amendment to reduce drastically the ceiling of the agriculture land area (See Table 3-1-3).

Table 3-1-3 Differences in the ceilings of the land area to be possessed before and after the fifth amendments to the Land Act

Region	Before the fifth amendment (ha)			After the fifth amendment (ha)		
	Farmland	Residence	Total	Farmland	Residence	Total
Terai	16.40	2.00	18.40	6.77	0.68	7.45
Kathmandu Valley	2.70	0.40	3.10	1.27	0.25	1.52
Others	4.10	0.80	4.90	3.56	0.25	3.81

Source: Saito; Saito and Paudel. 2015

The Nepal Living Standards Survey 2010/2011 revealed the situation of the land ownership and utilization as follows. Table 3-1-4 illustrates the land ownership and utilization by all the population of each region. As the left column of the table, “Proportion to all the land utilized”, indicates, 24.9% of the total land utilized by the population in Terai region is rented-in land. Meanwhile, the right hand of the same table explains the situation of the land which is rented out to others. As average in Terai region, 6.8% of the total land is rented out. The renting in and out of land is more actively undertaken in urban area than rural area in this region.

Table 3-1-4 Land Ownership and Utilization in Terai region

			Percentage to total operated land (%)			Percentage to total owned land (%)		
			Owned and operated land	Rented-in land	Total	Owned and operated land	Rented-in land	Total
Nepal			81.60	18.40	100.00	94.30	5.70	100.00
Mountain region			87.80	12.20	100.00	94.90	5.10	100.00
Hill region			86.20	13.80	100.00	95.00	5.00	100.00
Terai region	Total		75.10	24.90	100.00	93.20	6.80	100.00
	Urban Area		68.20	31.80	100.00	85.20	14.80	100.00
	Rural Area	Eastern Development Region	71.20	28.80	100.00	95.20	4.80	100.00
		Central Development Region	75.40	24.60	100.00	95.80	4.20	100.00
		Western Development Region	80.60	19.40	100.00	95.10	4.90	100.00
		Mid & Far Western Development Region	80.50	19.50	100.00	88.40	11.60	100.00

Source: Central Bureau of Statistics. National Living Standard Survey 2010/2011

[19] The Asia Foundation. 2014. LAND DISPUTES AND SETTLEMENT MECHANISMS IN NEPAL’S TERAI, JSRP Paper

[20] Saito et al. 2015. A Simulation Analysis on Land Reform in Nepal

Unlike the previous table, the following table 3-1-5 illustrates the land ownership and utilization by only farmers. The proportion of farmers whose farming land is all rented-in, in other words, the proportion of farmers without land in Terai region is 9.1%, which is relatively higher than that in other regions, since the proportion of national average is 5.4%, that in Mountain region is 1.5%, and that in Hill region is 2.7%. Within Terai region, the proportion of the farmers without land in Eastern and Central Development Regions is 9.1% and 11%, respectively. These proportions are higher than those in Western (3.2%), Mid- and Far-Western (3.7%) Development Regions. There are more population in Eastern and Central Development Regions, and therefore, the number of farmers without land is arguably also large in these development regions.

Based on the situation of land ownership in Terai region mentioned above, those points to be considered to bring forward the cooperation in the irrigation sector in Terai region are put together in "6-6 Considerations for Future Surveys and Implementation of the JICA-TCP".

Table 3-1-5 Land Ownership, Renting-in and Renting-out of Farmers in Terai region

			Percentage of households with owned agriculture land (%)	Percentage of households renting-out land (%)	Percentage of households renting-in land (%)	Percentage of households renting-in land only (%)
Nepal			94.60	10.20	31.60	5.40
Mountain region			98.50	10.60	28.10	1.50
Hill region			97.30	9.70	28.00	2.70
Terai region	Total		90.90	10.60	36.20	9.10
	Urban Area		80.50	17.50	38.60	19.50
	Rural Area	Eastern Development Region	90.90	8.80	41.10	9.10
		Central Development Region	89.00	8.10	35.90	11.00
		Western Development Region	96.80	8.30	31.80	3.20
		Mid & Far Western Development Region	96.30	15.90	31.20	3.70

Source: Central Bureau of Statistics. National Living Standard Survey 2010/2011

In the existing irrigation system, there have been reported disputes on the water distribution. Most of the canals are equipped with several intake and drainage points, and this allows those farmers in upper streams to induce more volume of water than they are supposed to do. Disputes may occur when an inequity of water distribution is seen (Stein. D and Suykens. B. 2014. "Land Disputes and Settlement Mechanisms in Nepal's Terai").

3-1-4 Ethnic issues

There are different ethnic and social groups in Terai region which are dedicated in agriculture. One of such groups is Madhesi people, for instance, and irrigation systems are important common assets for them. Madhesi established hundreds kilometers of canals in today's Jhapa and Morang Districts hundreds of years ago. Every year, Madhesi people live in areas between mid-west and far-east elects their village leaders (*badghar*) between January and February (One vote per household). Badghar has the authority to order village residents to repair canals within the village. For a canal runs through several villages, *badghars* of the concerned villages select a *Chaundhary* who is responsible for O&M of such a canal.

Chaundhary can give an instruction to *badghar* to send villagers for the construction and/or rehabilitation of such a canal. The equity among the villages is an important factor for the distribution of water from such a canal[21].

The promulgation of the new Constitution in 2015 has brought about a new social, economic and political tension in the country especially in Terai region. There has been seen protest activities over the country around the Constitution promulgated in September 2015. In Southern Nepal, the protest groups organized general strikes called *bandas*. Vehicles of those people who did not participate in the strikes, office buildings of the government agencies and facilities belonging to the police were attacked by the protest groups, and frequent conflicts between the protest groups and the security units have left more than fifty casualties from both sides.

This situation adds one more reason for DOI to develop guidelines for the Gender Equality and Social Inclusion (GESI) in order to promote the GESI in irrigation policies and projects. In line with this, DOI is making efforts to enhance the participation of different ethnic and social groups of Terai region in the irrigation related projects and activities.

3-2 Outline of Irrigation Systems

3-2-1 Definition of the Scale of Irrigation Systems

The acreage for small, medium, large and major scales of irrigation system are different between Hill and Terai region, because of topography. The table below shows the definition of scales of irrigation system in these two regions.

Table 3-2-1 Definition of Irrigation System Scale

Scale	Hill Area	Terai region
Major	> 1,000ha	> 5,000ha
Large	500 to 1,000ha	2,000 to 5,000ha
Medium	25 to 500ha	200 to 2000ha
Small	< 25ha	< 200ha

Source: Irrigation Policy 2013

The different scales of irrigation systems in Terai region can be classified into the following four categories: small (less than 200 ha), middle (from 200 to less than 2,000 ha)[22], large (from 2,000 to less than 5,000 ha), and major (more than 5,000 ha). Based on this categorization, DOI divides the irrigation systems into two categories for their own management purpose: the small and medium scale irrigation systems and the large and major scale irrigation systems.

3-2-2 Definition of Canals

The main and lower level canals are defined by stream order. Meanwhile, those secondary and lower level canals are classified by their irrigable areas. The table below summarizes the definitions of irrigation canals in Nepal. For example, a canal which can irrigate an area ranging from 30 to 100 ha is classified as tertiary canal, even if it is directly offtaking from the main canal.

[21] Cederroth, Sven (1995), 'Managing the Irrigation: Tharu Farmers and the Image of Common Good', Nordic Institute of Asian Studies, Denmark.

[22] This definition is different from the definition by ADS of the governmental middle-scale irrigation systems. According to ADS, the irrigated area of the governmental middle-scale irrigation systems ranges from 5,000 to 10,0000ha.

Table 3-2-2 Definitions of Canal

Terms utilized in this report	Terms	Definition
Main Canal	Main Canal	The canal off taking directly from the intake or headwork
Secondary Canals	Branch or Secondary Canal	The canal off taking from the main canal.
	Distributaries or Sub-Secondary Canals	The canal offtaking from main and other canals, , which irrigates the area from 100 to 500 hectares
Tertiary Canals	Minor or Tertiary Canals	The canal off taking from main or secondary canals, which irrigates the area from 30 to 100 hectares.
On-farm Canals	Watercourses	The canal off taking from main, secondary or tertiary canals, which irrigates the area from 4 to 30 hectares.
	Field Channels	The canal off taking from main, secondary or tertiary canals, which irrigates the area up to 4 hectares.

Source: Irrigation Policy 2013

3-2-3 Management Type of Irrigation Systems

These small and medium scale irrigation systems in Terai region, whose irrigated area is less than 2,000 ha, are originally traditional FMISs. They had been developed, operated and managed by the beneficiary farmers for years. For such FMISs to have government supports for the rehabilitation or upgrade of facilities, water user groups (WUGs) of those FMISs, which are composed of beneficiaries, are required to organize WUAs with the registration to IDD or another irrigation office in charge, prior to the submission of the application for government supports.

With the registration to the government agencies, the traditional WUGs are turned into the FMIS WUAs registered to the government, and they become eligible for the government support.

Such WUAs tend to have few problems and challenges in the collective management of irrigation facilities. They are organized on the basis of small scale community-based traditional groups for the irrigation, and they can develop their regulations based on the existing traditional organizational structure and regulations, although they can also refer to the organizational structure and regulations developed by the government, with the guidance of Association Organizer. Moreover, their members' experience in the management of the irrigation systems and the group of users will help the WUAs to manage their organizations.

The government intervention to FMISs is mainly on the organization and the registration of WUAs besides on the rehabilitation of facilities. The traditional organization structure and regulations applied on the ground are respected in the process of the registration to convert their irrigation system into an FMIS registered to the government. When the construction work is completed, and the training in O&M of the system and agriculture is implemented, the management of the irrigation system is transferred back to the concerned WUA of FMIS. After the transfer of management, the government provides a minimum intervention for O&M. The office of IDD/IDSD is normally situated far away from the WUAs, and this geographical distance likely contributes to less support from IDD/IDSD to the WUAs after the transfer and the initial training. Since such a FMIS is originally a property of beneficiary farmers, it cannot be the target of IMT, even if the government manages the system temporarily during the construction period.

For the medium scale irrigation systems among FMISs, GON through DOI has been implementing the

Medium Irrigation Project (MIP) with its own budget since 2004/05. The targets of this project are the medium scale irrigation systems over the country and its objectives are expansion of the irrigated area and improvement on the agricultural productivity. According to DOI, MIP has already completed works by August 2016 for 36,711 ha of the 288 irrigation systems, and is currently working for 95,433 ha of the 679 irrigation systems. DOI has the intension to continue the current support to the medium scale FMISs for the time being. The targets of those projects supported by donors, CMIASP-AF and IWRMP-AF are also medium scale FMISs (refer to 3-4-2 The Contents and Challenges of the On-going Projects).

In Terai region, there are a large number of FMISs registered to the government and the traditional FMISs which have never received the government support as well. According to the GWID, there are numerous groundwater irrigation systems in Terai region. IDD or IDSD of each district does not have the information on the actual number of FMISs within the jurisdiction. Consequently, DOI neither has the data of the actual number and name of FMISs.

On the other hand, there are large or major scale irrigation systems which are developed by DOI. They are called “Main Systems” and there are a total of 25 Main Systems in Terai region. Out of the 25 systems, 24 systems are directly administrated by IMD. These Main Systems are classified into 3 types by the water management conditions in the area prior to the establishment of Main System: Type 1) Systems which were established by GON to benefit rain-fed farming plots. Type 2) Systems which were established by GON to integrate several small-scale FMISs into one large-scale Main System, and Type 3) Systems which were established by GON to integrate the rain-fed farming plots and neighboring FMISs under a large-scale Main System.

They are JMISs, which are managed jointly by DOI (13 FIMDs and 1 IDD) and the WUAs. The number of the WUA members of JMIS may be over 1,000, and if it is the case, to manage such a big group, there should be put in place a systematic organizational structure and clear regulations on which the members can agree. Accordingly, the WUAs of JMIS are required higher organizational management capacity than those WUAs of FMIS. The operation of Main Systems requires experiences as well as engineering knowledge. Moreover, due to the scale of Main Systems, the total canal length tends to be long, and WUA’s burden for O&M is heavy in both the terms of work load and costs.

The columns of canal and maintenance of the following table show the distribution of roles on maintenance between GON and WUA, although details of such a distribution are determined by a written agreement as result of negotiation (Irrigation Regulation 2000, Irrigation Policy 2013). Depending on the specific conditions of each system, such as the scale, the status quo of facilities, and the WUA’s current level of capacity, the actual distribution of roles between GON and WUA can be adjusted. In JMISs, the problems of a delay and/or a lack in the development of the major irrigation facilities are often experienced. In order to make a required amount of water reach to tertiary and lower level canals, there are cases where WUAs take necessary measures including those tasks which are not original the WUAs’ tasks such as the cleaning of the main canals. Even when the major irrigation facilities are well developed, there are cases where the management of the entire irrigation system does not work fully and the water is not distributed in an equitable manner. Appropriate technical assistance to address such managerial problems is required.

Table 3-2-3 Distribution of roles in JMIS

Canal	Construction	Maintenance
Main Canals	DOI	DOI (IMD)
Secondary Canals	DOI	DOI (IMD) in the participation of WUA
Tertiary Canals	DOI or WUA (construction by outsourced contractors or by WUA members)	WUA
On-farm canals		

Note: The Irrigation Regulation 2000 and the Irrigation Policy 2013 describe the distribution of roles in the maintenance works, but not that in the construction.

Source: Irrigation Policy 2013 and DOI especially for the distribution of roles in the construction

The management of the large and major scale irrigation systems mentioned above is transferred from DOI to the WUAs of JMIS, which are organized with support from the FIMD. DOI provides the WUAs with the training in the organizational development, O&M, etc. The FIMD office is normally situated near from the WUAs and the FIMD and the WUAs can maintain a good level of mutual communication. Because of such a geographical proximity, the WUAs seem to have a better access to the government agencies to seek supports from them. FIMD provides the WUAs with technical assistance to develop the irrigation schedule and to increase the knowledge required for the irrigation management such as Evapotranspiration (ET) and irrigation efficiency, among others. However, the decision-making power is always left to the WUAs.

The following table is a summary of the comparison of features between FMISs and JMISs.

Table 3-2-4 Comparison of Features between FMISs and JMISs

Items	FMISs	JMISs partly handed over by IMT Project
Legislative Background (Law, Regulations)	Muluki Ain 1963 Water Resources Act 1992 Water Resource Regulation 1993 Irrigation Policy 2013	Water Resources Act 1992 Water Resource Regulations 1993 Irrigation Policy 2013
Strategic Background (Strategy, Plan)	Water Resource Strategy 2002 National Water Plan 2005 ADS 2015 - 2035	Water Resource Strategy 2002 National Water Plan 2005 ADS 2015 - 2035
Supervisory Office	Irrigation Development Division (IDD) Irrigation Development Sub-division (IDSD)	Irrigation Management Division Project Office (IMDPO)
Number of Irrigation Systems in Terai (surface water and groundwater systems)	3,500 – 7,000 ha (a total irrigated area is estimated as approximately 709,831 ha) [#1]	25 systems (total command area is 330,143 ha)
Command area in Terai region	Small systems (less than 200 ha) Medium systems (200 – 2,000 ha)	Large systems (2,000ha – 5,000ha) Major systems (more than 5,000ha)
Financial sources for the development / rehabilitation	Multi and bilateral donors Own funds of GON	Multi and bilateral donors Own funds of GON

Items	FMISs	JMISs partly handed over by IMT Project
O&M Implementation institutions / agencies	WUAs	➢ Headworks & main canals: DOI ➢ Secondary canals: DOI with participation of WUAs ➢ Tertiary canals & Distribution Networks: WUAs ➢ Policy: the regular management responsibility of large systems is gradually transferred from IMDPOs to WUAs.
Implementation institutions / agencies for the development and rehabilitations	➢ Water users in principle ➢ Water users with the support from the IDD/IDSD staff, in case that water users cannot technically and financially bear with burdens.	➢ Portions for DOI: DOI ➢ Portions for WUAs: ✓ Water users in principle ✓ Water users with the support from the IMDPO staff, in case that water users cannot technically and financially bear with burdens.
Issues for further development / rehabilitations	Increased irrigation efficiency (ADS[#2]) ✓ Improvement on headwork, main canal and distribution networks (ADS) ✓ Improvement on water management (ADS) ✓ Capacity development of WUAs (ADS)	Promotion of IMT (Irrigation Policy 2013, ADS) ✓ Capacity development of IMD (ADS) ✓ Capacity development of WUAs (ADS) ✓ Improvement on water management (ADS) ✓ Rehabilitation / Improvement of facilities (ADS)
Technical assistance needed in order to optimize water use for reliable year-round irrigation (2016.8.14 workshop results)	➢ Newly installation of tube-well as water source. ➢ Maintenance of existing DTWs & STWs ➢ Maintenance (dredging) of the existing reservoirs as water source. ➢ Enhancement of improvement on ISF collection mechanism, including periodical auditing system. ➢ Establishment/update of asset management of irrigation facilities. ➢ Construction and/or improvement of on-farm irrigation system ➢ Introduction of new technology to increase irrigation efficiency ➢ Construction/maintenance of water-regulating structures ➢ Establishment/improvement of drainage systems for the medium/large scale projects in plain area. ➢ Enhancement of construction of on-farm irrigation and drainage system	➢ Newly installation of tube-well as water source. ➢ Maintenance of existing DTWs & STWs ➢ Maintenance (dredging) of the existing reservoirs as water source. ➢ Enhancement of improvement on ISF collection mechanism, including periodical auditing system. ➢ Establishment/update of asset management of irrigation facilities. ➢ Construction and/or improvement of on-farm irrigation system ➢ Introduction of new technology to increase irrigation efficiency ➢ Construction/maintenance of water-regulating structures ➢ Establishment/improvement of drainage systems for the medium/large scale projects in plain area. ➢ Enhancement of construction of on-farm irrigation and drainage system

Items	FMISs	JMISs partly handed over by IMT Project
Relative importance on the above technical assistance weighted by participants of the workshop held in the DOI central office	**30%**	**70%**

#1 Irrigated area in Terai region (2011/12) = 953,740ha
Command area of the 25 Main Systems in Terai region = 330,143ha
Irrigated area (estimation) by FMISs in Terai region = 953,740 – 330,143 = 623,597ha
With the assumption of: the average size of FMIS command area = 100ha, No. of FMISs = 6,235
With the assumption of: the average size of FMIS command area = 200ha, No. of FMISs = 3,118
#2 ADS

Source: Survey team

3-2-4 The Process of Facility Improvement and Farmer's Participation

(1) FMIS

The farmers (WUG/WUA members) participate in the irrigation infrastructure rehabilitation/upgrading from the beginning. First of all, farmers have to make contact with IDD and to apply for improvement of facilities by submitting the filled "Demand Form" and depositing the amount of 50Rs./ha in accordance with the size of the command area. The process from the survey to designing is carried out by DOI staff discussing with the applicant WUG/WUA members, by utilizing the opportunities such as monthly meetings with the WUG/WUAs. It takes 2 to 3 months to go through this process. The following flow chart shows the process of infrastructure rehabilitation / upgrading of a FMIS. It involves the screening and examination at the IDD, the Regional Directorate and the DOI central office, respectively. It takes 2 to 3 years until the budget is allocated to the applied works, after the final approval by the DOI central office is given on the application.

(2) JMIS

The WUA's main executive committee submits the filled-up "Demand Form" to the FIMD office in charge. The FIMD staff and the concerned WUA members discuss the contents of government support, its priority, etc. to reach an agreement. Since the irrigation system was developed by GON, a feasibility study is not required for the rehabilitation / upgrading of the system, but the cost estimation is essential. Once a detailed plan of government support is developed, the FIMD makes a written proposal report and submits it to IMD. Once it is approved and the necessary budget is allocated, the government support will be provided.

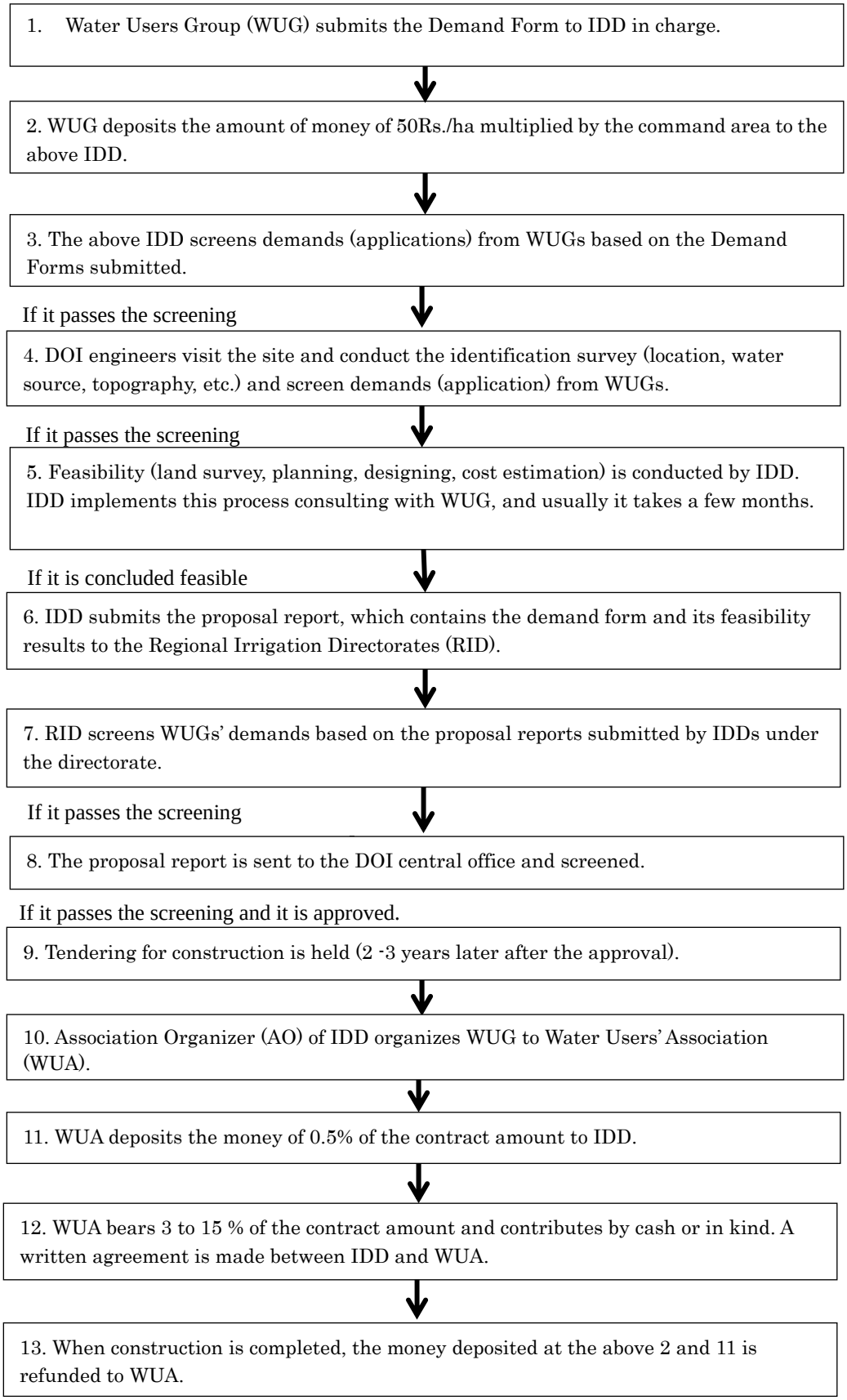


Figure 3-2-1 Flow Chart of Rehabilitation Process

Source: Survey team

Table 3-2-2 Comparison of the FMIS and the JMIS

Item	FMIS	JMIS
WUA	✓ Water users organize the WUAs at each level of the main, secondary and tertiary canals. In this regard, there is only the main committee established for a small scale system. The structure of the committees varies from the system to system. ✓ The WUA is registered to IDD or IDSD. ✓ A constitution is made by the WUA with support from IDD or IDSD. It can be made based on traditional rules. ✓ The committee members are selected by methods stipulated by the constitution, which is usually an election. ✓ The General Assembly Meeting is usually held once a year, and as needed for emergency case. It is stipulated in the constitution. ✓ The treasurer of the main committee manages finance. The financial status is reported to the members at the General Assembly Meeting. ✓ An audit report is submitted to IDD or IDSD annually in order to re-new the registration. ✓ Information is distributed from the main committee to the members through verbal messages, cell phone, notice to the public, FM radio, etc.	✓ Water users organize the WUA s at each level of the main, secondary and tertiary canals. The number and the structure of WUAs vary from the system to system. For those canals at a lower level than the tertiary canal and for the canals at the field level, water users organize Water Users Groups (WUGs). ✓ The WUA main committees are registered to FIMD. The WUAs at the secondary canal level are registered to the WUA main committees. The WUAs at the tertiary canal level are registered to the WUAs at the secondary canal level. ✓ A constitution is made by the WUA with support from FIMD. It is usually made based on traditional rules. ✓ The committee members are selected as stipulated in the constitution. They are usually selected by election. ✓ The General Assembly Meeting is usually held once a year, and as needed for emergency case. The General and Special Assembly Meetings are stipulated in the constitution. In case that there are too many WUA members to meet at the same time, the representative system can be adopted. ✓ The treasurer of the main committee of the WUA manages finance. The financial status is reported at the General Assembly Meetings. And then, the participants inform all other members. ✓ An audit report is submitted to FIMD annually in order to re-new the registration. ✓ Information is distributed from the main committee to members through verbal messages, cell phone, notice to the public, FM radio, etc.
Participation of Farmers	Refer to “3-2-4. The Process of Facility Improvement and Farmer’s Participation (1) FMIS”	Refer to “3-2-4. The Process of Facility Improvement and Farmer’s Participation (2) JMIS”

Item	FMIS	JMIS
Canal Cleaning	✓ The WUA is responsible for the entire irrigation system. ✓ No written records, except for expenditures. ✓ No written plans. The canals are cleaned twice a year before the commencement of the crop seasons, at least. ✓ The WUA can apply for technical or financial support from IDD for anything the WUA alone cannot handle.	✓ Responsibilities of FIMD and of the WUA are stipulated in the agreement (Table 3-2-3) ✓ FIMD's maintenance works are planned and reported since the budget is allocated from the consolidated fund. ✓ The WUA has no written records, except for expenditures. ✓ No written plans. The canals are cleaned twice a year before the commencement of the crop seasons, at least. FIMD may support the WUA to plan, if requested. ✓ The WUA can apply for technical or financial support from FIMD for anything the WUA alone cannot handle.
Repair works	✓ The WUA is responsible for the entire irrigation system. ✓ No written records, except for expenditures. ✓ The WUA can apply for technical or financial support to IDD in the rehabilitation, or for anything the WUA alone cannot handle. (Refer to "3-2-4. The Process of Facility Improvement and Farmer's Participation (1) FMIS")	✓ Responsibilities of FIMD and of the WUA are stipulated in the agreement (Table 3-2-3) ✓ The FIMD works are planned and reported since the budget is allocated from the consolidated fund. ✓ The WUA has no written records, except for expenditures. ✓ The WUA can apply for technical or financial support to FIMD in the rehabilitation or for anything that the WUA alone cannot handle (Refer to "3-2-4. The Process of Facility Improvement and Farmer's Participation (1) FMIS").
Water Allocation	✓ The WUA makes the irrigation schedule by going through the procedure written in the constitution. ✓ The schedule needs to be informed to and approved by all the WUA members. ✓ The WUA members can express objections to the schedule, if any.	✓ The WUA makes the irrigation schedule with support from FIMD. All the related decisions are made by the WUA. ✓ The schedule needs to be informed to the lower-level committees and to be approved by all the WUA members. ✓ The WUA members can express objections to the schedule, if any.
Water Delivery	✓ The WUA members operate the canal system and deliver water. ✓ No record is taken, except for the pumping irrigation systems.	✓ In accordance with the schedule, FIMD and the WUA operate the canal system in charge and deliver water. ✓ The Flow rate is confirmed by gauges or Parshall flumes if they are furnished.
Farming	✓ Paddy is cultivated in the monsoon season. ✓ Wheat, vegetables, pulses, maize are cultivated in the winter season. ✓ Vegetables, pulses are cultivated in the spring season where water is available. ✓ The farmers understand the importance of irrigation facilities. ✓ Increased benefits by improved yields and/or marketing becomes as incentive.	✓ Paddy is cultivated in the monsoon season. ✓ Wheat, vegetables, pulses, and maize are cultivated in the winter season. ✓ Vegetables, pulses are cultivated in the spring season, where water is available. ✓ Reliable water delivery down to the tail end becomes an incentive; reliable water delivery results in an expansion of irrigated area, and increased yields.

Source: DOI, WUA

3-3 Situation of Irrigation and Irrigated Agriculture

3-3-1 Crop Production in Terai Region

There are three crop seasons in Terai region: monsoon (summer) from July to October, winter from December to March and spring from March to July. While rice is cultivated in monsoon, wheat is a winter crop. The following figure is a crop calendar in Terai region.

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rice (Main)												
Rice (Spring)												
Maize (Winter)												
Wheat												
Maize (Spring)												
Rapeseed and Mustard												
Jute												
Pluses and Vegetables												

Figure 3-3-1 Crop Calendar in Terai Region

Source：DOA

The table below shows the cultivation areas of main crops in Terai region. Maize, pluses and vegetables are produced in the winter and spring seasons. The cultivation areas of rice in the region account for 68.3% of the national total areas, likewise, the areas of wheat, pulses and vegetable account for 57.2%, 75.3% and 55.6%, respectively. The cultivation areas of the Eastern and Central Development Regions in Terai region are significantly larger than those of other three Development Regions. The production of the Eastern and Central Development Regions in Terai region seems to contribute significantly to the national total production, and to play an important role in the irrigation development. Meanwhile, the Cultivation area of maize in Terai region accounts for only 17.4% and it is mainly produced in Hill region.

Table 3-3-1 Cultivation Area of Main Crops in Terai Region

Region	Eastern	Central	Western	Mid western	Far western	Total (Terai)	Nepal	Percent (%)
Paddy	297,363	280,744	190,850	126,730	120,246	1,015,933	1,486,951	68.3%
Maize	65,150	37,162	14,770	35,000	9,140	161,222	928,761	17.4%
Wheat	70,935	165,500	79,140	50,177	65,933	431,685	754,468	57.2%
Pulses	49,890	72,929	27,985	66,100	30,542	247,446	328,738	75.3%
Vegetables	42,742	57,775	12,740	13,812	14,630	141,699	254,932	55.6%

Source: MOAD. Agricultural Statistics in 2013/2014 in Nepal

3-3-2 Crop Production in Terai Region

The production of rice and pulses, among major crops, in Terai region accounts for 80% of the national total production of the same crops. These crops are produced more in the Eastern and Central Development Regions. The following table shows the production share of major crops among different Development Regions.

Table 3-3-2 Crop Production in Terai Region (tons)

Development Region	Rice	(%)	Wheat	(%)	Pluses	(%)	Vegetables	(%)
Eastern	1,066,353	21.1	183,900	9.8	50,240	14.3	584,880	17.1
Central	1,298,442	25.7	483,241	25.7	80,834	22.9	794,695	23.2
Western	761,711	15.1	245,458	13.0	32,529	9.2	208,073	6.1
Mid-Western	484,567	9.6	154,367	8.2	74,877	21.2	189,281	5.5
Far-Western	353,461	7.0	141,000	7.5	31,340	8.9	209,918	6.1
A total of Terai region	3,964,534	78.6	1,207,966	64.1	269,820	76.6	1,986,847	58.1
A total of Nepal	5,047,047		1,883,133		352,473		3,421,035	
Terai region/ Nepal (%)	78.6		64.1		76.6		58.1	

Source: MOAD. Agricultural Statistics in 2013/2014 in Nepal

3-3-3 Agricultural Cooperatives

The tables below show the number of agricultural cooperative in each district. There are a number of small scale cooperatives, and several cooperatives belong to one large scale or main irrigation system. Members of the cooperatives are different from those of WUAs. Water users of WUAs are not necessarily the member of the cooperatives.

Table 3-3-3 Number of Agricultural Cooperatives by District in Terai Region

Eastern Development Region (1,697 agricultural cooperatives in total)

District	Jhapa	Morang	Sunsari	Saptari	Siraha	Dhanusha	Mahottari
Agricultural Cooperatives	317	192	197	211	236	291	253

Central Development Region (1,390 agricultural cooperatives in total)

District	Sarlahi	Rautahat	Bara	Parsa	Chitwan
Agricultural Cooperatives	275	409	432	163	111

Western Development Region (516 agricultural cooperatives in total)

District	Nawalparasi	Rupandehi	Kapilbastu
Agricultural Cooperatives	73	132	311

Mid-Western Development Region (603 agricultural cooperatives in total)

District	Dang	Banke	Bardiya
Agricultural Cooperatives	253	188	162

Far-Western Development Region (393 agricultural cooperatives in total)

District	Kailali	Kanchanpur
Agricultural Cooperatives	205	188

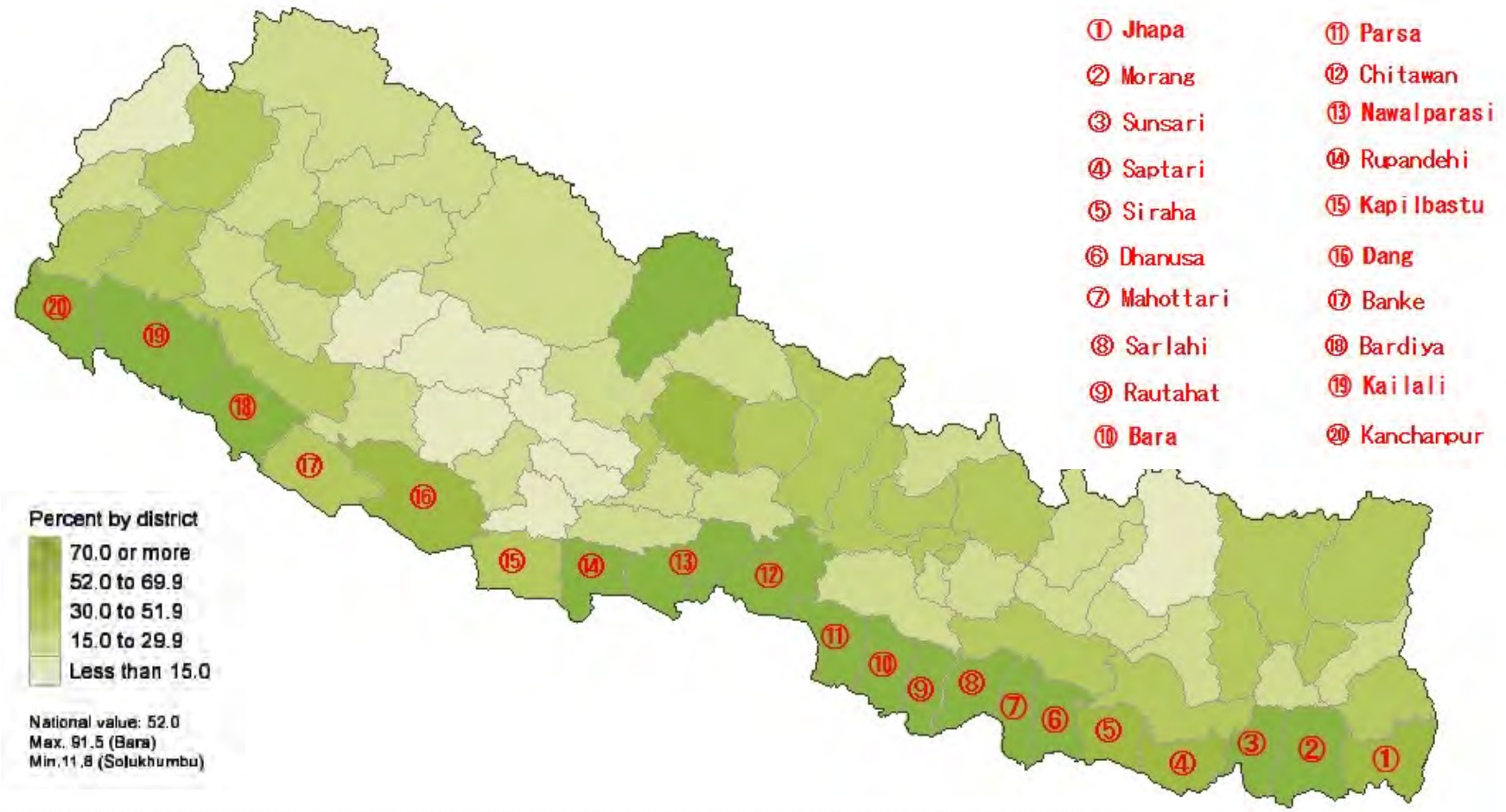
Source: DOA

Table 3-3-4 Farmland area and irrigated area by water source in Terai region

Development Region			Eastern						Central					
District			Jhapa	Morang	Sunsari	Saptari	Siraha	Dhanusa	Mahottari	Sarlahi	Rautahat	Bara	Parsa	Chitawan
No. of total holdings			120,538	126,891	86,650	89,241	88,527	96,006	80,844	98,288	79,233	81,292	59,496	n.a.
Area (ha) of total holdings			102,443	109,943	75,141	73,908	78,798	72,307	64,977	80,678	64,835	56,867	48,899	n.a.
No. of irrigated holdings reporting			70,518	92,912	69,063	61,062	62,404	72,564	59,177	69,597	74,042	75,103	52,012	n.a.
Area (ha) of irrigated holdings reporting			54,774	83,577	68,331	46,620	52,119	52,560	47,137	61,918	59,330	52,048	42,489	n.a.
River/lake/pond	by gravity	No. of holdings	30,072	35,628	35,094	21,679	13,393	20,474	20,730	15,084	14,460	13,443	4,559	n.a.
		Area (ha)	22,470	23,320	38,227	16,144	9,777	11,274	10,225	11,773	9,871	8,751	3,446	n.a.
	pumping	No. of holdings	2,506	6,187	2,128	9,024	6,303	24,001	8,919	13,780	9,862	10,748	16,085	n.a.
		Area (ha)	1,544	5,857	1,414	4,661	3,348	14,185	4,431	12,129	4,659	4,298	9,835	n.a.
Dam/reservoir		No. of holdings	4,461	16,706	1,365	11,088	4,851	6,194	13,359	17,910	14,794	11,147	20,272	n.a.
		Area (ha)	4,373	20,398	807	8,620	3,954	3,603	6,714	12,980	9,732	6,166	14,533	n.a.
Tube well/boring		No. of holdings	30,122	44,703	39,310	30,971	44,492	24,948	29,405	28,039	48,645	51,644	25,892	n.a.
		Area (ha)	22,050	31,714	27,162	16,761	33,689	14,237	18,516	21,984	32,524	30,760	12,525	n.a.
Others		No. of holdings	4,511	2,733	402	994	2,820	8,646	2,647	1,608	1,965	4,426	1,720	n.a.
		Area (ha)	2,400	1,395	104	309	701	5,272	1,323	396	364	485	1,273	n.a.
Mixed		No. of holdings	2,656	1,289	1,084	229	954	6,796	6,720	3,434	5,154	2,562	1,892	n.a.
		Area (ha)	1,938	893	617	126	650	3,990	5,929	2,657	2,180	1,587	876	n.a.
Percentage of Irrigated Land Area			53.5	76.0	90.9	63.1	66.1	72.7	72.5	76.7	91.5	91.5	86.9	76.3
Poverty Head Count Ratio			10.6	16.5	12.0	39.5	34.6	23.1	16.2	17.7	33.4	29.9	29.2	8.9

Development Region			Western			Mid-Western			Far-Western		Total
District			Nawalparasi	Rupandehi	Kapilbastu	Dang	Banke	Bardiya	Kailali	Kanchanpur	
No. of total holdings			101,337	104,174	74,770	86,623	61,433	68,063	111,662	70,573	1,685,641
Area (ha) of total holdings			56,125	71,188	64,578	61,952	44,120	47,234	66,659	44,353	1,285,003
No. of irrigated holdings reporting			82,269	92,334	41,778	65,388	40,648	52,957	101,559	65,640	1,301,027
Area (ha) of irrigated holdings reporting			42,584	58,925	28,068	43,151	22,405	37,940	60,079	39,685	953,740
River/lake/pond	by gravity	No. of holdings	25,950	13,371	12,040	8,173	3,997	9,200	23,988	47,518	368,853
		Area (ha)	10,571	6,403	5,869	4,198	2,013	6,979	12,418	29,628	243,354
	pumping	No. of holdings	13,115	23,275	16,559	1,482	9,532	2,139	11,660	1,678	188,983
		Area (ha)	6,722	11,135	10,115	490	4,757	893	4,873	988	106,334
Dam/reservoir		No. of holdings	10,789	7,338	6,384	50,003	1,015	24,102	4,628	15,638	242,044
		Area (ha)	5,301	4,172	4,516	34,797	361	18,717	3,295	8,775	171,816
Tube well/boring		No. of holdings	32,043	59,740	12,578	7,573	28,441	19,282	66,089	0	623,917
		Area (ha)	16,361	34,880	6,076	3,407	14,243	9,423	35,598	0	381,908
Others		No. of holdings	10,743	4,727	2,023	2,204	2,368	5,364	13,707	3,121	76,729
		Area (ha)	2,211	769	718	171	832	1,640	2,410	295	23,069
Mixed		No. of holdings	4,465	3,421	1,707	561	277	611	3,293	0	47,105
		Area (ha)	1,418	1,566	773	90	199	288	1,485	0	27,260
Percentage of Irrigated Land Area			75.9	82.8	43.5	69.7	50.8	80.3	90.1	89.5	74.2
Poverty Head Count Ratio			17.0	17.3	35.5	25.1	26.4	28.7	33.6	31	

Source: Central Bureau of Statistics. 2015. National Sample Census of Agriculture 2011-2012



Irrigation refers to purposively providing land with water, other than rain, for improving pastures or crop production. Natural flooding of land by rainfall or overflow of rivers is not considered as irrigation. rainwater or uncontrolled flooding, which is collected and later used on the holding, is considered irrigation.
Percentage of irrigated land is the total irrigated land of a district expressed as a percentage of total holdings area of that district.

Figure 3-3-2 Rate of Irrigated area by District

Source: Central Bureau of Statistics. 2014. Population Atlas of Nepal, 2014

3-3-4 Irrigated Area in Terai Region

Terai Region is an advanced irrigated area and irrigated areas account for 74.2% of a total farm land. Surface water constitute 54.6% of water resources for irrigation and 36.6% out of the surface water are supplied by rivers, lakes and ponds (gravity irrigation system: 25.5% and pump irrigation system: 11.1%), and 18% by dams and reservoirs. Meanwhile, groundwater irrigation (shallow and deep wells) accounts 40.0%. This implies the importance of groundwater development and utilization in Terai plain, particularly for the areas where is neither perennial rivers nor storage of water in dams or reservoirs. Table 3-3-4 indicates source of irrigation by region, and Figure 3-3-2 irrigation rate by district. The groundwater irrigation is necessary for year-round irrigation, and its irrigated area is expanded including conjunctive use with surface water. Table 3-3-5 shows areas under irrigation by main systems during monsoon season.

Table 3-3-5 Irrigated Area of the 25 Main Irrigation Systems in the Monsoon Season

S/N	Irrigation Area	Command Area (ha)	Irrigable Area (ha)	Beneficial Households
1	Kankai	8,000	7,000	11,000
2	Sunsari Morang	68,000	60,550	n.a.
3	Chanda Mohana	1,800	1,800	n.a.
4	Chandra Nahar	10,000	10,000	30,000
5	Koshi West Canal (Distribution System)	10,500	10,500	n.a.
6	Koshi Pump Canal	13,180	13,180	n.a.
7	Kamala	25,000	25,000	36,000
8	Hardinath	2,000	2,000	5,600
9	Mansumara	5,200	5,200	n.a.
10	Bagmati	37,600	n.a.	27,000
11	Jhanj	2,000	2,000	n.a.
12	Narayani	28,700	n.a.	n.a.
13	Narayani Tube Well	2,800	2,800	n.a.
14	Narayani Lift	4,750	4,700	n.a.
15	Khageri	3,900	3,900	10,000
16	Nepal Gandak Western Canal	10,300	9,000	n.a.
17	Bhairahawa Lumbini Bhumigath Jalshorat	20,309	10,443	7,000
18	Banganga	6,350	6,000	5,000
19	Praganna Kulo	6,684	5,800	3,900.
20	Babai	27,000	27,000	n.a.
21	Rajapur	14,870	13,200	n.a.
22	Pathraiya	2,000	2,000	n.a.
23	Mohana	2,000	2,000	n.a.
24	Mahakali	11,600	11,600	n.a.
25	Machawar Lift	5,600	3,500	n.a.
	A total of 25 Irrigation Systems	330,143	n.a.	n.a.

Source: Interview with DOI and WUA and their reply to questionnaires

3-3-5 Organizations Related to Irrigation Systems Management

Because of the government policy, irrigation management and O&M are decentralized to WUAs. In principle, small and medium scale irrigation systems are fully transferred to WUAs. Meanwhile, large and major scale irrigation systems are partly transferred to WUAs based on a written agreement between the GON and WUAs, in consideration of technical difficulties in O&M.

(1) Irrigation Management Division (IMD)

IMD has thirteen FIMDs in Terai region. Those thirteen IMDs and IDD of Rupandehi District jointly manages the large scale irrigation systems with the WUAs. In accordance with agreement with the WUAs, they implement (a) operation of irrigation facilities in charge, (b) maintenance and repair of irrigation facilities, (c) formulation of an irrigation plan with WUAs, (d) technical and/or financial support, on a demand basis, for repair works that WUA cannot handle, and (e) organizational development of WUA (Refer to "2-6 Department of Irrigation (DOI)").

(2) Irrigation Development Division (IDD)/ Irrigation Development Sub-Division (IDSD)

IDDs/IDSDs are in charge of rehabilitation and upgrade of irrigation facilities based on demand from WUAs and other farmer groups such as a non-registered water user group (WUG) of farmers. Since those irrigation systems are FMIS, IDDs/IDSDs are not involved in O&M. Once the construction works are completed, they hand over the facilities to respective WUAs (Refer to "2-6 Department of Irrigation (DOI)").

(3) WUA

WUAs are the managing bodies of irrigation systems, not only for FMISs but also for JMISs (Irrigation Regulation 2000). The WUAs of JMIS make decisions on those issues arising from the area under their management within the JMIS. GON supports the WUAs through consultations. In order to receive government assistance, beneficiaries have to establish WUAs following the GON policy, and the WUA main committees must have their written constitutions and be registered to an irrigation office in charge: FIMD, IDD or IDSD. It is necessary to turn in the audit report annually to the office to renew the registration.

The members of WUA main committee cannot exceed eleven, and at least 67% of the members shall be representatives from the areas irrigated with the secondary, tertiary and lower level canals. Water users at each level of the canals, from the main to the tertiary canals, should set up a WUA (Irrigation Policy 2013). The WUA at the tertiary canal composes of the WUA at the secondary canal and therefore is registered as water user to the WUA at the secondary canal. Likewise, a WUA at the secondary canal is registered as water user to the WUA at the main canal. The WUA at the main canal is registered to the government, such as FIMD. For those canals lower than the tertiary canal, a WUA is established at each canal. Those small scale irrigation systems consisting of only a main canal have a WUA at main canal only and does not have a hierarchy of WUAs with WUAs at main, secondary and tertiary canal levels WUAs.

The WUA committee at the main canal addresses issues related to the management of the entire irrigation system under the main canal, while the WUA committee at the secondary canal addresses the issues related to the management of the secondary canal, and the WUA committee at the tertiary canal addresses the issues related to the management of the tertiary canal. The WUA at the main canal can delegate their power and responsibilities to the lower level canal WUAs, and as a result, for example, WUAs at the tertiary canal may have the delegated power and responsibility to carry out the cleaning of their own canals. According to the irrigation policy in 2013, WUA shall have female representatives at a rate of 33% as well as proper representation of Dalit, Downtrodden and Backward ethnic communities.

WUA contributes to construction works by 3 to 15% of the contract amount and this contribution is cash or in kind (Irrigation policy in 2000). The word “in kind” means labor service. WUA members supervise contractors’ construction works after being trained by IDD technical staffs, since IDD engineers cannot come to the site for supervision every day. Meanwhile, WUAs manage, operate and maintain FMISs and on-farm facilities of JMIS. Workload of WUAs to implement O&M of main and secondary canals depends on agreement between the GON and WUA main committees. Activities at lower-level canal WUAs are based on the regulations written by individual WUAs.

3-3-6 Status of IMT

Whereas IMT is one of the important polities in the irrigation sector in recent years, the progress is lagged behind, because the development of irrigation facilities seems to be prioritized to the management of existing irrigation systems in budget allocation. Those projects with support from donor were often implemented as pilot, and within the framework of such projects, only those facilities managed by the target WUAs were improved. The extension of similar investment to other irrigation systems is still on-going. As seen earlier, the requirement of a great deal of budget and labor load for O&M of the intake facilities due to a large volume of sediments is one of the factors which contribute to such a delay in the promotion of IMT.

The progress of IMT in the 25 main systems in Terai region is not significant. In most of the WUAs, their members understand that they have to assume the responsibilities for O&M of the on-farm irrigation systems and for the provision of support to GON in O&M of the main and secondary canals, to benefit from the irrigation water. However there are the preconditions for the WUA members to perform such responsibilities. Namely, enough volume of water is delivered to their plots and they are satisfied with the yields of their crops. Nevertheless, such preconditions have not been met, since the water delivery is not reliable and the users cannot use irrigation water efficiently in many of the irrigation blocks.

The major problems can be summarized as follows:

(a) The tertiary and lower level canals within the irrigation system are not developed, or the functions of the irrigation system have been reduced because of aging (For example, the irrigation systems in Narayani, Kamala, Hardinath, Banganga, and Machawar).
(b) The irrigation water is not delivered as required due to the dilapidation of the main irrigation facilities for aging (For example, the irrigation systems in Hardinath, Machawar, Narayani, Banganga, and Chandra Nahar)
(c) The volume of water flow has been reduced due to changes of canal cross-section by scouring and/or sediments (The Banganga irrigation system)
(d) The amount of sediments accumulated in canals is too large to be removed manually (For example, the irrigation systems in Kamala, Hardinath, and Banganga)

The above cases show that the challenge identified by the WUAs is the fact that water is not reaching to every corner due to problems in somewhere within the irrigation system. Such malfunction of system may promote failures in the water management, and failures in the water management may lower the farmer’s willingness to undertake agricultural works as well as to participate in the WUA’s activities. This may lead to a reduction in the ISF collection rate and subsequently, a reduction of the WUA’s O&M activities. Then, the irrigation facilities may not be kept in good condition and degraded. The irrigation system falls

in a vicious cycle in this way.

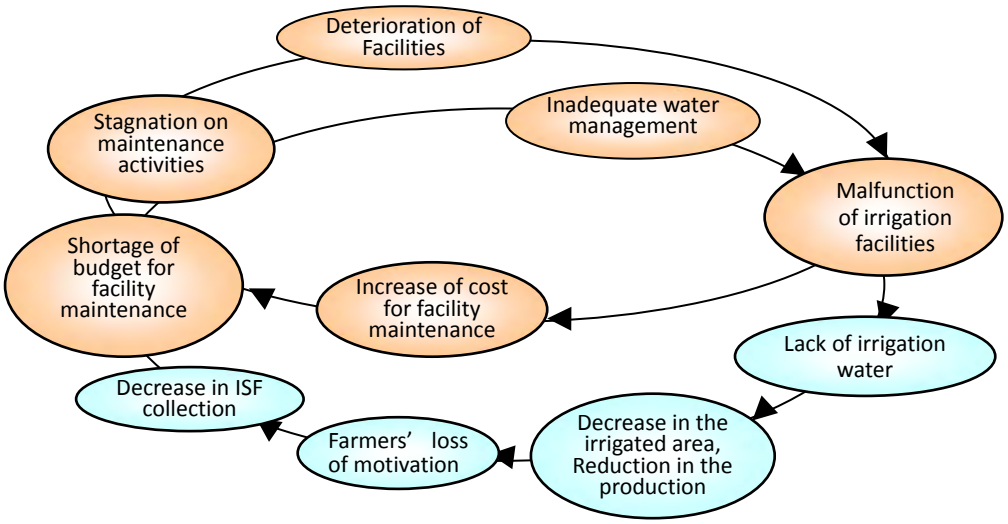


Figure 3-3-3 Image of Vicious Cycle in O&M of Irrigation Systems

Source: Survey team

When both hardware (infrastructure) and software (organizational and institution development, O&M, etc.) aspects are maintained well, IMT can be done in a successful manner. The following table shows IMT status of the main systems in Terai region. Software improvement is necessary for all of the systems, and most of them need rehabilitation of infrastructure. In case of irrigation taking surface water, problems with sedimentation would be serious due to large scale rivers.

IMT pilot projects do not target the entire large or medium scale irrigation systems, but a part of them (for instance, an irrigation block. Reference to Figure 3-3-4). WUA members and FIMD staffs learn the know-how of the pilot projects and are expected to disseminate it to the remaining irrigation blocks within the same systems. Currently, IWRMP-AF is implementing IMT pilot projects in the Narayani I (Block 2), Sunsari-Morang (Ramgunj Branch) and Mahakali Irrigation Systems.

Table 3-3-6 Status of IMT of Major Irrigation Systems in Terai region

S/N	Name of the Project	District	IMT Status			Conditions before the Project
			No Assistance necessary	Hardware improve-ment needed	Software improve-ment needed	
1	Kankai IS	Jhapa			✓	Type 3
2	Sunsari Morang IS	Sunsari & Morang		✓	✓	Type2
3	Chanda Mohana IS	Morang		✓	✓	Type 2
4	Chandra Nahar IS	Saptari		✓	✓	Type 2
5	Koshi West Canal (Distribution System) IS	Saptari		on-going	✓	Type 1
6	Koshi Pump Canal IS	Saptari		on-going	✓	Type 1
7	Kamala IS	Siraha & Dhanusha		on-going	✓	Type2
8	Hardinath IS	Dhanusha		✓	✓	Type
9	Mansumara IS	Sarlahi		✓	✓	Type 3
10	Bagmati IS	Sarlahi & Rautahat		✓	✓	Type 2
11	Jhanj IS	Rautahat		✓	✓	Type 3

S/N	Name of the Project	District	IMT Status			Conditions before the Project
			No Assistance necessary	Hardware improve-ment needed	Software improve-ment needed	
12	Narayani IS	Parsa, Bara & Rautahat		✓	✓	Type 1
13	Narayani Tube Well IS	Bara & Parsa		✓	✓	Type 1
14	Narayani Lift IS	Chitwan		✓	✓	Type 1
15	Khageri IS	Chitwan			✓	Type 3
16	Nepal Gandak Western Canal IS	Nawalparasi		✓	✓	Type 1
17	Bhairahawa Lumbini Bhumigath Jalshorat IS	Rupandehi		✓	✓	Type 1
18	Banganga IS	Kapilbastu		✓	✓	Type 3
19	Praganna Kulo IS	Dang			✓	Type 3
20	Babai IS	Bardiya		✓	✓	Type 3
21	Rajapur IS	Bardiya		✓	✓	Type 3
22	Pathraiya IS	Kailali		✓	✓	Type 3
23	Mohana IS	Kailali		✓	✓	Type 3
24	Mahakali IS	Kanchanpur		✓	✓	Type 3
25	Machawar IS	Rupandehi		✓	✓	Type 3
	TOTAL					

Note: Conditions before the Project:

1: There had been no traditional irrigation system at all. Farmers had practiced rain-fed agriculture.

2. There had been traditional FMISs and those FMISs were developed and integrated to a large system.

3. There had been both rain-fed area and traditional FMISs. Those areas were developed and integrated to a large system,

Source: IMD, DOI

The rightmost column of the table above shows the classification of each Main Irrigation System by the conditions of farming practices before the establishment. Out of the 25 systems, 7 systems categorized as Type 1 were established to benefit the rain-fed farming plots. 5 systems categorized as Type 2 were established to benefit several FMISs, and 13 systems categorized as Type 3 were established to benefit both rain-fed farming plots and their neighboring FMISs. As each system has different and specific background before its establishment, lessons from an IMT pilot project targeting a part of a system may not be relevant to other parts even within the same System.

Since the aforementioned IMT pilot projects tend to target only a part of the system, their approach may not contribute to an improvement on the performance of the entire system. Indeed, what would be required in order to break the vicious cycle and bring the positive cycle is that each stakeholder enhances his/her capacity to improve water management as a whole. In line with this, IMT should be promoted further.

The schematic diagram of irrigation blocks of Figure 3-3-4 illustrates a block rotation irrigation mechanism instead of the water distribution to the entire system at once. It is recommended to implement such block rotation irrigation on a pilot project basis.

Irrigation blocks are basically formed at the tertiary canal level. Representatives from the WUAs of the tertiary canals are the members of the WUAs of the secondary canals, and subsequently, representatives from the WUAs of the secondary canals are the member of the WUA of the main canal. Since the WUA at a higher level should coordinate all the WUAs under the same, all the WUAs should be involved in the

implementation of block rotation irrigation.

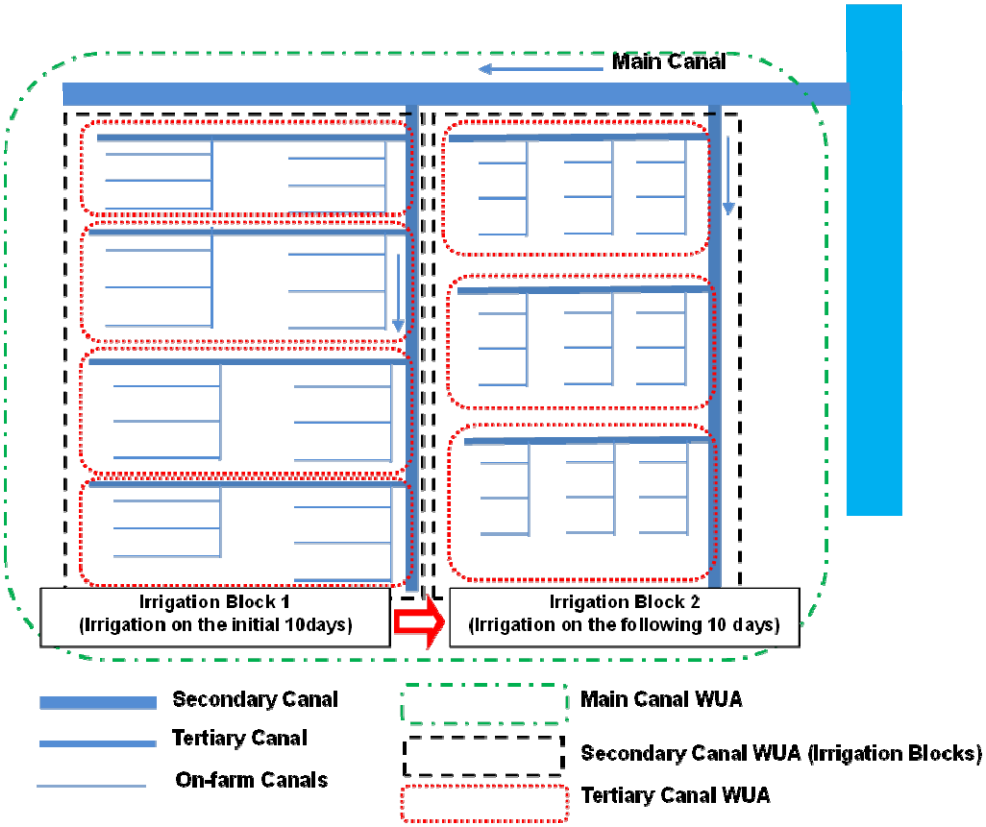


Figure 3-3-4 Schematic Diagram of Irrigation Blocks

Source: Survey team

3-4 Assistance in the Irrigation and Irrigated Agriculture Sectors by Other Donors

3-4-1 Content of Past Projects

(1) Nepal Irrigation Sector Program (NISP from November 1999 to June 2004 funded by WB)

The NISP project was launched by the DOI with financial assistance from WB in the Far-Western, Mid-Western, Western and Eastern development regions, covering an irrigable area of 68,735 ha. The project is aimed at introducing reforms in the water resource sector on a national scale, contributing to the National Water Resource Development Plan[23]. It also aims to increase productivity of the irrigation schemes through large scale adoption of proven technical intervention. Additionally, it supports the government with institutional and technical capability in water planning, management and orienting public agencies by handing over their O&M responsibility to user organizations.

(2) Irrigation and Water Resource Management Project (IWRMP, from 2007 to 2013 funded by WB)

Main objectives of the project were improvement of agricultural productivity in selected irrigation schemes and enhancement of institutional capacity for integrated water resource management. Primary

[23] National Water Resource Development Plan is made by WECS in 2003, which is mentioned in "WB Report No 31484: IMPLEMENTATION COMPLETION REPORT (IDA-30090) ON A CREDIT IN THE AMOUNT OF SDR 58.70 MILLION (US$ 79.77 MILLION EQUIVALENT) TO THE KINGDOM OF NEPAL FOR AN IRRIGATION SECTOR PROJECT (February 11, 2005)". However, its contents are unclear. Neither the Plan itself nor relevant materials are found in DOI.

target beneficiary groups of the project were water users and WUAs. The IWRMP was comprised of the following four components:

Component A: Rehabilitation and Modernization of Irrigation Infrastructure
Component B: Irrigation Management Transfer Reform
Component C: Institutional and Policy Support for Improved Water Management
Component D: Integrated Crop Water Management (ICWM)

(i) Component A: Rehabilitation and Modernization of Irrigation Infrastructure

Objective of this component were to improve irrigation water delivery service in the selected schemes: Mountain (1,024ha), Hills (10,680ha) and Terai Plain (1,624ha). Under this component, rehabilitation and improvement of 168 FMISs spreading over 40 districts in Nepal were conducted for the improvement of the irrigation water delivery to 26,392ha of land in total. With regard to groundwater, the project directly supported DTW groundwater schemes covering an estimated area of 2,100ha.

(ii) Component B: Irrigation Management Transfer Reform

The component was designed for the implementation of IMT to address problems on large scale irrigation system projects (JMIS projects) such as low capacity performance, poor O&M, low cost recovery, and inadequate maintenance funds. The component B worked with four legally empowered WUAs and implemented four subprojects located in Kankai, Sunsari Morang, Narayani, and Mahakali. Irrigated area of the four projects in total was about 23,100ha.

All the activities requiring civil construction have been completed. Activities of the WUA capacity development program in Kankai was also been finished. Meanwhile, development activities at a considerable number of WUAs still remain in the Sunsari, Morang, Narayani and Mahakali irrigation subprojects, and they were handed over to IWRMP-AF.

(iii) Component C: Institutional and Policy Support for Improved Water Management

Objective of the component C was to provide more effective and streamlined water resources management services at the national level within selected basins through institutional strengthening of relevant institutions, namely the Water and Energy Commission Secretariat (WECS) and the DOI. The activities included river basin plans, establishment of telemetry systems and initiation of rules and policy.

(iv) Component D: Integrated Crop Water Management (ICWM)

Primary objective of this component was to increase crop production and improve productivity and profitability of agriculture by means of integration between agriculture and water management. Sub-objectives of the Component D are as follows:

- Integration of crop and water management;
- Improvement of on-farm water distribution structure; and
- Investment support for communities and productive assets.

The activities included improvement support for field level channels and water distribution structures, community support for small scale investment such as unconventional irrigation

technologies, seed banks, storage facilities, market collection place and farm-to-market access facilities were provided.

(v) Issues and Problems

The following issues and problems were observed during the project implementation period. As the second issue explains, because the project focused only on the implementation of trainings, it did not cover overall capacity development of WUAs. Future project formulation should take account of this point.

- The Kankai, Mahakali and Sunsari Morang projects encountered frequent flood attacks. Especially edges of the command area nearby rivers exposed to the serious damage.
- The WUA capacity development programs focused on training only, thus did not meet the requirements for overall development of WUAs
- The budget allocated by the government for WUA capacity development works were not timely and adequate
- Participation of officers in workshops and field training programs was limited due to insufficient availability of qualified officers and engineers

(3) Irrigation Sector Project (ISP, from 1989 to 1996 funded by ADB)

The DOI implemented the ISP in thirty-five districts at the eastern and central development regions with assistance from ADB. The Irrigation policy (1988) stressed strategic approach on participation of farmers' groups and cost-sharing mechanism for irrigation development and O&M works of canals.

As pilot tests of the approach, the DOI implemented community development projects focusing on agriculture communities which had already managed traditional irrigation systems. The DOI also conducted programs to enhance WUAs' capacities in order to improve livelihood of small scale farmers, reduce poverty rate and generate employment opportunities in rural areas. The cropping intensity increased by 14% compared to the beginning of the projects which was 149%.

(4) Second Irrigation Sector Support project (SISP from 1997 to 2003 funded by ADB)

The SISP has been implemented as a follow up project of the ISP. The SISP was launched with the implementation of provisions for the Irrigation Policy (1992), which stresses the importance of participatory approaches of farmers in irrigation construction. The project targeted farming communities which already managed traditional irrigation systems and strengthened WUAs in thirty-five districts of the central and eastern development region of Nepal. The project scope was limited to enhancement of WUAs, improvement of FMIS, capacity development of irrigation offices and provision of agricultural extension services. The project accomplished 278 sub-projects (FMIS) covering 39,757ha out of the planned 283 projects which covers 41,147ha. About 278 WUAs were registered while 178 were planned. The cropping intensity increased by 40% compared to the beginning of the projects which was 170%. Yields of paddy, wheat and maize also increased thanks to improvement in water availability.

(5) Irrigation Management Transfer Project (IMTP from 1995 to 2004 funded by ADB and the USAID)

The DOI implemented the IMTP financed by ADB and United States Agency for International Development (USAID) which aimed to achieve the Irrigation Policy 1992. This project included

achievement of the Development Plan formulated in 1985 and irrigation management transfer to WUAs. The IMTP emphasized the need to improve O&M of the existing government operated projects through beneficiary participation and transferring O&M responsibilities. The total area transferred from the eight districts of Saptari, Dhanusha, Sarlahi, Chitwan, Nawalparasi, Kapilbastu, Kailali and Kanchanpur was 45,563 ha.

The project performance increased considerably when irrigation system rehabilitation (main, branch, tertiary) was completed. The participation of WUAs also increased and intensive water distribution schedule was implemented. Capacity of fourteen WUAs was developed to manage all the branch canals of the jointly managed irrigation project, except for Panchakanya, which was fully turned over to the farmers. The average irrigation intensity increased by 27% and productivity of irrigated paddy, maize and early paddy increased remarkably in three projects where farmers operated and maintained the branch canals.

(6) Community Managed Irrigated Agriculture Sector Project (CMIASP from 2006 to 2013 funded by ADB)

This ADB-assisted project is a follow-up program of the Irrigation Sector Project (ISP) and the Second Irrigation Sector Project (SISP) covering thirty-five districts in the Eastern and Central development regions. The objective is to improve agriculture productivity and sustainability of existing small and medium sized FMISs suffering from low productivity and high poverty incidence.

Under CMIASP, 111 irrigation subprojects (ISP) were implemented with a total target area of 16,105 ha. The subprojects are comprised of irrigation infrastructure development that involves rehabilitation of existing irrigation infrastructure and/or expansion of irrigation networks, social development, strengthening of WUAs, agricultural development and livelihood enhancement. A report on the evaluation is not obtained.

3-4-2 The Contents and Challenges of the On-going Projects

Currently, Community Managed Irrigated Agriculture Sector Project – Additional Financing (CMIASP-AF) supported by ADB and Integrated Water Resources Management Project – Additional Financing (IWRMP-AF) supported by WB are under implementation. The target area of CMIASP-AF is the Eastern and Central Development Regions, while that of IWRMP-AF is the Western, Mid-Western and Far-Western Development Regions. These two programs cover the whole country, dividing it into two zones. While the major target of these two programs is small and medium scale irrigation systems, which are FMIS, the IWRMP-AF is also implementing the IMT at the 3 main irrigation systems out of the 25 JMISs in Terai region.

Table 3-4-1 explains comparison of the CMIASP-AF and the IWRMP-AF. The contents of those programs are basically composed of rehabilitation of irrigation facilities, institutional development, water management and agriculture. Due to a lawsuit brought by consulting companies employed by the DOI, the water management of the IWRMP-AF component has been suspended. These contents are implemented for not only FMISs but also for three main irrigation systems under IMT. The DOI is in charge of rehabilitation of irrigation facilities, institutional development and water management, while the DOA implements agriculture component.

While field level officers of the DOI are in charge of the both programs of FMIS and employed consultants are supporting these officers, consultants (engineers, experts of social development, etc.) hired by WB implement IMTs of the three main irrigation systems. Those consultants and officers of the IMD listen to WUA members and address the issues related to agriculture, maintenance and improvement of facilities, institutional development, collaboration of water management and agriculture.

The project period is about five years, but rehabilitation of the facilities takes three years. Therefore, the capacity development of WUA members and the trainings in agriculture and water management have to be conducted simultaneously. Water is not yet distributed, as the rehabilitation of irrigation facilities has been still on-going, and the implementation of the soft components is not fully bringing about expected outputs. It is expected to find and apply solutions to those challenges posed by the tight schedule.

Table 3-4-1 Comparison of Contents between CMIASP-AF and IWRMP-AF

	CMIASP-AF (ADB)	IWRMP-AF (WB)
Period	2014 - 2020	2014 - 2018
Target area	Eastern and central development regions	Western, mid-western and far-western development regions
Irrigation Sub-projects	150 FMISs Out of which, 145 FMISs are traditional ones while the remaining 5 are newly developed.	83 FMISs
IMT	None	3 main systems[1] in Terai (large or major system)
Infrastructure	Rehabilitation and improvement of Irrigation Systems	Irrigation infrastructure improvement/rehabilitation
Institutional Development	Trainings of ✓ Organizational operation and accounting, ✓ Planning for O&M and water management ✓ Irrigation service fee (ISF) collection. ✓ Gender Equity and Social Inclusion (GESI) ✓ WUA strengthening	Trainings of ✓ Organizational operation and accounting, ✓ Planning for O&M and water management ✓ Irrigation service fee (ISF) collection. ✓ Gender Equity and Social Inclusion (GESI) ✓ WUA strengthening
Water Resources Management	None	✓ Integrated water resources management plan for hydropower and irrigation at river basins ✓ Policy support for productivity increase (Note) it is suspended.
Agriculture	✓ Leader farmer training ✓ Farmers Field School and demonstration: - On-farm Water Management Training - Water-saving Rice Technologies - Cropping Pattern - Improved Seed Production - Farm mechanization ✓ Soil management ✓ Market Support and Accessibility	✓ Leader farmer training ✓ Farmers Field School and demonstration: - On-farm Water Management Training - Water-saving Rice Technologies - Cropping Pattern - Improved Seed Production - Farm mechanization ✓ Soil management ✓ Market Support and Accessibility ✓ Trainings to 60 social mobilizers (28 females) in cropping pattern design, soil fertility management, and use of small farm machinery

1 Narayani Block ; 2 Sunsari-Morang Ramgunj Branch and Mahakali

Source: CMIASP-AF and IWRMP-AF

3-4-3 Problems with Implementation of Sub-projects by Donors

As for FMIS, DOI field staffs (IDD/IDSD staff) and local consultants hired by DOI mainly implement the sub-project components. Meanwhile, as for the IMT of the three main systems, WB consultants (engineers and sociologists) play core roles in facilitating IMT between FIMD and WUAs. They listen to WUA members to identify problems and solve them with FIMD staff so that farmers are willing to accept hand-over of the irrigation system. Such problems are usually infrastructure rehabilitation/upgrade, institutional development and O&M and farming. There is a common problem in implementation of CMIASP-AF and IWRMP-AF.

The irrigation sub-project implementation period of CMIASP-AF and IWRMP-AF is usually 5 years. And, the irrigation sub-project most likely includes the rehabilitation of headworks and/or main canal. In order to fund rehabilitation of such facilities, the procedure explained in Section 3-2-4 has to be taken. Therefore, it takes at least 3 years to finish the rehabilitation works. Meanwhile, O&M and agricultural components need at least 2 to 3 years respectively. That is, it takes 7 to 9 years to finish the irrigation sub-project because rehabilitation, O&M and agriculture should be implemented in series. Accordingly, the 5-year sub-project brings confusion on the implementation. In practice, it is not possible to provide O&M training to farmers using facilities under construction. Likewise, it is difficult to give farmers trainings related to farming without proper water delivery.

Coordination committees are established between DOI and DOA. They are not only at the central level, but also development regional and district level, too. The coordination committees are held as needed. At the beginning of the program, such as at the stage of the planning and sub-project selection, they may have meetings frequently, for instance, monthly. After that, they are held every 3 months during the implementation phase. They usually discuss planning and implementation schedule of the components in the coordination committees. Discussion at district-level committee is crucial because implementation of the program becomes usually behind schedule.

Since the main component of CMIASP-AF and IWRMP-AF is the rehabilitation of headworks and/or main canals, the sub-project requires an extension of the project period for a couple of years. However, in case of a program/project whose main component is O&M such as JICA-TCP, it seems feasible to achieve expected outputs and objectives of a pilot program/project within 5 years as far as well-functioning irrigation systems which do not require large scale rehabilitation works are selected as program/project site.

3-5 JICA's Cooperation in the Past

3-5-1 Janakpur Zone Agriculture Development Project (1980 - 1983)

A Model Farm Project of Irrigated Agriculture had been implemented from 1980 to 1983 as a part of the Janakpur Zone Agriculture Development Project. The model farm is the model of groundwater irrigation in rain-fed agricultural areas. Three district, namely Sarlahi, Mahottari and Dhanusha, are selected in Terai because it was confirmed that there were abundant groundwater in those 3 districts. There are 3 model farms with STW (4.1 to 5.6 ha) and 1 model farm with DTW (45.6 ha). Those model farms were served as not only hubs of extension activities but also models of groundwater irrigation.

3-5-2 Rajkudwa Irrigation Proejct

The “Integrated Rural Development Project in the Lumbini Zone”, which was conducted from 1988 to 1989 with support from JICA, marked the Rajkudwa Irrigation Project as one of the projects to be prioritized in the implementation. The project aimed at an expansion of irrigated area in the paddy fields located between the Gudrung and the Kondre rivers in Kapilvastu District.

Having the DOI of the Ministry of Water Resources as the responsible agency from GON, the pre-feasibility study was conducted in 1992. Likewise, the feasibility study from 1992 to 1993, and the basic designing mission in 1994, respectively. The population of the project site was 33,260 with 5,150 households at that time, and the project aimed to increase the irrigated area from 890ha to 1,800ha. The overall project cost was 681.8 million Nepal Rupees.

Nonetheless, the project has made no progress since the completion of basic designs in January 1995. In accordance with the report of the JICA’s Project Status Survey 2014, the project was cancelled no later than year 2000. The report says the reason of the cancellation is high cost.

3-5-3 Master Plan Study on Terai Groundwater Resources Evaluation and Development Project (1991 - 1995)

Irrigation by STWs is prioritized where surface water is not easily available and STW development is more advantageous technically and economically than surface water irrigation development. However, the irrigable area of DTWs is generally larger than that of STWs and it is supposed that DTW development is more advantageous technically and economically than STW development. Thus, the preliminary survey of the master plan survey mentioned above was conducted in March 1991. As a result, Jhapa, Mahottari and Banke districts selected as study areas for groundwater development by DTWs.

The master plan survey was implemented from October 1991 to March 1995. Potential areas of DTW irrigation were selected and a master plan was formulated regarding DTW irrigation. The target areas of the master plan, that is, potential areas of DTW irrigation were 17,000ha, 7,000ha and 8,000ha in Jhapa, Mahottari and Banke districts respectively. The entire project costs and periods were US$357.8 million (US$3,400/ha) and 10 years for Jhapa district, US$31.7 million (US$4,500/ha) and 9 years for Mahottari district and US$30.2 million (US$3,800/ha) and 8 years for Banke district. Also, it was concluded that the irrigable area of a DTW should be 30ha or more (pumping discharge is at least 30L/s) so that the irrigation system is economically feasible.

3-5-4 Feasibility Study on the Sunsari River Irrigation (2001 - 2002)

Based on the Scope of Work for the above mentioned study signed off on 29 November 2000, the study was conducted from April 2001 to December 2002. The objectives of the survey were formulation of an irrigation plan and its feasibility study as well as technical transfer to Nepali engineers through the survey. The target area of the survey was 168.2km^2, beneficiary population was 97,700 (13 VDC, 16,200 households). A rough irrigation plan was formulated in the first year of the survey. In the second year, a development plan and an implementation schedule were formulated followed by the feasibility study. The target area for irrigation development was 10,544ha, of which 397ha was STW irrigation. The overall project cost was US$18.1 million. Also, the project evaluation concluded that it should be implemented early, because it exceeds 12% that is the Nepali opportunity cost and it is anticipated that spillover effect

to the landless poverty group. The JICA's Project Status Survey 2014 has reported that it was in preparation for implementation as of year 2003.

Chapter 4 Problems/Challenges of Each Irrigation System

4-1 Irrigation Systems which were the target of the Detailed Study

Through an interview with IMD, those target irrigation systems for the study were selected. To select JMISs, it was considered to select: 1) both good and poor JMISs in the operation and management, 2) both the JMISs with good and poor potential in the water resources availability, 3) both the JMISs with and without supports from other donors and 4) the JMISs recommended by IMD or in the workshops (Table 4-1-1). The FMIS's selection criterion for the study was either being good in the operation and management, having supports from other donors, or having groundwater as water resource in order to include different types of FMISs in the study targets (Table 4-1-2). Figure 4-1-1 indicates the JMISs and FMISs visited and studied by the Survey team.

Table 4-1-1 Irrigation Systems Studied in the Survey (JMIS)

Irrigation System	District	Command Area	Reason for the Selection as a Target Survey Area
Kankai	Jhapa	8,000ha	Well-managed JMIS and recommended by IMD as a pilot project site
Kamala	Siraha & Dhanusha	25,000ha	A poorly managed JMIS
Hardinath	Dhanusha	2,000ha	A JMIS having insufficient water and poor management
Narayani	Parsa, Bara & Rautahat	28,700ha	A JMIS having insufficient water and with supports from the other donors (WB)
Banganga	Kapilbastu	6,350ha	A JMIS having sufficient water resources and reservoir
Machawar	Rupandehi	5,600ha	A JMIS using pump and water resources are in short supply in spring
Praganna Kulo	Dang	5,800ha	Nominated as a pilot project candidate by the workshop participants
Bagmati	Sarlahi & Rautahat	37,600ha	Nominated as a pilot project candidate by the workshop participants
Chandra Nahar	Saptari	10,000ha	Nominated as a pilot project candidate by the workshop participants

Source: Survey Team

Table 4-1-2 Irrigation Systems Studied in the Survey (FMIS)

Irrigation System	District	Reason for the Selection as a Target Survey Area
Buwa Gramin (115ha, 172HH)	Morang	A well-managed FMIS
Kalikoshi (187ha, 2,000HH)	Morang	A well-managed FMIS
Dudhmati (230ha, 600HH)	Mahottari	A subproject site of the other donors' project (CMIASP-AF funded by ADB)
Itiyakulo (2,500ha, 8,450HH)	Rupandehi	A well-managed FMIS and a subproject site of the other donors' project (CMIASP-AF funded by ADB)
Jhimjhime (200ha. 800HH)	Rupandehi	A subproject site of the other donors' project (IWRMP-AF funded by WB)
Tamsariya (240ha, 540HH)	Rupandehi	A FMIS combining ground water and surface water

( ) Irrigated area and beneficiary households identified in the field survey

Source: Survey Team

Figure 4-1-1 Locations of Studied Irrigation Systems

● JMIS ● FMIS

Source: Survey Team

4-2 JMIS

4-2-1 Conditions of Irrigation

Following Table 4-2-1 indicates condition of irrigation systems studied by the Survey.

Table 4-2-1 Water Source and Irrigated Areas of the studied JMISs

Irrigation System	Water Source	Means of Water Intake	Area (ha)			
			Command Area	Irrigable Area		
				Rainy Season	Winter	Spring
Kankai	Perennial River	Diversion Dam	8,000	7,000 (5,500)	4,000 (3,000)	3,600 (2,500)
Kamala	Perennial River	Barrage	25,000	25,000	25,000	10,000
Hardinath	Perennial River	Diversion Dam	2,000	2,000	2,000	1,000
Narayani	Perennial River	Barrage in India	28,700	-	-	-
Banganga	Perennial/Seasonal Rivers	Diversion Dam & Reservoir	6,350	6,000	4,000	2,000
Machawar	Perennial River	Diversion Dam	5,600	3,500	3,000	50
Praganna Kulo	Perennial River	-	6,684	5,800	3,500	3,500
Bagmati	Perennial River	Diversion Dam	37,600	-	-	-
Chandra Nahar	Perennial River	Diversion Dam	10,000	10,000	10,000	8,000

Note) The figures in parentheses of Kankai are actual irrigated areas at present.

Source：Responses to the Questionnaire applied to the JMISs

The information on the irrigable area in Table 4-2-1 was obtained by applying the questionnaire to the concerned JMISs. The values of the irrigable areas in the rainy season of the table above seem reliable, while the figures of the irrigable areas in winter and spring seem overestimated. All of the irrigation systems take water from perennial rivers except the Banganga irrigation system. The irrigation systems

take water from the headworks by diverting flow of rivers. The irrigated areas in the rainy season are the same as those in the winter season, or may be the former is little less than the latter. Nevertheless, the irrigated areas in the spring season decreases significantly. This can be attributed to little discharge of rivers before the rainy season, and annual water discharge of those rivers shall be confirmed.

4-2-2 WUA

(1) Organization

The responsibility of government for O&M of the irrigation facilities of JMISs varies depending on the irrigation systems. The JMISs which were studied in this survey were listed in the following table, and they are categorized in two types: Type-A and Type-B. In the Type-A JMIS, the GON controls the main canal only and in the Type-B JMIS, the GON controls both main and secondary canals. The GON usually controls up to the secondary canals in the large scale irrigation systems whose command area is more than 10,000ha (The irrigated areas highlighted in bold font and underlined in Table 4-2-2).

Table 4-2-2 O&M of JMISs and WUAs' Participation into the Irrigation Projects

JMIS	O&M Responsibility Distribution*1	Command Area (ha)	Beneficiary Households *2	WUAs' Participation into Projects		
				Planning	Designing	Construction
Kankai	A (GON: Main)	8,000	11,000	Yes	No	Yes
Kamala	B (GON: Secondary)	**25,000**	36,000	-	-	Yes
Hardinath	A (GON: Main)	2,000	5,600	-	-	Yes
Narayani	A (GON: Main)	28,700	-	Yes	No	No
Banganga	A (GON: Main)	6,350	5,000	Yes	No	No
Machawar	A (GON: Main)	5,600	n.a.	Yes	Yes	Yes
Praganna Kulo	A (GON: Main)	6,684	3,900	Yes	No	Yes
Bagmati	B (GON: Secondary)	**37,600**	27,000	Yes	No	Yes
Chandra Nahar	B (GON: Secondary)	**10,000**	30,000	Yes	No	Yes

*1: A: the GON controls up to the main canal、B: the government controls both the main and the secondary canals.
*2: The Number is estimated based on the response to the questionnaire and data shared by individual households.
Source：Responses to the Questionnaire applied to the JMISs

The number of beneficiary households of each JMIS is obtained from the responses to the questionnaire applied to the JMISs or estimated based on the average farmland area per household, so that it should be considered just as a reference. Regarding the WUAs participation into the establishment of the JMISs, many of them seems to have participated into the planning phase, but not in the designing and actual construction works. How the WUAs have participated in the establishment process, and what of the distribution of roles in the management of JMISs, the WUAs have understood may be confirmed at a later stage.

A WUA committee is set up at each level of canals: main, secondary and tertiary. WUAs usually have a discussion with FIMD in charge about irrigation schedule. Each committee is composed of president, vice-president, secretary, treasurer, and representatives from lower-level canal WUA committees. At least, 33% women participation are required as well as proper representation from Dalit, Downtrodden, Backward ethnic communities. Committee members are elected every two years; their term is stipulated in the constitutions of the committee. The upper-level canal WUAs inform the committees' decisions and reports to the lower-level canal WUAs.

Table 4-2-3 Status of the WUAs

Irrigation System	Status	Problems
Kankai	There is a main canal committee, secondary canal committees and tertiary canal committees.	n.a.
Kamala	There is a main committee, secondary canal level committees and tertiary canal level committees for each of east and west main canals.	There are inactive WUAs due to no development of the command area (the tertiary and lower level canals) under the WUA's management.
Hardinath	There is a main committee, secondary canal level committees and tertiary canal level committees for each of east and west main canals.	n.a.
Narayani	The main committee has been not functioning for last 10 years. The IMD is now re-organizing the main committee. Secondary committees at Blocks 2 and 8 are acting at present.	There are inactive WUAs due to no development of command areas (the tertiary and lower level canals) under the WUA's management.
Banganga	There is a main committee, secondary canal level committees and tertiary canal level committees.	WUA has been refusing the IMT due to deteriorated/ malfunctioning/ disabled infrastructure in the command area (the tertiary and lower level canals) under the WUA's management.
Machawar	There is a main committee and secondary canal level committees.	The ISF is high because of pumping irrigation system, and its collection rate is low.
Praganna Kulo	There are 3 main canals and 3 WUA main committees on the right bank of the river. There is a coordination committee for these 3 WUA main committees.	Since DOI developed the area where conventional FMISs were concentrated in order to establish the JMIS, the WUGs of original FMISs were transformed into the WUA. The WUA has adopted the WUGs' traditional rules to manage the JMIS.
Bagmati (GAR2WUA)[#1]	Tertiary canal level committees are established and secondary canal level committees are under the formation at present for where the tertiary canals were established in the command areas under the WUA's management.	The WUA main committee has not yet organized.
Chandra Nahar	There is a main committee, secondary canal level committees and tertiary (village channel) level committees. The WUA is well-functioning.	The entire irrigation system is deteriorated, but the deterioration within the command area under the WUA's management is worse and not working. Due to the situation, the WUA has not agreed with the IMT.

[#1] IMT has been implemented and the WUA at the main canal level has not been yet organized. So far, tertiary canal level committees have been established for the developed command area, and the preparation for the establishment of secondary canal level committees is underway. The GAR2WUA, one of the tertiary canal level committees was studied in particular (GAR2 stands for the second tertiary canal in the right bank of the Gadhaiya secondary canal which is a branch canal of the east main canal.). Since each WUA in the Bagmati irrigation system is independently operated, the current situation and challenges of the WUAs within the same irrigation system may vary from WUA to WUA. To understand the situation and challenges faced by other WUAs, further studies will be required.

Source: WUA and FIMD

The irrigation facilities of the Bnganga system are extensively destroyed. The Chandra Nahar system becomes malfunctioning due to aging. Under such circumstances, any transfer of the management to the WUAs has not taken place in these two irrigation systems. In the Chandra Nahar system, actually, the

WUAs are well-organized and active at the secondary and tertiary canals, although these WUAs have not agreed with the implementation of IMT. These WUAs are not able to afford the costs for the rehabilitation of their irrigation facilities, and a prompt rehabilitation by GON of the irrigation facilities is awaited. .

The WUAs of Kankai, Praganna Kulo, Bagmati (GAR2) and Chandra Nahar are evaluated as well organized by DOI, since the WUAs of these irrigation systems have followed the instructions provided by DOI. Meanwhile, the WUAs of the Banganga and Kamala Irrigation Systems are evaluated as not well organized. The WUAs of these irrigation systems do not seem to trust DOI, since the water is not distributed to the WUA members. Their irrigation systems have not yet had the tertiary canals and are not functioning due to severe deterioration.

Those highly evaluated WUAs are the ones which have a long history (e.g. Chandra Nahar), whose on-farm facilities are either functioning well or under development (e.g. Kankai and Bagmati), or which are closely united as organization (e.g. Praganna Kulo). In any case, whether water is distributed or not affect the results of evaluation and actual conditions of each of the WUAs.

(2) Registration

All the WUA main committees are registered by application to the irrigation office in charge: FIMD or IDD. The secondary canal level committees are registered to the main committee, and the tertiary canal level committees are registered to the respective secondary canal level committees. The WUA main committee has to submit the audit report to the irrigation office so as to renew the registration. The WUAs of all the surveyed irrigation systems have already completed their registration.

(3) Constitution

All the registered WUAs, including the secondary and tertiary level ones, have the written constitutions since it is a prerequisite for the registration. Thus, prior to the registration, a WUA has to make a constitution by its own members under the guidance of FIMD or IDD. The association organizer (AO) is in charge of such activities. The contents of the Constitution vary from WUA to WUA, as it is tailored for each of the WUAs considering the respective circumstances.

(4) Board Members

WUA board members are selected through election. The election may be carried out indirectly by representatives from the systems when there are a number of WUA members.

(5) General Assembly

General assembly is held once a year. It can be also held when necessary, such as an emergency case.

(6) Financial

The treasurer is in charge of finance. The collected ISF is first shared between the WUA and the GON. Then, the WUA portion is further shared between the WUA main committee and the lower level WUA committees. The WUA main committee has to prepare an audit report and submit it to the irrigation office (FIMD or IDD) for the registration renewal. The financial status shall be also reported to the WUA members at the annual general assembly meeting.

Regarding the ISF, beneficiaries sometimes do not pay the charged fines or do not follow the constitution,

and the management around ISF should be improved. Deteriorated and malfunctioning irrigation facilities in the Banganga System discourage some beneficiaries to pay ISF, and the collection rate of ISF remained to 30%. In the Chandra Nahar System, the WUA has not collected the ISF for the last three years. This is because farmers are still struggling to recover from the damages and losses caused by the flood which occurred three years ago.

The Machawar Irrigation System is a pumping irrigation system, and it is a heavy burden for the WUA to pay the expensive electric bills. The amount of ISF has to be high, and as a consequence, the ISF collection rate declines. Only four pumps out of the ten in the irrigation system are currently working for only 12 hours per day due to blackouts. The pumping capacity has been reduced since those pumps have already 35 years and are deteriorated. All these conditions have affected negatively the ISF collection rate of the Machawar System. Meanwhile, in the Banganga Irrigation system, the irrigation facilities except headworks had been impaired and the WUA refused the IMT, and the ISF collection rate remains low.

In contrast, the ISF collection rate of the Kankai, Hardinath and Bagmati WUAs is 70%. Despite water shortage together with inadequate water management, the ISF collection rate remains high in the Hardinath Irrigation System. This may be attributed to the fact that the irrigated area of the Irrigation System is relatively small and farmers can practice three cropping seasons per year. 2,000ha of paddy in the rainy, winter and spring seasons, respectively. The WUA members desilt sediments from the irrigation facilities with a help from FIMD and this contributes to avoid malfunctioning of the irrigation system, and hence: a high collection rate of ISF.

Table 4-2-4 ISF: Collection Rates and Distribution between WUAs and the GON

Irrigation System	Amount	Collection Period	Collection Rate	Penalty	Share	
					WUA	GON
Kankai	300 Rs./0.66ha/crop	Jun – Jul	70%	No water delivery	90%	10%
Kamala	150 Rs./ha/crop	Dec – Jun	40%	double payment	80%	20%
Hardinath	150 Rs./ha/crop	Dec – Jun	60 - 70%	double payment	80%	20%
Narayani (Block 2)	300 Rs./ha/crop	Aug – Oct	60%	No penalty	80%	20%
Banganga	150 Rs./ha/crop	After winter/summer crop harvest	**30%**	Ban on participation in elections	90%	10%
Machawar	750 Rs./ha/yr	-	**10 - 20%**	25% increased payment	90%	10%
Praganna Kulo	600 Rs./ha/yr	Crop season end	50%	-	100%	0%
Bagmati (GAR2)	600 Rs./ha/yr	-	60 - 70%	-	100%#1	0%
Chandra Nahar	60 Rs./ha/crop (until 3 years ago) None for the last 3 years	-	n.a.	No penalty	n.a.	n.a.

#1: The information source was the GAR2 WUA. Meanwhile, according to the FIMD in charge of the Bagmati Irrigation System, the share rates of the collected ISF between the WUA and GON are 70% and 30%, respectively.

Source：WUAs

(7) Means of information transfer from the WUA main committee to its members

The means below are used for information transfer from the WUA main committee to its members.

- Verbal message from main committee members to lower level canal WUAs, including cell phone

in Kamala, Narayani and Banganga
- Announcing with microphones and speakers in Kamala and Hardinath
- FM radio (local announcement in FMISs and JMISs in Kankai and Bagmati)
- Putting an article on newspaper in Chandra Nahar
- Posting on a WUA notice board in Machawar
- Announcing with speakers on a bicycle in Bagmati

4-2-3 Irrigation Facilities

(1) Condition of Irrigation Facilities

All the irrigation systems have hardware problems. Causes of the deterioration are mostly aging and budget shortage for the rehabilitation. The GON cannot afford the rehabilitation of all the JMISs and therefore, multi-/bi-lateral assistance, such as the Saudi Fund for Development, is indispensable.

The following table summarizes the current condition of irrigation facilities of the respective irrigation systems, including canals and the other hydraulic structures. The headworks and the main canals, which are maintained by the GON, are functioning in most of the irrigation systems. The repair of the headwork of the Kankai Irrigation System is scheduled for the spring season of 2017, the rehabilitation of the entire system will be completed at the same time.

Compared to the headwork and the main canal, the secondary and tertiary canals are not maintained well. WUAs are in charge of the maintenance of these canals, however, they are not able to keep them in a good condition, due to inadequate budget and technology for the maintenance. It seems that there are a few irrigation systems, which require a major rehabilitation to their principal structures, although a functional diagnosis of the irrigation structures has not been carried out to each of the structures.

Table 4-2-5 Condition of Irrigation Facilities in Each Irrigation System Reviewed by the Interview Survey

Irrigation System	Condition of Irrigation Facilities			
	Headwork/Water Source	Main Canal	Secondary Canal	Tertiary Canal
Kankai	C	B	C	C
Kamala	-	B	C	D
Hardinath	-	B	C	-
Narayani	-	C	C	-
Banganga	B	C	C	C
Machawar	-	C	D	D
Praganna Kulo	-	B	B	B
Bagmati	A	B	B	C
Chandra Nahar	B	C	C	D

A = Maintenance and repair are done and functioning properly
B = Warning signs are found but functioning during the next crop season
C = Partly malfunctioning
D = Dilapidated and malfunctioning in whole
E = Partly disabled

Source：Interview with JMIS based on questionnaires

Table 4-2-6 Condition of Irrigation Facilities

Irrigation System	Condition	Problem
Kankai	The facilities are rehabilitated by IWRMP and the headwork, main, secondary and tertiary canals are in good condition.	● Embankment portions of the secondary and tertiary canals are preferentially lined. The headwork is to be rehabilitated in the spring of 2017
Kamala	The system has aged as a whole though the headwork is maintained in a good condition. The main and secondary canals have significant sediments. Unlined portion of the canals are soured and needs reshaping. The command area at the tertiary and lower level canals under the WUA's management has not been developed.	● The FIMD in charge is not able to desilt the extensive sediments due to budget shortage. ● The FIMD in charge does not have enough capacity to develop the irrigation system within the command area (the tertiary and lower level canals) under the management of WUA. ● The FIMD has not been able to develop the command area. ● The WUAs cannot manage water in the command area at the tertiary and lower level canals under the management of WUAs due to non-existence of water control facilities.
Hardinath	The system has dilapidated as a whole though the headwork is maintained in a good condition. Main and secondary canals have significant sediments. Unlined portion of canals are soured and needs reshaping. Tertiary and field canals are underdeveloped.	● Seepage loss from unlined canals is significant. ● Some sluice gates are broken. ● Canal reshaping is needed. ● The FIMD is not able to solve the above problems due to budget shortage.
Narayani	The system has dilapidated as a whole, and canal capacity has decreased due to sediments. There are no tertiary systems developed.	● Desilting and reshaping are needed to recover the canal capacity, ● The WUAs cannot manage water in the command area (the tertiary and lower level canals) due to non-existence of tertiary systems. ● The FIMD is not able to solve the above problems due to budget shortage.
Banganga	The system has dilapidated as a whole though the headwork is maintained in a good condition. The unlined portion of the main canal is scoured significantly. There are 2 reservoirs for the dry season irrigation in the system, but both of them are filled with sediments. The tertiary systems are malfunctioning and some structures are disabled.	● Desilting and reshaping are needed to recover the canal and the reservoir capacities, ● The WUAs cannot manage water in the command area (the tertiary and lower level canals) due to non-existence of water control facilities. ● The FIMD is not able to solve the above problems due to budget shortage.

Irrigation System	Condition	Problem
Machawar	Only 4 pumps out of 10 are workable due to aging. In addition, those 4 pumps are aging (35 years old) and the pumping capacity has decreased. Moreover, the brick-lined canals are partly broken due to the insufficient compaction of backfilled soils.	● Irrigation is not feasible during approximately 12-hours blackouts per day. ● ISF is not sufficiently collected for brick-lining repair; ISF mainly used for pump operators' salary. ● Governmental financial support (3,000,000Rs/yr) is not enough: electricity costs 2,200,000Rs/yr; grease costs 800,000Rs/yr; and the remaining is used for the canal maintenance. ● IDD Rupandehi does not have budget to replace the pumps and/or rehabilitate the canals.
Praganna Kulo	Since the system has started its operation in 2005 and is still new, it is maintained in a good condition. The system does not have headwork because it will be buried with sediments within one year. There are 3 side intakes and temporary canals channeled in the riverbed by the DOI guiding water from a river to the intake.	● The DOI should always be prepared for excavation of temporary canals ● Because of uncontrollable intake, water supply is unstable.
Bagmati	The barrage is in good condition, and there is a generator in case of blackout. The sluice gates are rehabilitated and well-functioning. These rehabilitations are owing to the Saudi Fund for Development.	● The command area (the tertiary and lower level canals) has been partially developed with tertiary systems. But there still remain areas where not yet developed.
Chandra Nahar	The system was established in 1927, almost 90 years ago. The facilities are malfunctioning. The tertiary systems (village channels) are also malfunctioning.	● The whole systems need rehabilitation since it has never had major rehabilitation for nearly 90 years.

Source：WUAs and FIMDs

The following table summarizes above identified problems:

Table 4-2-7 Summary of Malfunctioning of Irrigation Facilities

Problems	Keyword	Example of the systems
Problems caused by natural conditions	Sediments, insufficient cross section, desilting, command area (the tertiary and lower level canals) (irrigated farmland)	Kamala、Narayani, Banganga
Problems caused by water shielding of structures	Water leakage	Hardinath
Problems caused by control accuracy of the facilities	Water control facilities, sluice gate	Kamala, Hardinath, Banganga
Problems caused by aging of the facilities	Deterioration, aging	Kamala, Hardinath, Narayani, Banganga, Machawar, Chandra Nahar
Problems caused by the operation of the facilities	Pump	Machawar
Problems caused by efficient water use and equity	Rotation at the main and tertiary canals	Kamala, Hardinath, Narayani, Banganga, Chandra Nahar

Source：WUAs and FIMDs

Since IWRMP funded by the WB (refer to 3-4-1) has just rehabilitated the irrigation system in Kankai, (Figure 4-2-1) further large scale rehabilitation is unnecessary except for the planned repair works of the

headwork next spring. FIMD gate operator keeps a record of the operation including cross-regulator, opening of head-regulator, flow rate and water depth. A main committee, secondary canal level committees and tertiary level committees are also organized by IWRMP and they are actively involved in the activities. Meanwhile, sufficient water is not supplied to the downstream of the command area due to excess water use at the upper stream. Additionally, plot to plot irrigation is common in the Kankai system and therefore water use efficiency should be improved by enhancing on-farm distribution systems.

The problem caused by the natural conditions is inevitable. The river flow brings soils derived from weak stratum in the upper stream of Terai region. The Kankai irrigation system has a settling basin which facilitates removal of suspended soils before such soils enter into the canals, and this helps to reduce the sediment load in the irrigation system. Such a facility is necessary for other irrigation systems and the GON is expected to support them in the installation of such a facility.

Soil derived from the areas vulnerable to rainfall is likely to enter large scale irrigation systems, which taking water from large rivers with the high volume of water flow. Such a large scale irrigation system is assumed to have more sediment load to be removed than small scale irrigation systems. Large scale irrigation facilities require not only advanced operation but also intensive desilting works and therefore the GON and donors supports would be necessary.

A problem with water tightness of structures is mainly attributed to defective lining of canals in the irrigation systems. Lining is particularly necessary for canals constructed in the foundation mainly consisting of sand and gravel. Once lining is damaged and irrigation water seeps underground, shortage of water in an irrigation system would be caused. Besides sluice gates would be collapsed, if water leakage is caused around the gate and the leaked water washes out surrounding foundation.

Inaccurate operation of the facilities causes problems on the water allocation; especially on the equity of water delivery in the command area (the tertiary and lower level canals). Other problems are usually prioritized to be solved to ensure the water is reaching to facilities.

In order to address properly those problems arising from the aging of the irrigation facilities, the decisions on the rehabilitation or updating should be made based on adequate technical knowledge and experiences. Given that the facilities are still functioning despite aging, other more urgent issues can be prioritized to the rehabilitation of such facilities.

The Machawar irrigation system is the only system which has difficulties in its operation of the facilities. In case of pump irrigation, feasibility of projects should be examined in advance. Providing that the situation has significantly changed since the pump irrigation is constructed, alternative plans should be assessed for the irrigation system and/or selection of crops to be irrigated should be reviewed.

Problems on efficient water use can be divided into two major issues. One is that the downstream blocks where water supply is often trouble are to be prioritized for water supply at the main canal level; the upstream blocks should be received water later. This arrangement can secure equity of water allocation within the irrigation system. Though the system in Chandra Nahar adopts this measure and distributes water at the main canal level and each irrigation block, it does not fully implement due to malfunctioning of irrigation facilities. The other irrigation systems are not implementing the above measure; thus, it should be prioritized in such irrigation systems immediately. Another problem is inefficient use of

supplied water which relates to the accurate operation of the facilities aiming at equity of water distribution among the beneficiaries in the irrigation blocks. This issue will remain behind because there would be other issues to be prioritized.

As mentioned above, an issue of irrigation systems in Terai region is how to improve function of overall irrigation facilities but their bottlenecks differ individually. Thus, an operation and management plan for the whole irrigation system should be developed firstly. The plan is expected to design with experts having substantial experiences and sufficient knowledge and this enables the plan to assure its feasibility and efficiency.

4-2-4 Maintenance

(1) Inspection and Maintenance

Periodical inspection is a basic requirement for the maintenance work for irrigation systems followed by cleaning and repair. It is confirmed that inspection on headworks and pumps in the JMISs is usually conducted after finishing irrigation period in spring, implementation of inspection on other facilities is not recognized. This is mainly because cleaning is considered to be the most effective avoiding malfunctioning of irrigation facilities due to circumstances of heavy sediments. Besides, other case shows that maintenance works of aging irrigation pumps require much budget and workloads and therefore would be bottlenecks of irrigation in such system.

Effective and equal water supply requires proper operation and control of irrigation facilities including sluice gates. In fact, sediments in the canals are the biggest challenge for each irrigation system and the cleaning of the canals would be fundamental for the operation and management as explained below:

(2) Cleaning

The major maintenance works undertaken by WUAs is the cleaning of canals. As part of their responsibility, WUAs clean the canals whose management was handed over by the GON. In principle, FIMD cleans the main canal and FIMD and WUAs jointly clean the secondary canals. Table below illustrates the current status of cleaning of canals, which are carried out as part of the maintenance works, in the JMISs

Table 4-2-8 Frequency of Canal Cleaning and its Record

Irrigation System	Main Canal			Secondary Canal			Tertiary Canal		
	Organization in charge	Frequency	Record	Organization in charge	Frequency	Record	Organization in charge	Frequency	Record
Kankai	GON	1/year	Yes	GON	1/year	Yes	WUA	1-2/year	Yes
Kamala	GON	1/year	Yes	GON	1/year	Yes	WUA	2/year	Yes
Hardinath	GON	1/year	Yes	GON	1/year	Yes	WUA	2/year	-
Narayani	GON	1/year	Yes	GON	-	-	WUA	-	-
Banganga	GON	-	Yes	GON	-	Yes	WUA	2/year	Yes
Machawar	WUA	1/year	No	WUA	1/year	Yes	WUA	1/year	-
Praganna Kulo	GON & WUA	2/year	No	WUA	2/year	No	WUA	-	No
Bagmati	GON	-	Yes	GON	-	Yes	WUA	-	Yes
Chandra Nahar	GON	1/year	Yes	GON	1/year	Yes	WUA	-	No

Source：Interview with JMIS based on questionnaire

The GON controls main and secondary canal level water use facilities and canals in Kamala, Bagmati and Chandra Nahar and is also in charge of cleaning of those canals. While only the main canal is managed by

the GON in Kankai, Hardinath, Narayani and Banganga, it implements the cleaning of both the main and secondary canals.

On the other hand, the WUAs in Machawar and Praganna Kulo implements cleaning of the main canals which the GON is responsible for. Although details of responsibilities for management of the facilities and cleaning of the canals are not studied, they should be clarified in advance for the smooth joint operation. Actual responsibilities of the GON and WUAs should be identified for the further development of JMIS. The following table summarizes a situation of the canal cleaning and its related problems.

Table 4-2-9 Status of Canal Cleaning

Irrigation System	Current Status	Problems
Kankai	The main canal is cleaned (desilted and mowed) by the FIMD once a year but not in all the parts in accordance with a schedule. Work record is also taken. The secondary canals are cleaned by the FIMD once a year. The tertiary canals are cleaned by the respective WUAs (tertiary canal level WUAs) once or twice a year.	● The WUAs do not have annual plan of cleaning. No record of cleaning has been taken, but it could be confirmed through the revision of the expenditure record.
Kamala	Main works are desilting for the main, secondary and tertiary canals. The FIMD cleans the main and secondary canals timely once a year based on its observation. The WUAs contribute to the FIMD maintenance works of the secondary canals in kind. There are work records.	● Extent of sedimentation is significant, and the amount of sediments is beyond the capacity of manual desilting, that is mechanical dredging is necessary. Various sizes of excavators are necessary in accordance with size of the canals.
Hardinath	Main works are desilting. The FIMD implements desilting of the main canals once a year. The FIMD also clean the secondary canals once a year and the WUAs contribute to it in kind. Meanwhile, the WUAs implements desilting of the tertiary canals twice a year. Since the desilting by the FIMD is once a year, the WUAs have to desilt the main and secondary canals by themselves when the amount of sediments is large.	● The desilting budget of the FIMD is not sufficient since extent of sedimentation is significant. ● The WUAs need excavators due to large volume of sediments.
Narayani	Main canal is not cleaned by the FIMD. Secondary canals are also not cleaned by WUAs.	● Maintenance budget of the FIMD is not sufficient. ● WUAs are inactive except for Blocks 2 and 8. Thus, the amount of ISF collected is little except for Blocks 2 and 8.
Banganga	Main works are desilting. The cleaning is under the responsibility of the FIMD because no facilities are handed over to the WUAs. The main and secondary canals are cleaned by the FIMD. Some records are kept. However, the FIMD is not able to dredge 2 reservoirs filled with sediments. The tertiary canals are cleaned by the WUAs where the WUAs are active twice a year.	● The FIMD does not have enough budget to clean up the tertiary canals. ● Amount of collected ISF is not enough for cleaning the tertiary canals.
Machawar	The pumps are maintained frequently by 4 operators, who were subject to trainings for pump maintenance: greasing, simple replacement of parts and fuses, etc. The pump operators get paid 50% from IDD and the other 50% from the WUA main committee. The main and secondary canals are cleaned by the WUA once a year before the monsoon season, and the tertiary canals twice a year before the monsoon and winter crop seasons	● Maintenance costs of the pumps are high due to costs of grease and spare parts. ● It is difficult to clean the brick-lined canal, which is not so strong and the surface is not smooth due to joints; excavators cannot be used unlike concrete-lining.

Irrigation System	Current Status	Problems
Praganna Kulo	The main canals are cleaned by the FIMD and the WUA twice a year before the monsoon season and winter crop seasons. The secondary canals are cleaned by the WUA twice a year before the monsoon and winter crop season. The WUA sometimes cleans the tertiary canals.	● The system was developed by integrating various FMISs and the rain-fed farmlands which had existed in the area. The JMIS has been managed by adopting the traditional rules which the FMISs had established and applied. Under such rules, regular cleaning of canals is undertaken. When flooding, the FIMD closes intakes and prevents soil intrusion into the facilities, and this practice makes the cleaning easier.
Bagmati	The main and secondary canals are cleaned by the FIMD once a year before the monsoon season. Tertiary canals are cleaned by the WUA where the WUAs are established twice a year in the case of GAR2.	● The system is on the way of IMT process. The WUA main committee is not yet established. The secondary and tertiary level WUA committees are still under capacity building by the FIMD.
Chandra Nahar	The main and secondary canals are cleaned by the FIMD once a year. There are records. The tertiary canals (village channel) are cleaned by the WUAs.	● The irrigation facilities need repair/rehabilitation rather than maintenance.

Source：WUA and FIMD

Due to heavy sediments, the desilting is beyond capacity of the WUAs in Kamala and Hardinath. As aforementioned, the systems require facilities such as settling basin that removes suspended soil particles before entering into the canals or introduction of excavators as the WUAs expect. Regarding the use of excavators, the case in Machawar pointed out a difficulty in mechanical dredging due to the difference of lining materials.

The Narayani case indicates a difficulty in collecting ISF from the areas where WUAs are inactive. Though the facilities are deteriorated and their rehabilitation and maintenance are necessary, the WUA in Banganga is well-functioning and implement the cleaning of the tertiary canals twice a year. This implies that capacity development of WUAs is important to improve the performance of irrigation systems.

(3) Repair

According to JMIS, heavy desilting/dredging by excavators is often regarded as repair in Nepal, but there is no clear definition. Repair works that WUAs can conduct by themselves are limited to DIY level. Such repair works are small canal reshaping (small amount of earthwork). At the Machawar Lift Irrigation System, there are pump operators who were trained for pump maintenance, but they are not able to repair or replace the pumps. The WUA members are able to carry out repair works, but it must be done under the instructions of the DOI technical staffs.

There are two funding sources to endure the rehabilitation costs. First, WUAs can outsource the rehabilitation works with the disbursement from the collected ISF. Secondly, WUAs can request financial support to DOI, especially when the rehabilitation works are too costly for them. However, it takes usually a long time to go through the required procedure to receive the requested support, the use of the ISF is more common on the ground.

4-2-5 Water Allocation

(1) Water Distribution Plan

Water distribution planning, irrigation schedule with rotation plans, are made by WUAs. However, WUAs

have expertise neither on crop water requirement nor water use efficiency although they are the decision maker. Accordingly, FIMD supports WUAs to make irrigation schedules through advises and discussions with them from technical point of view. In Chandra Nahar, the FIMD advises the WUA to preferentially allocate water to downstream beneficiaries as aforementioned. Due to the dilapidated facilities, an overall irrigation distribution system is not functional.

On the other hand, the irrigation schedule of the Machawar Lift Irrigation System is solely decided by the WUA based on the discussion by respective representatives from 9 branches canals, because they know discharge rates and conditions of the pumps. However, the schedule is only designed for equal water distribution plan among the branches canals and the plans of individual branch canals within each WUA are undeveloped.

Equitable water distribution results in increased collection of ISF and expansion of irrigated areas. Thus, the DOI expects technical support for the preparation of an irrigation plan.

(2) Water Delivery

In JMIS, the government gate operators deliver water in accordance with the schedule by operating canal structures in the portion under the FIMD's responsibility, while WUA members operates the systems in the portion under WUA's responsibility. The government operators adjust the gate opening by calibrations or counting the thread ridge of the spindle of sluice gate or by observing the water level gauge for the rating curve or the depth of water flowing through the Partial flumes.

Figure 4-2-1 Sluice Gates of the Tertiary Canals in Kankai

Source: Survey Team

On the other hand, there are usually no proper flow control structures, i.e. on-farm systems, in the command area and WUA members are not able to manage water. Further, they operate sluice gates without measuring the water discharge even if there are flow control structures. That is, water is not delivered efficiently in the command area.

Figure 4-2-1 shows water intakes of the tertiary canals of the Kankai irrigation system. Thanks to sedimentation basin at the beginning of the main canal, sand entering the irrigation facilities is limited and therefore water is smoothly delivered to the main canal. Meanwhile, plans for operation of sluice gates at the secondary and the tertiary canals are undeveloped and the water discharge is also not controlled.

4-2-6 Farming

The key for farmers to have motivation in agriculture is profitability. The farmers in Terai region is not able to compete against Indian farmers who get subsidized plentifully by the government (Table 4-2-10).

Fertilizer costs 1,000NPR/50kg in Nepal, while 384NPR/50kg in India. Diammonium phosphate (DAP) costs 2,350NPR/50kg in Nepal, while 1,280 NPR/50kg in India. Tractor-plowing costs 1,600NPR/ha in Nepal, while 1,000NPR/ha in India. Moreover, there is crop insurance in India but not in Nepal.

Table 4-2-10 Examples of Subsidy Comparisons between Nepal and India

Item	Nepal	India
Fertilizer	1,000 NRs/50kg	384 NRs/50kg
DAP	2,350 NRs/50kg	1,280 NRs/50kg
Tractor-plowing	1,600 NRs/ha	1,000 NRs/ha
Crop Insurance	No	Yes

Source：WUAs and DADO

Since the rice farming is not so profitable, most of households cultivate vegetables, maize, wheat, pulses, sugarcane, oil seeds, aquaculture, etc. in winter and/or in spring. Rice is mainly for self-consumption in such households. Most of households also have non-farm income by retail business, self-employment (carpenter, plasterer, etc.), manual labor (construction, agriculture), working abroad (Middle East, India, etc.).

Therefore, it is necessary to improve profitability of agriculture so that farmers are motivated to do farming. In order to increase farm income, what is necessary are improvements of yield, cropping intensity, product quality, marketing to sell higher price and/or cost reduction in farming. Two cropping is very common in Terai region: monsoon rice and winter upland crops. But three cropping is not so practiced, that is, the extension of year-round irrigation will enable three cropping so that farmers earn more farm income.

Expansion of cultivated areas in winter and spring, particularly cultivation of cash crops, would directly increase farmers' income and generate a positive impact. Provided WUAs' activities and proper water distribution, irrigation water for the farming are available, capacity development of WUAs would motivate farmers.

As Chapter 3 described, technical support for farming is also implemented by irrigation projects such as IWRMP-AF (2013 to 2014) funded by WB and CMIASP-AF (2013 to 2018) funded by ADB and should further approached in the context of water management and agriculture. MOAD and DOA administrate agriculture projects. A trouble between officers of the DOI and the DOA is not reported in the project areas of WB and ADB.

4-2-7 Identified Challenges

DOI engineers tend to focus more on main and secondary canals so as to improve irrigation efficiency. This is because they recognize the main and secondary canals as fundamental facilities for O&M. The larger irrigation systems are, the more important the canals are because more sediment from upper stream of a river is entering into the facilities. In addition to operation of whole irrigation facilities, a problem with desilting of heavy sediments makes the IMT difficult. This would be a main factor that JMIS as large scale irrigation system is less successful while operation of the FMIS as small scale one goes smoothly *(Identified Challenge: Measures for Sediments)*.

The collection rate of ISF largely depends on the condition of facilities in the irrigation systems. There are two most commonly observed cases as follows: 1) The maintenance of irrigation facilities is lagged

behind in the schedule, so that farmers cannot irrigate their farmland, when necessary. This results in non-payment of ISF by farmers, and then the work again delays due to a shortage in the maintenance budget. Thus, the irrigation system management falls into the vicious cycle; and 2) The preset ISF rate may not be enough to cover the necessary maintenance costs, although the irrigation facilities are well-maintained and the ISF collection rate remains high (Table 5-4-1). Regarding the former case, only those farmers who have benefitted from enough irrigation water tend to pay ISF, but the overall ISF collection in the JMIS is not working well. As for the latter case, the amount of ISF should be reviewed by the WUAs for the sustainable irrigation management *(Identified Challenge: ISF Collection)*.

Capacity development of the WUA members in the planning of O&M is necessary. There are too many problems to be solved, and no one is able to prioritize all of them to address. Even the problems are prioritized, they are not addressed in the priority order. For example, though WUA members should appreciate the importance of the cleaning, it may be difficult for them to do so, due to the fact that irrigation facilities are disabled and not functioning. Therefore, the rehabilitation of facilities by the GON is necessary in order to promote members' better understanding of O&M. In this regard, technical support may be more feasible in the Kankai Irrigation System than any other irrigation systems, because their facilities are functioning *(Identified Challenge: O&M Planning)*.

The water management system which can improve on efficiency in water use and equity in water distribution among the beneficiaries within the command areas (the tertiary and lower level canals) of WUAs has not been established in many of the JMISs. In some JMISs where such a water management system has been developed and applied, the system often does not work properly. Although farmers understand the importance of on-farm irrigation systems in the command areas (the tertiary and lower level canals), they often lack know-how of the water distribution based on the measurement of water volume. Technical supports by DOI engineers are necessary for the establishment of irrigation system in the command areas (the tertiary and lower level canals), although such supports are not available at present *(Identified Challenge: Equitable water distribution within the command areas of WUA)*.

Not all the DOI engineers acknowledge properly the importance of irrigation system within the command area (the tertiary and lower level canals), although such terminal facilities are equally important as the main and secondary canals are. They tend to focus only on the main and secondary canals. This implies that an interface, connecting the main and secondary canals with on-farm irrigation systems, or with the irrigation systems within the command areas (the tertiary and lower level canals) under the WUA's management is likely to have problems which disturb the efficient use of overall irrigation systems *(Identified Challenge: Technical assistance in the water management within the command areas of WUA)*.

What improves farmers' motivation on agriculture is an improvement on the profitability of farming, and an improvement on productivity, cropping intensity and crop quality is part of the challenges identified to this end. Besides, the collection of market information is necessary since it enables farmers to buy agricultural inputs at lower prices and sell their produces at higher prices. The availability of year-round irrigation may also work as one of the incentives for farmers to produce more. Thus, those interventions for the irrigation sector shall ideally go in tandem with interventions for the agriculture sector *(Identified Challenge: Agricultural Development)*.

An improvement on the efficiency of the entire irrigation systems may keep the current water delivery systems efficient. If the systems are further developed and year-round irrigation becomes feasible, the conditions for agricultural in Terai region would be improved significantly. The introduction of cash crops could increase farmers' household income, while the profitability of rice in the region is not high, because of the low competency in the prices compared to the same commodity of the neighboring country, India. Furthermore, the year-round irrigation would contribute to the DOI's promotion of IMT *(Identified Challenge: Year-round irrigation).*

4-3 FMIS

4-3-1 WUA

(1) Organization

In case of the FMIS, there is a WUA main committee but no lower level committees, because the system is small. The WUA main committee is composed of representatives from areas instead of representatives from lower level canals.

(2) Registration

All the WUA main committees are registered by application to the IDD. The WUA main committee has to submit an audit report to an irrigation office so as to renew the registration.

(3) Constitution

All the registered WUAs have a written constitution. Since the FMISs are small community-based irrigation system which have been managed by water users since before the government intervention. The governing rules are still based on the traditional rules.

(4) Board Members

The board members (president, vice president, secretary and treasurer) are selected through election once every two years but it is often vote of confidence.

(5) General Assembly

A general assembly is held once a year. In this regard, it will be held when needed, such as for emergency.

(6) Finance

Table 4-3-1 ISF and Its Collection Rate

Irrigation System	Amount	Collection Rate
Buwa Gramin[#1]	3,000 Rs./ha/crop	90%
Kalikoshi	Collected only when necessary	n.a.
Dudhmati	Not yet collected. To be collected once the headwork upgrading is finished	n.a.
Jhimjhime [#2]	Not collected (Penalty charges only)	n.a.
Tamsariya (DTW conjunctive use)	200Rs./hour (No Pay, No Water)	100%

#1 When a member attends a WUA activity such as canal cleaning, she or he gets paid 500 Rs. as daily pay. This is one of the refund systems of ISF.

#2 If a member does not attend to WUA activities such as canal cleaning, the person pay a fine of 6,000 Rs./ha. Some members with small holdings do not attend to WUA activities intentionally and pay fine, which is small amount.

Source: Interview to WUAs

The treasurer is in charge of finance. Collected ISF is kept by the WUAs because the system is fully

transferred to it. The WUA main committee has to prepare an audit report and submit it to the irrigation office (FIMD or IDD) for the registration renewal. Financial status is also reported to its members at the general assembly.

Table 4-3-1 above shows the amounts of ISF and the ISF collection rates of the studied FMISs. In some systems the ISF collected at a fixed amount and the collection rates are as high as 90 or 100%, while in other systems, the ISF is collected only when necessary. Thus, the collection rates of FMISs significantly differ from the ones of JMISs.

(7) Information transfer from the WUA main committee to its members

The following means are used for information transfer from the WUA main committee to its members:

- Verbal messages, including the conversation on cell phones, from the main committee members to the lower level canal WUAs; and
- FM radio.

4-3-2 Irrigation Facilities

(1) Conditions of the Irrigation Facilities

Conditions of the irrigation facilities are summarized in the table below. The construction firstly targets on headwork, followed by a main canal (Table 4-3-2). On-farm irrigation systems are not targeted for infrastructure improvement.

Table 4-3-2 Irrigation Facilities of FMISs Visited

Irrigation System	Status
Buwa Gramin	Main canal is kept in good condition. There is neither headwork nor secondary canals.
Kalikoshi	The WUA is building facilities by little and little, getting technical assistance from the IDD.
Dudhmati	The headwork is under construction by CMIASP-AF. The earthen weir is upgraded to concrete one. The main canal is not upgraded because the benefit-cost ratio is lower than other candidate systems.
Itiyakulo	The headwork is relocated to upstream by 150m because the riverbed is eroded and river water level lowered.
Jhimjhime	The headwork is under upgrading. The main canal in the upstream portion is flume.
Tamsariya (DTW conjunctive use)	There are 4 DTWs in 6 areas. The systems are handed over to the WUA just 3 months ago. It is a conjunctive use system where groundwater is used supplementary, except for Area 6. The surface water irrigation systems mainly used is a traditional one.

Source：WUA

4-3-3 Maintenance

(1) Cleaning

The WUAs of FMISs traditionally know the importance of facilities and share a common understanding of operation and management in the systems. In this regard, the WUAs in the JMIS should start from the planning and is behind in the irrigation management (Table 4-3-3).

Table 4-3-3 Canal Cleaning

Irrigation System	Status
Buwa Gramin	The WUA assigns cleaning works of the main canal to groups (villages) in the system. No record is taken.
Kalikoshi	The WUA cleans canals twice a year before monsoon and winter crop seasons. No record is taken.
Dudhmati	The WUA has not yet started activities. After completion of the headwork construction, it will join IDD's trainings and then begin activities.
Jhimjhime	The WUA cleans three times a year before monsoon, winter and spring crop seasons. The cleaning takes 2 to 3 days by 3 groups of the WUA members.
Tamsariya (DTW conjunctive use)	Since water is clean and it flows in the pipelines from DTWs, no cleaning is needed.

Source：WUA

(2) Repair

As for repair works that need cement, unlike routine maintenance, the WUAs implement them under technical and financial supports of IDD/IDSD. General cleaning of the canals is done by the WUAs.

4-3-4 Water Allocation

(1) Water Distribution Plan

1) Surface Water Irrigation System

The WUA main committee makes an allocation plan and an irrigation schedule. The committee members take the plan and the schedule back to her/his area and report to the members.

2) Groundwater Irrigation System in Tamsariya

The users make a phone call to the pump operator in charge and order the timing and the duration of water delivery. The ISF is not collected on a basis of area but on a basis of time. The WUA members strictly follow the no-payment-no-water rule.

(2) Water Delivery

The WUA members operate the irrigation facilities by themselves. Even the DTWs are operated by the farmers trained by GWID staffs in Tamsariya.

4-3-5 Identified Challenges

Compared to the WUAs of JMIS, the WUAs of FMIS are working smoothly with less strict rules. They collect ISF by following their traditional rules, and they do not need more strict rules. The FMISs have been managed by their water users before the GON started the management of irrigation systems, and therefore, the GON does not see the necessity to strengthen the management of FMISs although it provides FMISs with the initial training and the government portion of the rehabilitation costs. DOI does not recognize so far any challenge of the management of FMISs to be addressed.

Chapter 5 Problems of Irrigation Development and Challenges Extracted through the Survey

This chapter presents considerations regarding problems, challenges and orientation of improvement of irrigation development by GON, on the basis of results of the workshop on 14 August 2016, in which DOI staff participated, and results of existing irrigation facilities and other donors' assistance programs considered in the antecedent chapters. Then, it considers relevance of the GON's application for JICA-TCP, in terms of its objectives, contents and inputs, from the viewpoint how the JICA-TCP contributes to solving problems and challenges on irrigation development of Nepal.

5-1 Challenges Identified in the Field

As mentioned in Chapter 4, challenges identified through field visits of JMISs are as follows:

Challenge #1: Countermeasures against sediments;
Challenge #2: ISF collection;
Challenge #3: Formulation of maintenance plan;
Challenge #4: Equitable water distribution within the on-farm area;
Challenge #5: Technical assistance for on-farm water management;
Challenge #6: Improvement of farming; and
Challenge #7: Year-round irrigation.

5-2 Problem and Objective Analyses in the Workshop

As the preparatory works for the workshop on 14 August, the Survey team narrowed challenges identified through the report of "Preparatory Survey on JICA's Cooperation Program for Agriculture and Rural Development in Nepal -Food Production and Agriculture in Terai- (2013)" down to those related to O&M of irrigation facilities, water management and capacity strengthening of DOI staff and WUA members. In the workshop, DOI staff analyzed causes of irrigation development problems (Problem Analysis). In addition, the Survey team pointed out problems of irrigation in the on-farm area where WUA is responsible for water management, as well as problems regarding major facilities. The summary is as follows.

1) Water is not available enough for winter and spring cultivation from seasonal rivers. In addition, Narayani Irrigation System does not receive water from the perennial river, which is its water source, because India does not have to give water to Nepal based on the international treaty[24] between Nepal and India.
2) There are irrigation systems that are not able to convey designed discharge due to disabled/malfunctioning canal structures (e.g. cross- and head-regulators), or canal cross-section reduced by erosion/scouring/collapse of side slope or sediments.
3) Seepage loss of water from unlined canals is larger in the dry season (winter and spring) than in the rainy season (monsoon) because soils are drier.
4) Water is not distributed equitably among water users in the on-farm area. Allocated water is limited and water users in the upstream zone over-irrigate. Consequently, water shortage occurs in the downstream zone.

[24] Water rights of India and Nepal are 90% and 10% respectively, in accordance with the international treaty.

5) Water is not efficiently delivered and/or utilized even if water is available. Since the plot-to-plot irrigation is widely practiced in the on-farm area, the application efficiency is low.
6) There are no drainage systems in the on-farm area, or they are malfunctioning even if they exist.

The workshop participants arranged the narrowed-down challenges and the above causes in a problem diagram. Then, they re-arranged the problem diagram to an objective diagram which shows possible countermeasures to solve the problems. The proposed core objective of the objective diagram was "Maximize irrigated area through the optimization of irrigation water distribution based on agreement and mutual understanding among stakeholders", but the workshop participants changed the core objective to "Optimize water use for reliable year-round irrigation". That is to say, the orientation to improve the current irrigation state in Terai region has been changed from "expansion of irrigated area" to "reliable year-round irrigation".

Figure 5-2-1 is the objective diagram formulated through discussion by the participants. The figure shows the overall goal on the leftmost side, and means to attain it are developed to the right-hand side. In addition, it shows the applicability to FMIS and JMIS as well as possibility of implementation/assistance by GON, WUAs, donors and NGOs as a matrix: the code "Y" indicates "applicable".

In order to optimize water use for reliable year-round irrigation, the participants pointed out the necessity of capacity building of DOI staff and beneficiary farmers, improvement of O&M and construction including rehabilitation of existing facilities. Since the construction most likely becomes out of scope of the JICA-TCP, the following explains the other two necessities.

- ✓ Capacity Building: it is necessary to strengthen the functions and roles of IMD, inclusive of its review, so that IMD is able to give technical assistance and advices to DOI field staff and farmers and also to make stronger cooperative relationship with them[25].
- ✓ O&M[26]: possible activities are the calculation of crop water requirements as well as irrigation requirements based on such crop water requirements, the formulation of water allocation plan based on available water volume and an improvement of water management by both GON and WUAs[27].

5-3 Challenges and Countermeasures Based on Field Survey and Workshop

Challenges recognized through field surveys and pointed out in the workshop are tabulated in Table 5-3-1 item by item. There are 9 items and they are: (a) Implementation of O&M; (b) Diversification of water sources; (c) Construction of irrigation facilities; (d) ISF Collection; (e) Maintenance Plan; (f) Organizational management; (g) Technical assistance in water management; (h) Agriculture; and (i)

[25] Trainings that IMD conducts for WUA members are demand-basis, that is, DOI gives them trainings that they request. Training that they request are supposed to be on-farm water distribution, water distribution in the farm plot including crop water management, ISF collection method, etc.

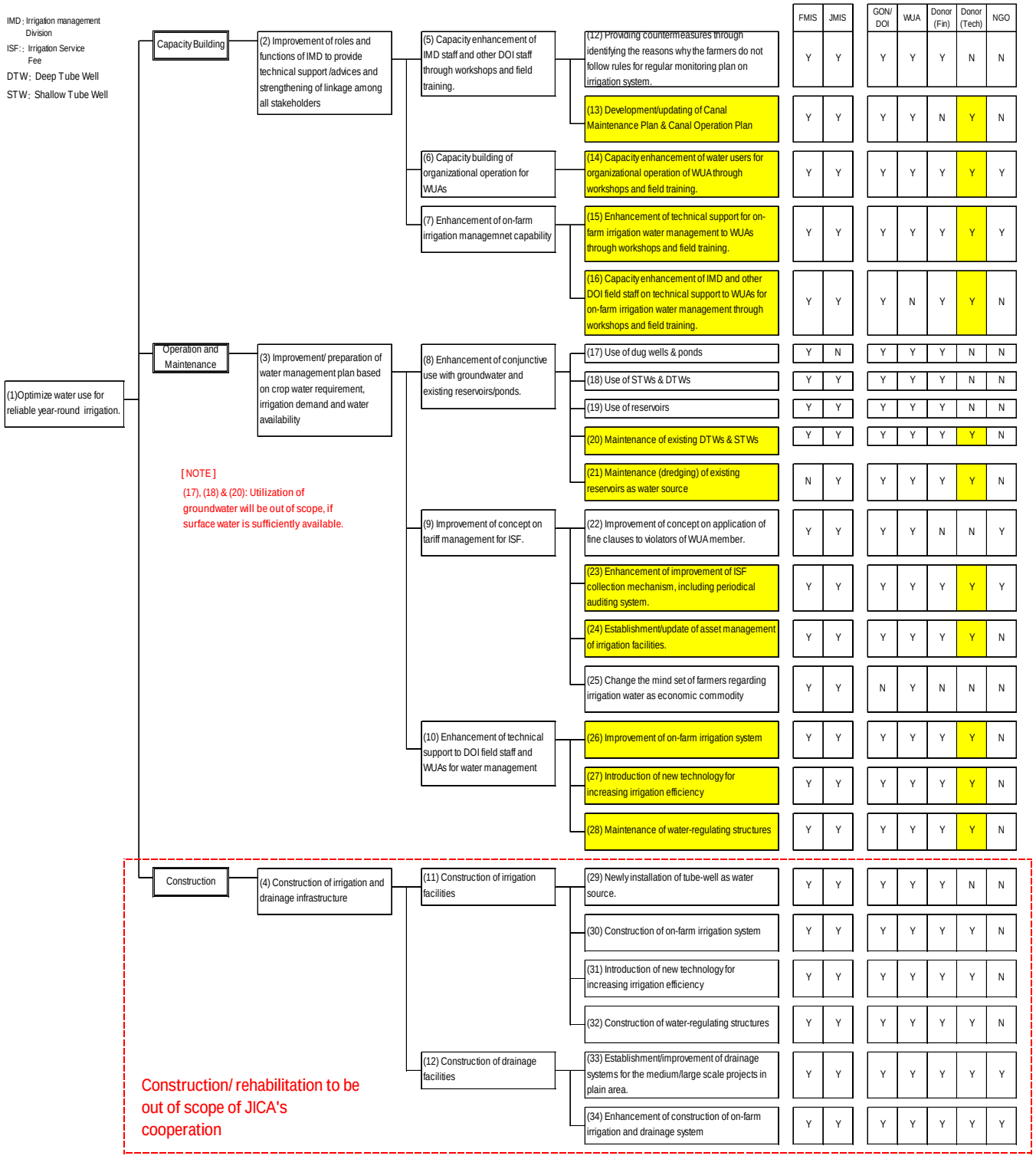
[26] The O&M here means not only the operation and maintenance of irrigation facilities but also the water management in the Irrigation Systems.

[27] In a JMIS, FIMD (DOI) estimates the crop water requirement and the demand of irrigation water and explains them to the WUAs, so that the WUAs and FIMD can reach an agreement through discussion. In accordance with the agreement, FIMD should deliver the water to the WUAs. In the areas managed by the WUAs, the water is distributed in accordance with the estimate made by FIMD, due to the technical constraints of the WUAs. For the Kankai Irrigation System, the IWRMP consultants employed by WB developed a computer program to calculate water requirement for each crop and the demand of irrigation water. FIMD in charge of the Irrigation System calculates the water requirement by utilizing the computer program.

Expansion of irrigation services. As for the first 3 items ((a), (b) and (c)), it is assumed that GON will take care of them, while for the remaining 6 items ((d), (e), (f), (g), (h) and (i)), there is a possibility to be addressed through the implementation of the JICA-TCP.

The primordial precondition for the target areas for the JICA-TCP is that the irrigate facilities are functioning and to make this precondition meets, whether the amount of ISF is appropriate or not would be a possible challenge. It is confirmed that in those irrigation systems where the facilities are constructed and maintained, the ISF collection rates are high, yet the amount of ISF is still lower (0.2 to 0.6%. Refer to 5-4-2 Pilot Project Site of JICA-TCP) than the cases in other countries as a fact (3 to 4% in the Philippines and Myanmar). It is recommended to set an appropriate amount so as to put a sustainable maintenance mechanism of the irrigation system in place.

The development of a maintenance plan is necessary to take stock of all the facilities, including those at the plot level, within the command areas of WUAs, and may be in a high priority for WUAs, although its priority cannot be high for individual water users. On the other hand, those individual water users put a high priority in the technical assistance in the water management, since techniques to make water reach each beneficiary will be acquired by addressing this item. The organizational management and agriculture are the items prioritized following to the technical assistance in the water management.



Causes that year -round irrigation does not expand are:
[1] Surface water is not available enough for cultivation in winter and spring → Possible solutions: (18) (29)
[2] Inequity on water distribution amomg WUA members → Possible solutions: (12) (14)
[3] Farmers make lands fallow → Possible solutions: n.a.
[4] Water is available but its delivery and/or utilization are not efficient → Possible solutions: (13) (14) (15) (16) (17) (19) (22) (23) (25)
[5] Lack of water control facilities at the on-farm level → Possible solutions: (29) (30) (31) (32) (27)
[6] Malfunctioning and/or disabled irrigation facilities → Possible solutions: (20) (21) (26) (27) (28) (31) (32)
[7] Seepage loss from unlined canals → Possible solutions: canal lining

Figure 5-2-1 Objective Analysis and Countermeasures & Activities for Irrigation Improvement

Source: Survey team

Table 5-3-1 Challenges Identified through Field Visits, Challenges Recognized in the Workshop and Possible Countermeasures

Item	Challenges identified through field visits	Challenges recognized in the workshop	Possible countermeasures
(a) Implementation of O&M	1) Countermeasures against sediments	20) Maintenance of existing DTWs & STWs 21) Maintenance (dredging) of existing reservoirs as water source 28) Maintenance of water-regulating structures	Profound upgrading of water intake facilities of JMIS, including construction of settling basin, except for Kankai Irrigation System
(b) Diversification of water sources		17) Use of dug wells & ponds 18) Use of STWs & DTWs 19) Use of reservoirs 29) Newly installation of tube-well as water source.	Construction after investigating possibilities of new water sources
(c) Construction of irrigation facilities		30) Construction of on-farm irrigation system 31) Introduction of new technology for increasing irrigation efficiency 32) Construction of water-regulating structures 33) Establishment/improvement of drainage systems for the medium/large scale projects 34) Enhancement of construction of on-farm irrigation and drainage system	Construction by GON and construction of some on-farm irrigation facilities by JICA-TCP
(d) ISF Collection	2) ISF Collection	22) Improvement of concept on application of fine clauses to violators of WUA member. 23) Enhancement of improvement of ISF collection mechanism, including periodical auditing system 25) Change the mind set of farmers regarding irrigation water as economic commodity	The implementation is possible within the framework of JICA-TCP. However, it may be difficult to get an agreement from those farmers who have never benefitted from the irrigation water. The proportion of ISF to the gross income per unit area is lower than that in similar cases in other countries.
(e) Maintenance Plan	3) Formulation of maintenance plan	12) Providing countermeasures through identifying the reasons why the farmers do not follow rules for regular monitoring plan on irrigation system. 13) Development/updating of Canal Maintenance Plan & Canal Operation Plan 24) Establishment/update of asset management of irrigation facilities.	Implementation of Technical Cooperation
(f) Organizational management		14) Capacity enhancement of water users for organizational operation of WUA through workshops and field training.	Implementation of Technical Cooperation

Item	Challenges identified through field visits	Challenges recognized in the workshop	Possible countermeasures
(g) Technical assistance in water management	4) Equitable water distribution within the on-farm area, which is the area where WUA manages water 5) Technical assistance for water management within the on-farm area (on-farm water management)	15) Enhancement of technical support for on-farm irrigation water management to WUAs through workshops and field training. 16) Capacity enhancement of IMD and other DOI field staff on technical support to WUAs for on-farm irrigation water management through workshops and field training. 26) Improvement of on-farm irrigation system (facilities and water management) 27) Introduction of new technology for increasing irrigation efficiency	Implementation of Technical Cooperation
(h) Agriculture	6) Improvement of Farming		Implementation of Technical Cooperation
(i) Expansion of the Irrigation Service	7) Year-round irrigation	1) Optimize water use for reliable year-round irrigation.	This is the goal when all of the above countermeasures are completed.

Note: The numbers of item listed in the column of “Challenges identified through field visits” are consistent with those put to the challenges listed in Section 5-1 “Challenges Identified in the Field”. The numbers of item shown in the column of “Challenges recognized in the workshop” are consistent with those put to the countermeasures proposed in Figure 5-2-1 to each of the challenges identified in the workshop.

Source: Survey team

5-4 Targets of Technical Cooperation and Possible Activities

As summarized in Table 5-3-1, the 5 items, which are ISF collection, maintenance plan, organizational operation and technical assistance of maintenance, can be possible activities of JICA-TCP. Then, the prerequisite to be candidate sites of the JICA-TCP is existence of irrigation systems where fundamental canal structures and irrigation facilities are functioning. The examination and concrete challenges of JICA-TCP candidate JMISs are presented below.

5-4-1 Candidate Irrigation Systems (JMISs)

The workshop participants have nominated the following 5 irrigation systems for the JICA-TCP pilot project: Chandra Nahar, Bagmati, Bhairahawa Lumbini Groundwater, Praganna Kulo and Patharaiya. Meanwhile, the irrigation system that IMD recommends is Kankai irrigation system.

Table 5-4-2 tabulates the current states of those 6 irrigation systems, including Kankai, in terms of hardware and software. In addition, Table 5-4-3 summarizes history and challenges of each irrigation system. Here, it is reasonable to remove Bhairahawa Lumbini Groundwater and Patharaiya from the JICA-TCP candidate sites because of the following reasons.

1) Bhairahawa Lumbini Groundwater Irrigation System
   This is the pumping irrigation system whose water source is DTWs. Some pumps are needed to be replaced. JICA-TCP should target surface water irrigation systems that DOI puts higher priority than groundwater ones.

2) Patharaiya Irrigation System
   This requires a major rehabilitation/upgrade of the entire system, that is, irrigation facilities from the headworks, through the main, secondary and tertiary canals to on-farm irrigation systems at the tail. It would require a significant amount of finance and 3 -5 years for the construction works.

Now, there are 4 candidate sites remaining: Kankai, Chandra Nahar, Bagmati and Praganna Kulo. The water sources of these 4 systems are perennial rivers. Namely, water is available even in the dry season. It is reasonable to select the pilot project site from these 4 systems. As for these 4 systems, the Survey team gave scores to those 4 systems in terms of necessity of rehabilitation, water source, possibility of irrigation during the dry season, number of canals and ISF collection rate. As a result, Kankai and Bagmati have got high scores followed by Chandra Nahar and Praganna Kulo (Table 5-4-4).

5-4-2 Pilot Project Site of JICA-TCP

Irrigation systems that JICA-TCP should target were identified to be Kankai, Chandra Nahar, Bagmati and Praganna Kulo. In accordance with scoring shown in Table 5-4-4, Kankai and Bagmati have higher priority than the other two systems. The table below shows outlines of these 4 systems. The command areas of Kankai and Bagmati are 8,000ha and 45,600ha respectively, and the beneficiary households of Kankai and Bagmati are approximately 11,000 and 32,600. In addition, the average farm-holding sizes of Kankai and Bagmati are very different. Whereas the former is 0.73ha, the latter is 1.40ha.

Table 5-4-1 Specifications of Candidate Sites of Pilot Project

Item		Irrigation System			
		Kankai	Chandra Nahar	Bagmati	Praganna Kulo
Main Canal	Nos.	1	1	2	5[#1]
	Length (km)	36	31	48.2	56
Secondary Canal	Nos.	22	12	6	–
	Length (km)	74	43	112	150
Tertiary Canal	Nos.	287	237	21	–
	Length (km)	110	31	122.4	71
Irrigation	Area (ha)	7,000 Irrigable area (rainy season)	10,000 Irrigable area (rainy season)	37,600 Command Area	5,800 Irrigable area (rainy season)
Beneficiary	Households	11,000	30,000	27,000	3,900
Avg. Holding Size	(ha)	0.64	0.33	1.40	1.50
ISF (a)	Rs/ha/crop	300Rs/0.66ha	n.a.	n.a.	n.a.
	Rs/ha/year (a)	n.a.	n.a.	600	600
Monsoon Paddy (MS)	Yield（t/ha）	3.8	3.6	4.5	3.4
	Farm gate price (Rs/kg)	25	22	Self-consumption	20
	Income (Rs) (b)	95,000	79,200	99,000	68,000
(a)/(b) for the MS	%	0.3	0.2[#2]	0.6	0.49

#1 Including canals from seasonal rivers

#2 Assuming 60 Rs./ha/crop (ISF of 3 years ago)

Source: IMD and DOI

5-4-3 Current State of Candidate Irrigation Systems

Tables 5-4-5 and 5-4-6 show challenges and countermeasures of Kankai and Bagmati Irrigation Systems, which are prioritized candidate sites. The targets of technical cooperation are 1) DOI engineers, including FIMD staff and 2) WUA members. Meanwhile, the following are recognized as contents that should be implemented in technical cooperation: efficient water management plan and implementation of on-farm water management. Most farm plots are delivered water by plot-to-plot irrigation, but a watercourse was found in Bagmati, where a pipe is installed between the tertiary canal and the watercourse so that water flows into the watercourse (Figure 5-4-3). Since the watercourse enables water users to irrigate farm plots respectively, the irrigation efficiency is improved. It is recommended that FIMD staff disseminates this practice. In addition, it is confirmed that WUA members are willing to pay ISF.

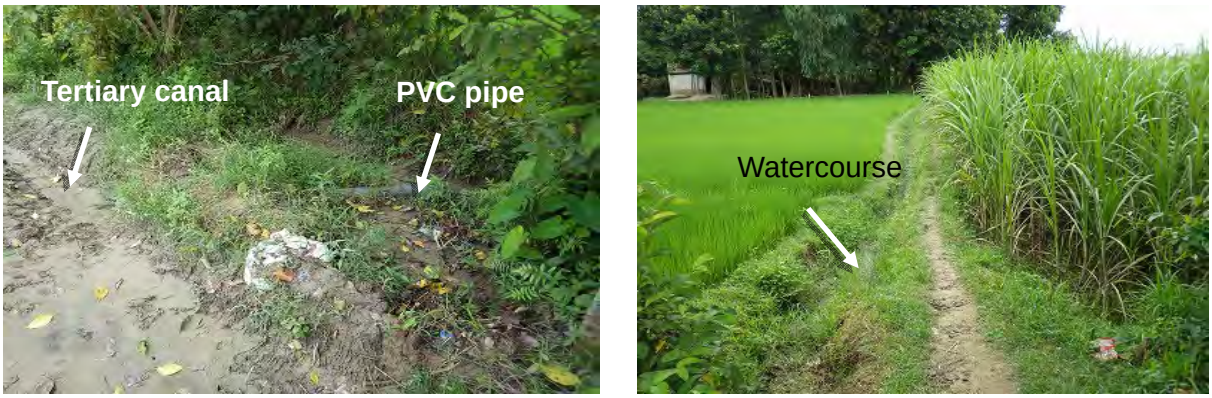


Figure 5-4-1 Tertiary canal and PVC pipe to take water off to the watercourse (left) and watercourse (right) in Bagmati

Source: Survey team

Table 5-4-2 Current States of Hardware and Software of Candidate Irrigation Systems

Candidate Irrigation System	Hardware (Y: Necessary, N: Not necessary) Necessity of Improvement			Software (Y: Necessary, N: Not necessary) Necessity of Improvement			Remarks
	Headworks & Main Canals	Branch/ Secondary Canals	Tertiary canals & On-farm Systems	Headworks & Main Canals	Branch/ Secondary Canals	Tertiary canals & On-farm Systems	
Kankai	N[#1]	N	Y[#2]	Y	Y	Y	#1: The Maintenance of weir has been already scheduled. #2: Field ditches are necessary to be made
Chandra Nahar	N	N	Y	Y	Y	Y	GON shoulders the maintenance costs of main canals, branch canals and other hardware.
Bagmati	N	N	Y	Y	Y	Y	GON shoulders the maintenance costs of main canals, branch canals and other hardware.
Praganna Kulo	N	N	Y	Y	Y	Y	GON implements the maintenance of main canals, branch canals and other hardware.
Bhairahawa Lumbini Groundwater	Y	N	N	Y	Y	Y	Some pumps need to be replaced.
Patharaiya	Y	Y	Y	Y	Y	Y	GON shoulders the maintenance costs of main canals, branch canals and other hardware.

Source: IMD and field visit survey

Table 5-4-3 Outlines of Candidate Irrigation Systems

Candidate Irrigation System	Outline
Kankai	It was designed by a Japanese consulting company in 1970s, and rehabilitated by IWRMP. There is a settling basin built between the diversion on Kankai river and the intake of the main canal. The length of the main canal is 36km, of which 11.5km is concrete-lined. The WUA has been reorganized by IWRMP. The crop water requirement is estimated by the Penman-Monteith method so as to decide the irrigation requirement. It is an irrigation system for spring rice cultivation. Therefore, Kankai-system farmers are not as active in vegetable cultivation as farmers of other irrigation systems.
Chandra Nahar	It was constructed nearly 100 years ago. Since then, no major rehabilitation was implemented. Some facilities are disabled and DOI is carrying on rehabilitation. WUAs have been established from the main-canal level to the tertiary-canal level. The WUA main committee has cadasters and design drawings. No irrigation facilities are handed over to WUA at present because the facilities are dilapidated and needs rehabilitation and WUA does not agree.
Bagmati	It is possible to operate the barrage during the blackout because there is a generator in case of emergency. Canal structures such as cross-regulators are under rehabilitation, supported by Saudi Funds for Development (SFD). FIMD is currently carrying on IMT while rehabilitating canal structures as well as developing its command areas. Tertiary-canal-level WUAs are established where the command area has been developed, and the establishment of secondary-canal-level WUAs is in progress.

Candidate Irrigation System	Outline
Praganna Kulo	It is located on the right-bank side of Rapti river at the foot of the Hill area of Nepal. There are significant sediments on the river bed. The river is perennial and 300m wide at the location. Neither diversion dam nor barrage is built. There are 3 side intakes on the right riverbank, and each side intake has a main canal. The irrigable area is 5,800ha. The 1st, 2nd and 3rd intakes irrigate 500ha, 4,400ha and 900ha, respectively. In addition, there are 2 more main canals which take water at 2 weirs on 2 seasonal rivers in the command area. Each main canal of the aforementioned 3 main canals has WUA main committee, and there is a WUA joint committee in order to coordinate those 3 WUAs. DOI/FIMD is responsible for O&M of side intakes and main canals as well as channeling the riverbed by excavator so that river water flows to the side intakes. The system used to be 3 FMISs that are more than 100 years old, and DOI developed them to the larger irrigation systems. The joint management has begun since 2005. In this regard, the WUAs are still operated by their traditional rules. Actually, it is an aggregation of 3 different irrigation sub-systems. Therefore, JICA-TCP will have to pay attention to all of the 3 sub-systems so that economic disparity of farm households among the 3 sub-systems does not enlarge, if JICA-TCP targets Praganna Kulo Irrigation System. The WUA joint committee does not mean unification of the 3 WUAs.
Bhairahawa Lumbini Groundwater	It is a groundwater irrigation system in Rupandehi district. The 22-year construction works ends in 1999, and 181 DTWs are built. However, 12 DTWs out of 181 are now inactive. The remaining 169 DTWs irrigate 20,309ha, but some of them are necessary to be replaced. The groundwater-pumping irrigation is significant affected by electric supply: pumps do not work during blackout. Not only Rupandehi district but also nationwide districts are suffering from blackout of nearly 12 hours per day. Even if electricity is supplied, the voltage is lower than standard because demand is high and exceeds supply. Consequently, the operation efficiency of pumps is not good.
Patharaiya	It is necessary to rehabilitate headworks, main canals, secondary canals, tertiary canals and lower level canals. Rehabilitation of these facilities must be finished till the soft component focusing on on-farm water management begins

Source: IMD and field visit surveys

Table 5-4-4 Scoring to Select Irrigation Systems for JICA-TCP

Irrigation System (See the figure below)	a. Necessity of rehabilitation	b. Water source	c. Water intake during the dry season	d. Number of main canals and WUAs	e. ISF collection state	TOTAL
Kankai	**5**	**5**	**5**	**5**	**5**	**25**
Chandra Nahar	3	5	5	5	1	19
Bagmati	**5**	**5**	**5**	**3**	**5**	**23**
Praganna Kulo[#2]	5	5	3	2	3	18
Bhairahawa Lumbini Groundwater [#1]	0	0	5	0	5	10
Patharaiya[#3]	0	5	5	n.a.	n.a.	10

Source: Survey team

Scoring

a. Necessity of rehabilitation: Less (5 pts.) ↔More (0 pts.)
b. Surface water (5 pts.), Groundwater (0 pts.)
c. Groundwater (5 pts.), Perennial river (4 pts.), Reservoir (3 pts.), Seasonal river (0 pts.)
d. 1 main canal & 1 WUA (5 pts.), 2 main canals and 2 WUAs, each on the right and left bank sides (3 pts.), 3 main canals and 3 WUAs (2 pts.)
e. Collection rate: Higher (5 pts.) ↔Lower (0 pts.)

#1 There are 64 main canals. ISF collection rate is assumed very high because it is a pumping irrigation system.
#2 ISF collection rate is supposed around 50% based on interview to Chief Divisional Engineer of the system.
#3 Detailed information was not available.

Table 5-4-5 Challenges and Possible Activities in Kankai Irrigation Systems

#	Current Challenges	Possible Activities in JICA-TCP	Targets	Expected Outcomes
1 **A**	✓ There is no maintenance plan of headworks, main canal and secondary canals	✓ Support that FIMD formulates maintenance plan, rehabilitation plans (incl. periodic inspection) of water intake and conveyance facilities as well as budget plan to implement them.	✓ FIMD staff ✓ Other DOI staff	✓ It is able to know facilities to be managed, and ✓ Maintenance is carried out timely and properly, and it is possible to avoid becoming malfunctioning due to lack of budget.
2 **A**	✓ There is no maintenance plan of tertiary canals	✓ Support that WUAs formulate maintenance plan, rehabilitation plans of on-farm irrigation facilities as well as budget plan to implement them	✓ WUA members ✓ FIMD and other DOI staff (Training of Trainers: ToT)	✓ It is able to know facilities to be managed, and ✓ WUA becomes able to maintain on-farm facilities timely and properly, without relying on GON.
3 **A**	✓ Tail-end farmers in the on-farm area do not receive water because upstream farmers take water more than allocated volume.	✓ Support irrigation practice by rotation such as irrigating from the tail-end plot towards upstream and cropping, and ✓ Give guidance on reviewing proper irrigation requirement.	✓ WUA members ✓ FIMD and other DOI staff (ToT)	✓ Equitable irrigation is practiced in the on-farm area, ✓ The amount of ISF collected increases, and ✓ Irrigated area in the spring crop season increases.
4 **B**	✓ Since the farm plot surface is uneven. Such plot needs extra water.	✓ Implement leveling of farm plots (implement in demonstration plot.)	✓ WUA members ✓ DADO and DOA staff (ToT)	✓ Water use efficiency in the on-farm area is improved, and then irrigated area increases particularly in the spring crop season.
5 **B**	✓ Since the plot-to-plot irrigation is the dominant practice, extra irrigation water is needed and, at the same time, drainage problems take place.	✓ Develop watercourses and farm ditches in the on-farm area so that each plot receives water from watercourses/farm ditches.	✓ WUA members ✓ FIMD and other DOI staff (ToT)	✓ Water use efficiency in the on-farm area is improved, and then irrigated area increases particularly in the spring crop season, and ✓ Farm plots with drainage problems decease.
6 **C**	✓ WUA members hope for technical trainings of rice cultivation, but DOA has not yet tackled it.	✓ Demonstrate paddy cultivation, ✓ Give training of fertilizer application level and methods, and ✓ Give training of seed production.	✓ WUA members ✓ DADO and DOA staffs(ToT)	✓ Water use for low-land paddy cultivation is improved, ✓ Since fertilizer is costly, farmers can reduce the production costs by learning how to use fertilizer properly, and ✓ It is expected that quality seeds make yields increase.
7 **C**	✓ The ISF collection rate is 70% at present, and the WUA seek to raise the collection rate and the fee. However, the decrease of the collection rate is feared due to raise in fee.	✓ Give guidance on proper ISF (money amount), how to calculate it and how to charge it, and ✓ Support formulation of a reporting system of maintenance plan, the amount of ISF collected and expense to WUA members.	✓ WUA members ✓ FIMD and other DOI staff (ToT)	✓ WUAs stop relying on GON for costs of WUA activities (operation, maintenance and management) and, ✓ The revenue of WUA becomes stable because the feeling of unfairness on charging ISF decreases within WUA.

#) **A**: Most Important, **B:** Important, **C**: As necessary

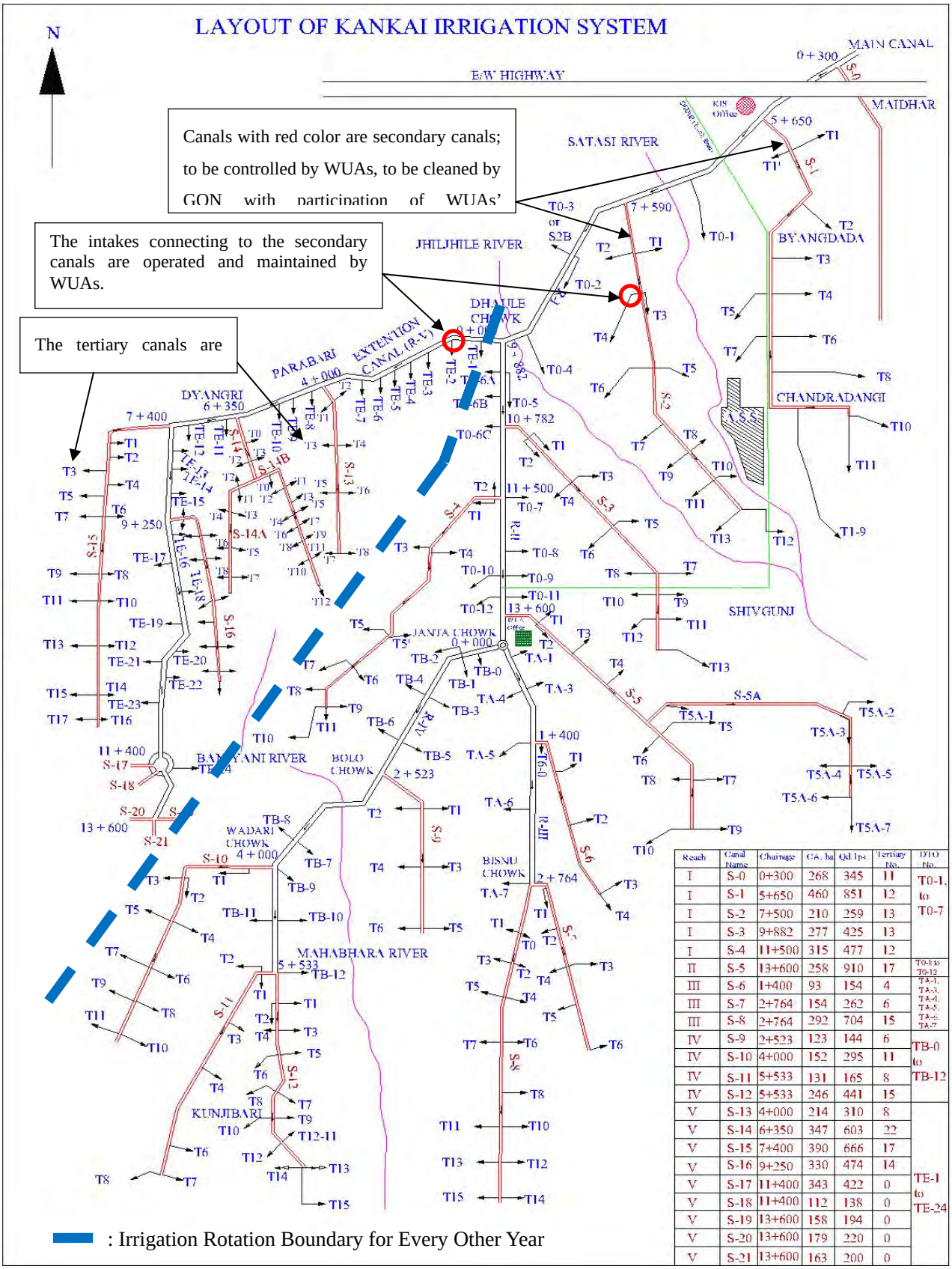
Source: Survey team

Table 5-4-6 Challenges and Possible Activities in Bagmati Irrigation Systems (Hearing from the GAR2 Tertiary-canal-level WUA)

#	Current Challenges	Possible Activities in JICA-TCP	Targets	Expected Outcomes
1 **A**	✓ There is neither maintenance plan nor rehabilitation plan of on-farm irrigation facilities.	✓ Support that WUAs formulate maintenance plan, rehabilitation plans of on-farm irrigation facilities, ✓ Support financial resource planning to implement the above plans, and ✓ Support formulation of recording system of implementation and reporting system.	✓ WUA members ✓ DOI officers including the FIMD officers (TOT)	✓ WUA becomes able to maintain on-farm facilities timely and properly, without relying on GON, and ✓ The reliability of irrigation becomes better.
2 **A**	✓ Peon (employee of WUA), who distribute water in the on-farm area, measures nothing on water delivery, and also takes no record of water delivery.	✓ Give guidance to Peon so that he is able to give proper amount of water to each plot, and ✓ Support that farmers gain knowledge about proper amount of irrigation water so that they do not instruct Peon to over-irrigate.	✓ WUA members ✓ FIMD and other DOI staff (ToT)	✓ Water use efficiency in the on-farm area is improved and, ✓ Thereby, system-wide water use efficiency is improved.
3 **B**	✓ Irrigation facilities are not developed in the on-farm area. (Water distribution is not efficient because water is controlled by embanking and cutting soil banks, which needs excessive works.)	✓ Give technical guidance of how to build division boxes by a participatory way; division boxes are placed in the on-farm area.	✓ WUA members ✓ FIMD and other DOI staff (ToT)	✓ The accuracy of water diversion is improved. Thereby water use efficiency in the on-farm area is improved. ✓ The workload of Peon is reduced. Subsequently the efficiency of water distribution is improved.
4 **B**	✓ Since the farm plot surface is uneven. Such plot needs extra water.	✓ Implement leveling of farm plots (implement in demonstration plot.)	✓ WUA members ✓ DADO and DOA staff (ToT)	✓ Water use efficiency in the on-farm area is improved, and then irrigated area increases particularly in the spring crop season.
5 **C**	✓ Since the plot-to-plot irrigation is the dominant practice, extra irrigation water is needed.	✓ Develop watercourses and farm ditches in the on-farm area so that each plot receives water from watercourses/farm ditches directly.	✓ WUA members ✓ FIMD and other DOI staff (ToT)	✓ The loss of water due to deep percolation decreases during water distribution. Thereby, water use efficiency in the on-farm area is improved, and then irrigated area increases particularly in the spring crop season.
6 **C**	✓ There is no repair record of the tertiary canals. (FIMD has a record if it supported WUA to repair the tertiary canal.)	✓ Give guidance to WUAs so that they make records of repair.	✓ WUA members ✓ FIMD and other DOI staff (ToT)	✓ It becomes possible to identify spots where repair works implemented frequently from the repair records and to select spots where radical countermeasures (upgrade) should be implemented.
7 **C**	✓ The ISF collection rate is 60-70% at present, and the WUA seek to raise the collection rate and the fee. However, the decrease of the collection rate is feared due to raise in fee.	✓ Give guidance on proper ISF (money amount) , how to calculate it and how to charge it, and ✓ Support formulation of a reporting system of maintenance plan, the amount of ISF collected and expense to WUA members.	✓ WUA members ✓ FIMD and other DOI staff (ToT)	✓ WUAs stop relying on GON for costs of WUA activities (operation, maintenance and management) and, ✓ The revenue of WUA becomes stable because the feeling of unfairness on charging ISF decreases within WUA.
8 **C**	✓ FIMD is working on WUA establishment at the secondary-canal and tertiary-canal levels in Bagmati Irrigation System, but it is not getting along.	✓ Support farmers so as to establish WUAs together with Bagmati IMD staff.	✓ FIMD and other DOI staff (ToT)	✓ Establishment of WUAs makes the management of Bagmati Irrigation System smoother.

#) **A**: Most Important, **B:** Important, **C**: As necessary

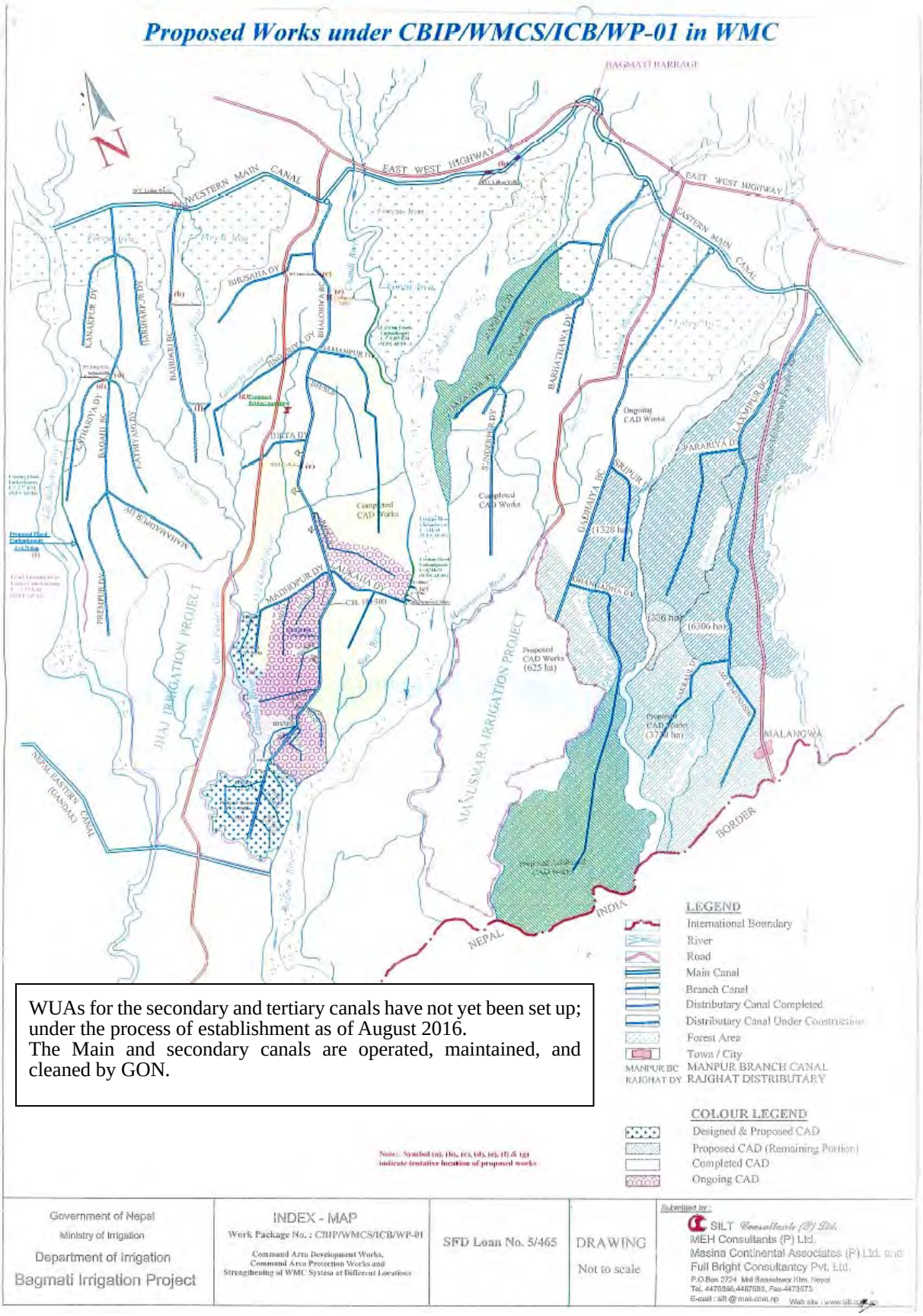
Source: Survey team



Reach	Canal Name	Chainage	CA, ha	Qd,l/s	Tertiary No.	DTO No.
I	S-0	0+300	268	345	11	T0-1, to T0-7
I	S-1	5+650	460	851	12	
I	S-2	7+500	210	259	13	
I	S-3	9+882	277	425	13	
I	S-4	11+500	315	477	12	
II	S-5	13+600	258	910	17	T0-8 to T0-12
III	S-6	1+400	93	154	4	TA-1, TA-3, TA-4, TA-5, TA-6, TA-7
III	S-7	2+764	154	262	6	
III	S-8	2+764	292	704	15	
IV	S-9	2+523	123	144	6	TB-0 to TB-12
IV	S-10	4+000	152	295	11	
IV	S-11	5+533	131	165	8	
IV	S-12	5+533	246	441	15	
V	S-13	4+000	214	310	8	TE-1 to TE-24
V	S-14	6+350	347	603	22	
V	S-15	7+400	390	666	17	
V	S-16	9+250	330	474	14	
V	S-17	11+400	343	422	0	
V	S-18	11+400	112	138	0	
V	S-19	13+600	158	194	0	
V	S-20	13+600	179	220	0	
V	S-21	13+600	163	200	0	

Figure 5-4-2 Layout of Kankai Irrigation System

Source: Survey team



WUAs for the secondary and tertiary canals have not yet been set up; under the process of establishment as of August 2016.
The Main and secondary canals are operated, maintained, and cleaned by GON.

Figure 5-4-3 Layout of Bagmati Irrigation System

Source: Survey team

The outline of the Kankai Irrigation System can be summarized as follows:

Table 5-4-7 Reaches of the Kankai Irrigation System

Construction Year	Reach	Secondary Canal	Remarks
1971 – 1981 (Phase I)	I	S0 - S1	A = 4,000 ha Main Canal L = 22.5km (All are Lining Canal)
	II	S3 – S5	
	III	S6 - S8	
	IV	S9 - S12	
1980 - 1990 (Phase II)	V	S13 - S21	A = 3,000 ha Main Canal L = 13.6 km (Lining length: 700m)

Source: KIMD and the WUA of the Kankai Irrigation System

There are 190 WUAs at the tertiary canal level, 22 at the secondary canal level and 5 block WUAs established in the Kankai Irrigation System. Each block WUA consists of two representatives (one female and one male) and therefore there are 10 representatives in total. At the top of the hierarchy of WUAs, a main canal WUA is established with a total of 15 members, consisting of a president, a vice-president, a secretary, a treasurer and the former president in addition to the 10 representatives from the block WUAs. The president, the vice-president, the secretary and the treasurer are elected from the members of 190 tertiary canal level WUAs. Concerning the relation between the blocks and the reaches, the block 1 has the reach I, the block 2 has the reaches II and III, the block 3 has the reach IV, and the block 4 plus the block 5 constitute the command area of the reach V.

It is said that the total command area of the Kankai Irrigation System is 8,000ha. However, the irrigable area is up to 7,000ha, and the current irrigated area is 5,500ha. The main crop to be irrigated during the rainy season is paddy rice, and usually there is sufficient volume of water available. The maximum discharge of the river in the rainy season is considered as 5,200$m^{3/}$s., based on the record marked in 2011. The delivery capacity of the main canal is 10.15m^3/s, and all the command area of 7,000ha can be irrigated in the rainy season. For the winter and spring seasons, the annual rotation method is applied between the Reaches I, II, III, IV and the Reach V. The minimum discharge of the river in winter is 7.74m^3/s, and it is seen as technically feasible that 50% of such a minimum discharge, namely 3.87m^3/s of water can be off-taken by the Kankai Irrigation System to irrigate up to 4,000ha.

Table 5-4-8 Actual irrigable areas and the targets of irrigated areas of the Kankai Irrigation System

Irrigation system	Water source	Means of water intake	Area (ha)			
			Command Area	Irrigable Area		
				Rainy season	Winter	Spring
Kankai	Perennial River	Diversion Weir	8,000			
(1) Actual Irrigated Area				5,500	3,000	2,500
(2) Irrigable Area				7,000	4,000	4,000
(3) Target Increased Area (= (2) - (1))				1,500 (+27%)	1,000 (+33%)	1,100 (+44%)
(4) Target Crop				Rice	Wheat	Rice, Vegetables

Source: KIMD and WUA in the Kankai Irrigation System

According to the hearing from 14 out of the 15 representatives to the WUA at the main canal, the farmers are used to produce paddy rice in the rainy and spring seasons, and leave the plots fallow in the winter season. However, in recent years, DADO has been promoting the wheat production in the winter season through the provision of a 50% of subsidy to seeds and fertilizers (including limes) to individual farmers.

This has contributed to an increase of the number of farmers who are engaged to the wheat production. This DADO's wheat promotion program has paid 5,000Rs./ha in cash to the farmers of model farm as an incentive measure[28]. The model farm system was started with 50ha in 2015 and the area will be expanded to 100 ha in the winter season of 2016/2017. Moreover, marketing support to match the farmers with traders is planned to be commenced. The WUA is willing to expand the wheat production areas up to 1,000 -1,500ha with the understanding that the volume of irrigation water of their Irrigation System is enough to do so.

The Constitution of the WUAs in the Kankai Irrigation System was developed for the first time 23 years ago, and it has been revised six times so far. The latest amendment was given in September 2016 and through which, it is stipulated that 40% of the representatives and especially the Treasurer of the WUA at the main canal should be female. It was also added to the Constitution that 33% of the representatives and members to the WUAs at the secondary and tertiary canals should be also female. Besides, to improve the transparency in the accounting, the number of signers to deposit to and to withdraw from the bank accounts is increased to two, so that either the Secretary or the Treasurer should also sign checks or slips together with the President. The amendment also requires the disclosure of all cash transactions and the establishment of the audit mechanisms. The consultation and approval on the amendment is carried out by 225 representatives, which are consisting of the 181 existing representatives and 2 more ad-hoc representatives from each of the WUAs at the secondary canal.

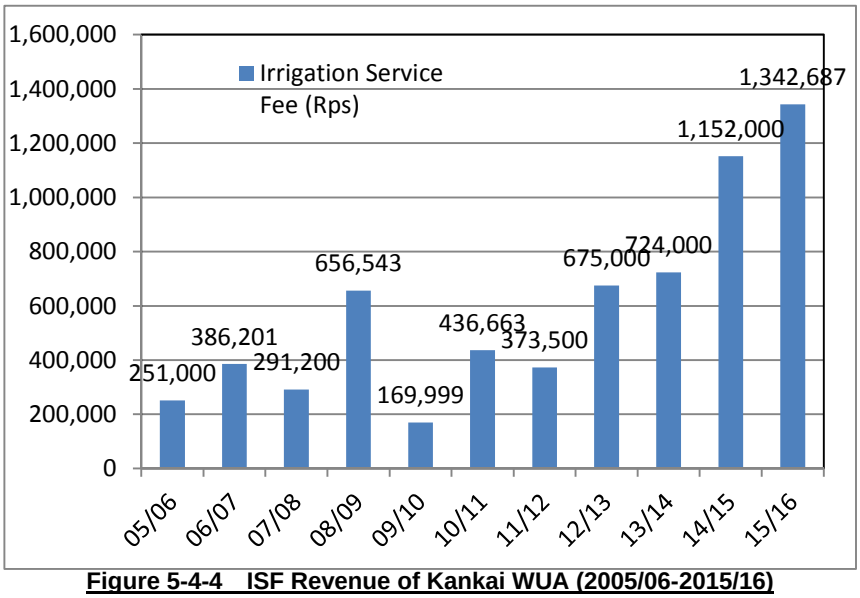


Figure 5-4-4 ISF Revenue of Kankai WUA (2005/06-2015/16)

Source: Kankai WUA

Meanwhile, the Kankai Irrigation Management Division (KIMD), an office of DOI, which is in charge of the Kankai Irrigation System, has a total of eleven (11) staffs, consisting of: two civil engineers (full-time and part-time), two agriculture engineers (full- and part-time), one assistant engineer (full-time), two administrative officers and others three staffs.

In 2015, 1.4 million Rs. is collected annually as ISF in the Kankai Irrigation System. The members should pay

[28] According to the interviews with farmers, 5,000 Rs. per ha worked effectively as incentive and they were motivated to produce wheat.

200Rs. per 0.66ha twice a year after each harvest. In other words, the ISF rate of this Irrigation System was 400Rs./0.66ha/year. Since 2016, the rate was raised to cover the costs of O&M, and the members now should pay 300/0.66ha/six months. ISF revenue has been increasing in recent years shown in Figure 5-4-4; it is reported that percentage of collected amount is 64% for whole WUA and that of irrigated area reaches 90% or more. The share rates of the collected ISF between the WUAs and the GON are 90% and 10%, respectively. The share for the WUAs is again distributed among the WUAs at the different levels: 40% to the main canal level WUA, 20% to the secondary canal level WUAs, and the remaining 40% to the tertiary canal level WUAs. When the collected ISF is insufficient for the implementation of activities, the WUA can ask for support from KIMD. In 2015, KIMD disbursed 0.6 million Rs. for the maintenance of the main canal of the Kankai Irrigation System.

Table 5-4-9 shows the distribution of roles between GON (DOI/IMD) and the WUAs in O&M and the management of the Kankai Irrigation System. While Table 3-2-3 describes that DOI is responsible for O&M of branch or secondary canals with the participation of WUAs as general rules, this rule does not fit to the reality of the Kankai Irrigation System, where the O&M of the secondary canals are left to the WUAs, while DOI takes care of O&M of only the main canal.

Table 5-4-9 Distribution of Roles in the maintenance works for the Kankai JMIS

Canal	Operated, Maintained and Managed by
Main Canals	DOI (IMD)
Secondary Canals	WUA
Distributaries or Sub-Secondary Canals	
Tertiary Canals	WUA
On-farm canals	

GON provided one tractor, one backhoe and one threshing machine to the WUAs of the Kankai Irrigation System in 2015 and the WUAs are responsible for the O&M of those machineries. The WUAs construct the tertiary canals by using the backhoe and the construction budget disbursed by KIMD from the budget allocated to the implementation of IWRMP, in order to cover the costs of earth work, fuel, labor, transportation and wage for backhoe operators (500Rs./day) and watchmen. Regarding the establishment of the tertiary canals from S17 to S21 of the Reach V, only 10% of the construction works has been completed so far, which comprises the connections with the secondary canal and the water diversion gates. The works of the Reach V shall be finished by 2018 and therefore, all the planned construction works for the Kankai Irrigation System would be completed, though some of the tertiary canals from S0 to S16 may remain incomplete. A comprehensive IMT of the Kankai Irrigation System is planned to be also undertaken, once physical works are completed. Meanwhile, GON continues taking care of the water management and cleaning of the main canal. The average height of sediment through the year is about 30cm.

Although most of the construction works of the tertiary canals from S0 to S16 have been finished, some works still remain. KIMD has no plan to construct new tertiary canals, and has budgeted 0.6 million Rs. for 2016 only to undertake maintenance works. KIMD will support the WUA in the maintenance works by clarifying the priority among the secondary and tertiary canals. The structure of the tertiary canals is simple enough so that they can be established manually.

KIMD employs gate keepers for operating the gates of the secondary canals and measuring water discharge at S0 – S16 and she/he measures the discharge three times a day. A total of sixteen gate keepers engage the works in the canals between S0 and S16 and earn 500 Rs. per day per person. One of the sixteen keepers operates 2 gates. While the hired gate keepers operate the gates which divert water to the secondary canals from the main, the WUA members operates the lower level canals by themselves.

The WUA affirmed that the canal S1 is always recommended for a pilot project of any technical cooperation. However, the canal S1 is already well maintained. Therefore, the WUA proposes other canals which are not yet well maintained, such as S8, S17 and S18, whose maintenance is smoothly managed, yet it would be better option that secondary, tertiary and on-farm canals are constructed in poorly managed areas such as S8, S17 and S18, and then such models are disseminated to the other areas. This needs further investigation.

5-5 Importance of System-wide Water Management

A series of activities aforementioned will contribute to "Optimize water use for reliable year-round irrigation". However, the perspective of the system-wide improvement of water management seems to be a little bit missing in accordance with participants' statements during the workshop. That may be because that it was a workshop that targeted DOI staff, that is, they paid particular attention to capacity strengthening on water management, organizational operation and crop water management by WUA. However, it is essential to improve the system-wide irrigation efficiency so as to optimize water use.

The ADS aims at transferring the responsibility for O&M of principal facilities such as headworks and main canals to WUAs in future. Of course, it depends on the size of irrigation systems, but it is obviously infeasible in near future when one thinks about the capability of WUAs. As a result, the joint management is the basic and dominant management form, which GON (DOI) takes responsibility for O&M of headworks, main canals and large secondary canals (red parts in the figure below) and WUA manages smaller canals, usually the tertiary and lower level canals , down to the farmland (blue parts in the

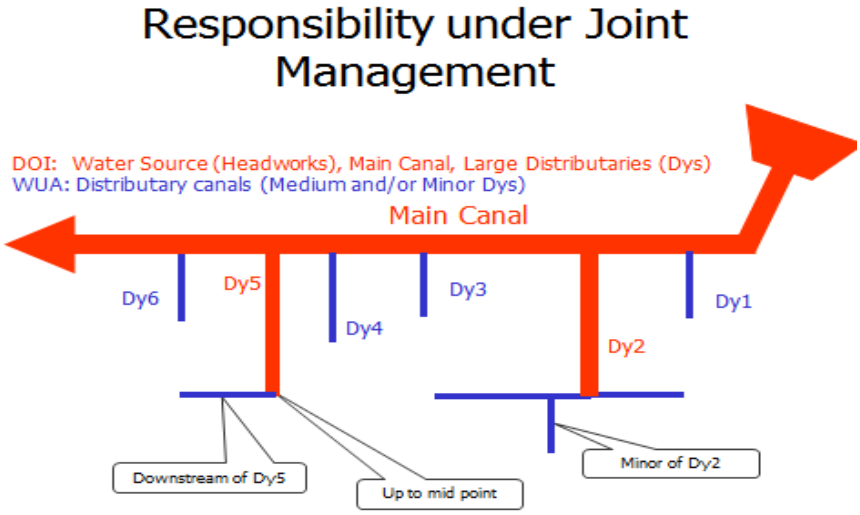


Figure 5-5-1 Conceptual Diagram of Joint Management

Source: Survey team

figure below).

The joint management requires clear hydraulic borders between the government-managing area and the WUA-managing area in the same irrigation system. Usually, the borders are drawn at the starting points of tertiary canals. It is easy to make the hydraulic borders, because the head-regulators are installed in the gates at the starting points of the tertiary canals. Accordingly, the GON's role is to deliver the amount of water agreed with WUA to the management interface, and WUA pays some money to GON in exchange for the delivery service from ISF collected from the WUA members. Then, it is the WUA or/and WUG that are in charge of water distribution amongst lower-level canals and on-farm water management below the interface.

GON (DOI) has to distribute water to all the tertiary canals which are offtaking from the main canal, since the WUAs are basically established at such level. The water should be distributed in accordance with the areas to be irrigated and the cropping plans in an equitable manner. During the dry season when water is not available enough, DOI has to distribute water in a volume reduced by a certain rate to all the canals (to all the WUAs), in conformity with areas to be irrigated with the available volume of water.

In some cases, it may be necessary to impose a water distribution method that enhances the system-wide irrigation efficiency. For example, first, water shall be delivered to the areas (the WUAs) at the tail of the canal systems where tend to be suffered from water shortage. Once the ploughing and seeding are done, water should be delivered to the next areas along with the tertiary canals. Thus the water is distributed gradually by zoning starting from the farthest areas in the canal systems until all the areas are irrigated.

Based on the premise that irrigation facilities are in a condition to perform their minimum functions as hardware, in order to improve the system-wise efficiency, it is necessary to support both GON and WUA in their capacity development. It is indispensable for DOI to enhance the capability to manage water at the headworks and main canals, because DOI has to deliver water equitably to every WUA, and it forms the base for WUAs to develop their capacity to manage the command areas (the tertiary and lower level canals) under their management. Thus, it is expected that the JICA-TCP implements activities concerning the importance and improvement of the system-wide water management by GON, referring to the priority activities identified in the workshop in which DOI staff participated.

5-6 Relevance of Contents Applied from GON

5-6-1 Background of the Application

GON has been implementing large scale irrigation development and irrigation system management for the last several decades. At present, GON is trying to transfer the 25 main irrigation systems in Terai region to WUA in accordance with the IMT policy. Once the IMT is completed, WUA takes responsibility for the on-farm area below a branch canal in the irrigation system. Meanwhile, GON takes responsibility for delivering irrigation water equitably to the most upstream point of the on-farm area that each WUA manages.

However, such joint management is not functioning well so far. Accordingly, water is not necessarily utilized efficiently. Even if water sources of some irrigation systems are perennial rivers and water is available through the year, their irrigated area in the dry season (winter and spring) is limited to less than half of the command area, or it is very little.

Under such circumstances, GON is intensively carrying on rehabilitation/upgrade of headworks and conveyance systems (main canals, large branch canals) of the main irrigation systems, so as to improve irrigation efficiency and expand the year-round irrigated area of the existing irrigation systems. Moreover, GON (DOI) has acknowledged the importance of facility rehabilitation and water management in the on-farm area, in order to improve water utilization within the existing irrigation system. Whereat, DOI has applied for JICA-TCP, which contributes to the expansion of year-round irrigated area, focusing on improvement of improvement of O&M and water management in the on-farm area.

5-6-2 Relevance of Objectives of the GON's Application

The irrigation efficiency of the irrigation system consists of two efficiencies: conveyance efficiency and application efficiency. The former is the efficiency of water conveyance from the water intake facilities to the point where WUA starts water management with responsibility, and the latter is the efficiency of applying water to farm plots. The former can be improved greatly by structural rehabilitation of canals and/or by building water-control structures. On the other hand, what is important to improve the latter is to supply the right amount of water to the effective root zone[29] of crops in the right manner, taking crop water requirement and loss of water into consideration. In other words, farmers need to learn so-called "on-farm water management[30]", which is the water management technologies in the on-farm area.

From the above viewpoints, the improvement of on-farm water management is a reasonable approach so as to improve the application efficiency and expand the year-round irrigated area. However, the on-farm water management has a limitation, which is that it does not necessarily improve the system-wide water management or water use although it improves the irrigation efficiency within respective farm plots. It is essential to involve water management including the water-conveyance process in order to enhance the system-wide irrigation efficiency and increase year-round irrigated area.

Therefore, the improvement of on-farm water management is just the prerequisite to increase the year-round irrigated area, but it cannot be the sufficient condition. The increase of the year-round irrigated area requires the system-wide optimization of water management. That is, the optimization needs not only WUA's improving on-farm water management but also DOI's improving water management on the water-conveyance facilities and delivering water to WUAs equitably and timely.

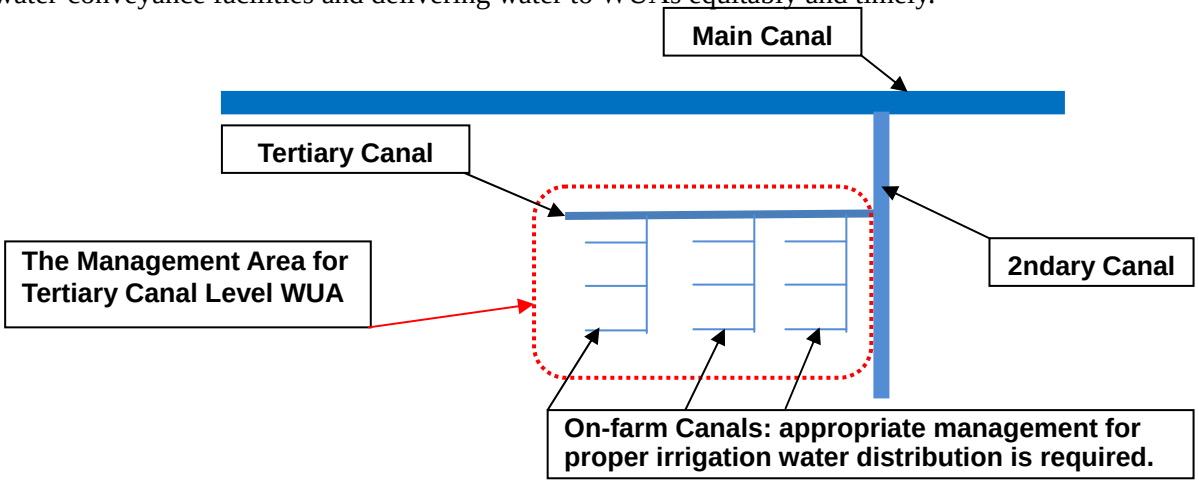


Figure 5-6-1 Image of the water management area at the on-farm canal level

Source: Survey team

[29] This is a range of depth of soil where the plant roots can uptake soil moisture most effectively.

[30] This means the distribution and utilization of water on crops within each of the farming plots in an effective and efficient way.

5-6-3 Target Area

The irrigated farmlands in Terai region occupy 72.6% of the nationwide irrigated area. The production amounts of paddy, wheat, pulses and vegetables in Terai region account for 78.6%, 64.1%, 76.6% and 58.1% of the nationwide production amounts, respectively. There are numerous FMISs (small and medium scale irrigation systems) and 25 JMISs (large scale irrigation systems). Irrigated agriculture in those FMISs and JMISs in Terai region is important from the viewpoint of the food security, and GON has proposed Terai region as the target are of JICA-TCP. Thus, it is concluded that the JICA-TCP targets irrigation systems scattered in Terai region.

5-6-4 Joint Management in the IMT Process

ADS aims at implementing the full IMT of less-than-10000ha JMISs (13 out of the 25 main systems in Terai region). However, large facilities of those systems such as headworks, main canals and large branch canals are currently under management of DOI. Accordingly, they are now jointly-managed by DOI and WUA.

Irrigation systems under JMIS are large scale ones with large catchment area. Hence, it is difficult for WUA to operate and maintain large facilities alone by WUA's own funds and technologies. Then, it is recommended that the joint management go on as a superior way of managing large scale irrigation systems from now on, and that JICA-TCP does not implement the full IMT but the partial IMT for joint management. As for more-than-10000ha irrigation systems, in addition, ADS intends to transfer more reasonability to WUA than the present reasonability, in terms of facilities to be handed over. However, what is of paramount importance is to establish a sustainable joint management at each system corresponding to the capability of WUA, taking the sediment state into account.

Joint management firstly enables DOI to reduce the maintenance costs of irrigation systems, because WUA takes responsibility of O&M in the on-farm area, including financial responsibility. As a result, DOI becomes able to allocate budgets for O&M of principal facilities, rehabilitation necessary or new projects. Moreover, it will be possible to improve the management system of the government responsible portion of the JMIS, since FIMDs become able to employ more gate operators and/or other staff for the O&M of main canals.

On the other hand, IMT imposes WUA to take heavier reasonability and more burdens of O&M. Therefore, there must be benefits for WUA more than the burdens, or it is necessary that the feeling of fairness, if any, must dissolve, so that WUA to agree to IMT. In fact, famers had not been satisfied with irrigation services and the government had not been able to provide better irrigation services to farmers, in many instances such as Mexico where IMT was implemented relatively smoothly.

As a result, IMT is likely to go successfully in many cases where WUAs are organized in an evolutional manner by phasing, starting from the management at the farmland level, through that at the turn-out level (by water users' groups), and that at the tertiary canal. Such IMT is established based on the farmers' initiative of doing by themselves because the government cannot do it. Besides, the organization of WUAs can give peer pressure to upstream farmers' groups, which take more water than they need, so as to attain more equitable distribution of water within an irrigation system. .

There are many case studies of IMT, and the following is an example of such studies. The basic is to make a win-win relationship between the government and farmers. At the first sight, it seems that the government gains more profits than farmers do, e.g. maintenance cost reduction. But the WUA officially established as an organization becomes able to demand water on an equal footing. The WUA becomes able to duly complain to other WUAs in the same system, which takes excessive water, through the government as mediator. Meanwhile, the government becomes able to concentrate on equitable water distribution among all the WUAs (among all the tertiary canals) through enhanced gate operation on the main canal.

Case study of IMT: FAO Water Reports No.32 Irrigation Management Transfer - Worldwide efforts and results (2007)

1) The table on the right-hand side (Table 5-6-1) is a series of IMT cases investigated. The table shows that IMT was implemented at the field canal level in 25 cases and that it was implemented at the distributary canal level in 23 cases. That is, principal facilities such as headworks and main canals are under management of the government in all of 48 cases. In other words, all cases are joint management. In accordance with the case study, it is concluded that "WUAs have the potential to perform their basic functions but that they need sustained training, consultation, support services and a proper legal basis in order to enable them to function effectively". It is also concluded from Figure 5-6-1 that "Right IMT makes a reduction in the government O&M cost, but the farmers' financial burden for O&M does not necessarily increase after IMT."

Table 5-6-1 Area Where WUA is Responsible after IMT

Basic O&M functions performed by WUAs after management transfer	Number of cases	
	Field canal level	Distributary canal level
All	8	5
Most	14	12
Half	2	3
Fewer than half	1	3
Total cases reported	25	23

2) It was only 4 cases out of the 43 cases that the quality of maintenance has deteriorated after IMT. All of those 4 cases are African countries, and the government reduced the financial contribution to O&M drastically while farmers could not compensate the amount reduced for O&M by the self-pay burden. Thus, IMT was not successful in those 4 countries.

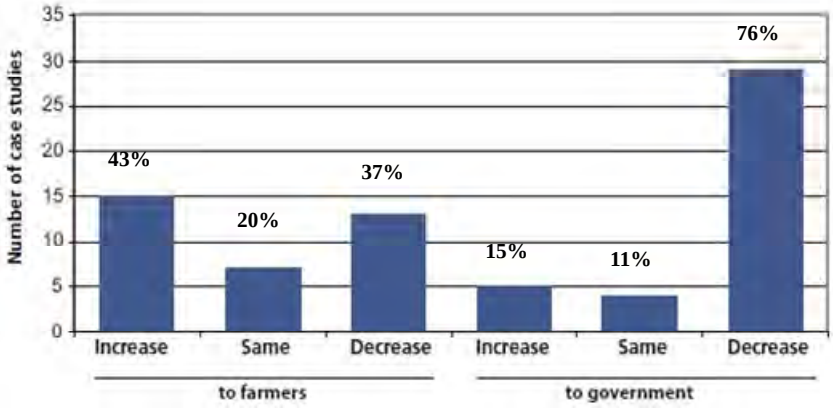


Figure 5-6-1 Change of Expense for O&M after IMT

3) The ISF collection rate went up after IMT at 75% of irrigation systems studied. This fact implies that IMT has improved the quality of irrigation water delivery service. Figure 5-6-2 shows the transition of the ISF

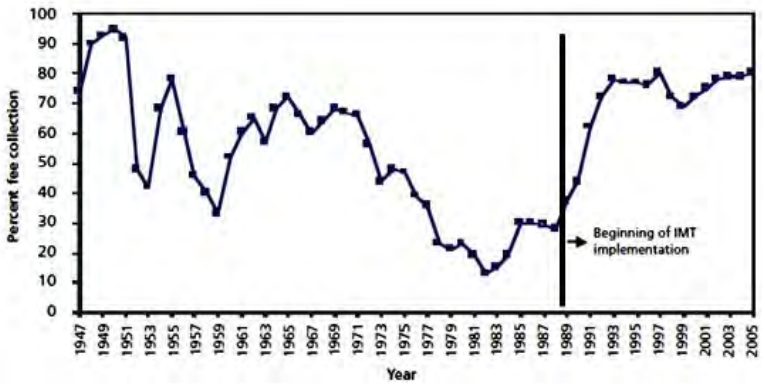


Figure 5-6-2 Transition of the Average IMT Collection Rate (Mexico, 2006)

collection rate of a successful case in Mexico, which is often cited as a successful one. The ISF collection rate had kept declining before IMT, but it turned to go up after IMT.

4) The timeliness of irrigation was obviously improved at 30 out of 39 cases studied (Figure 5-6-3). Farmers receive water more timely after IMT, that is, at the time closer to when they want to irrigate before IMT. Further, the equity of water distribution was obviously improved, too. In other words, over-irrigation by upstream farmers has decreased and tail-end farmers receive more water than before IMT.

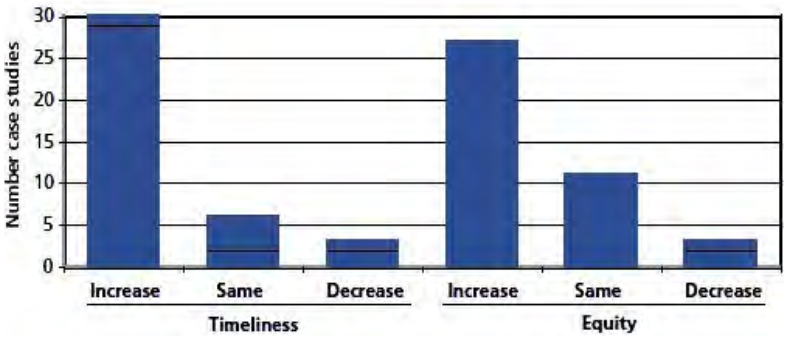


Figure 5-6-3 Changes of Timeliness and Equity of Water Distribution through IMT

5) The improvement of irrigation water distribution normally results in increased cropping intensity and/or extended irrigated area. The extension of irrigated area has been reported at 25 out of 39 cases studied (Figure 5-6-4). In this regard, it is very difficult to identify causes of increased crop yield because there are many elements that have influences on crop yield other than water use improvement. For instance, sudden changes of crop yields can be caused by elements related to neither cultivation technologies nor water use: e.g. political decisions. However, crop yield increases after IMT have been reported at 21 out of 33 cases studied (Figure 5-6-4). This result indicates the possibility that irrigation water delivery of the right amount at the right time enhances crop yields. Then, enhanced crop yields have potential to increase farm income per unit area and subsequently to improve the ISF collection rate.

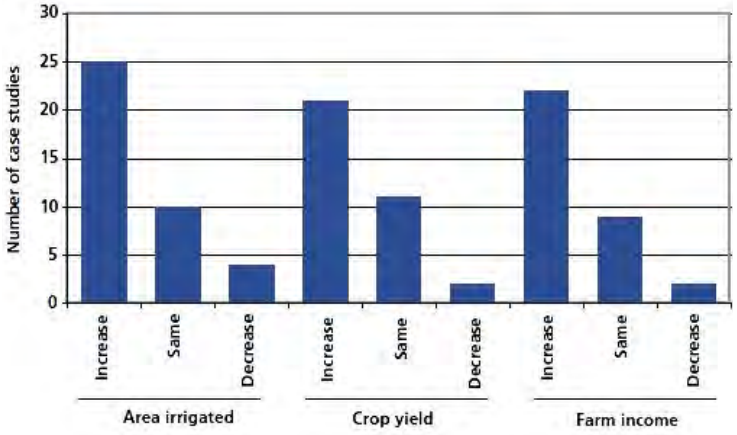


Figure 5-6-4 Changes of Irrigated Area, Crop Yield and Farm Income through IMT

5-6-5 Involvement of JICA-TCP in Future IMT Implementation by GON

Many IMT cases studied in the above have proved the possibility that IMT has effects on making water distribution more proper, crop yield increase, farm income increase and enabling the government to reduce the maintenance cost. In this regard, it should be noted that all of the cases were so-called “Partial IMT” which transfers on-farm facilities only (e.g. tertiary canals, watercourses) to WUA, that is, irrigation systems are under joint management after IMT.

Irrigation management is being transferred from DOI to WUA in accordance with the IMT policy that

GON has adopted as an irrigation management policy. In JMISs, watercourses and farm ditches have been transferred to WUAs. The tertiary canals, sub-secondary canals and/or secondary canals have been also transferred to WUA, although the situation varies from system to system.

In order to implement irrigation with a high system-wide efficiency while improving on-farm water management requested by IMD of DOI, it is necessary to implement joint management at a high level, which is established through partial IMT tailored to the size of the irrigation system. Consequently, JICA-TCP needs to work on both DOI and WUA in order to implement joint management at a high level.

5-6-6 Target Irrigation Systems for the IMT Approach

The IMT policy was formulated in 1992, and it has been consistently a major policy of DOI since then (Irrigation Policy 1992, 1997, 2003, 2013). Further, ADS intends to attain more efficient use of water in both FMISs and JMISs, including the 25 main systems in Terai region, by 2035.

The total command area of 25 main irrigation systems accounts for 34.8% (331,644ha) of the total irrigated area in Terai region. The average command area of the 25 main systems is 13,000ha, and the remaining 65.2% (622,096ha) is the area irrigated by numerous FMISs scattered in Terai region. The exact number of FMISs is unknown, but it is supposed that there are 3,000-6,000 FMISs, assuming the average command area of FMISs is 100-200ha.

Partial IMT is in progress at the 25 JMISs. On the other hand, many FMISs have been originally constructed by Farmers themselves. Accordingly, it is farmers who have the ownership of the irrigation system and its O&M responsibility from the beginning. Thus, FMISs cannot be the target of IMT, and it is reasonable that irrigation systems for the pilot project of JICA-TCP are selected from the 25 JMISs. However, FMISs are supposed to have something to study in terms of cohesion, rules and organizational operation of WUA.

According to DOI, the O&M of FMIS is good in many cases, compared to JMIS. That is probably because (a) the irrigation facilities and WUA are much smaller scale compared to JMIS, (b) beneficiaries live in the same village or in some nearby villages, that is, peer-pressure functions under such circumstances, and it is easier to manage the irrigation system and operate WUA owing to the above (a) and (b). Therefore, the O&M of FMISs are implemented more smoothly than those of JMISs.

However, assuming one of WUAs in a JMIS is equivalent to the WUA of a FMIS, the same organizational rules as those of FMIS is applicable to WUAs in JMIS. Then, from this aspect, the idea of study tour as a part of training occurs. Which to say, WUA members of the JMIS that JICA-TCP targets visit a FMIS and learn organizational operation, etc. from the WUA of the FMIS. There are a number of WUAs in a single JMIS. Coordination among WUAs should be eventually the responsibility of DOI, which manages the main canal delivering water to those WUAs in the downstream[31].

[31] The tertiary-canal-level WUA registers to the secondary-canal-level WUA of the secondary canal that supplies water to the tertiary canal. Likewise, the secondary-canal-level WUA registers to the main-canal-level WUA of the main canal that supplies water to the secondary canal. Then, the main-canal-level WUA registers to GON (FIMD). The coordination among WUAs should be under the responsibility of the upper-level WUA to which they register, and eventually it should be the responsibility of GON to which the main-canal-level WUA registers.

5-6-7 Contents of Technical Transfer that IMD-DOI Expects

The "Y" in the column of the "Donor (Tech)" column in Figure 5-2-1 indicates the necessity of technical assistance by donor organizations, which DOI expects. JICA-TCP is able to cooperate in these technical fields: (13), (14), (15), (16), (20), (21), (23), (24), (26) and (27) (highlighted in yellow). These technical contents will contribute to the improvement of the system-wide O&M as well as on-farm water management.

It is the prerequisite that GON implements rehabilitation/upgrade of facilities by its own funds if necessary for JICA-TCP. Therefore, the JICA-TCP does not include the component of facility rehabilitation/upgrade. JICA-TCP aims to increase the year-round irrigated area by capacity strengthening of both DOI staff and WUAs and improvement of water management from the conveyance system to the on-farm level.

5-6-8 Relevance of Applied Contents for JICA-TCP from GON

The table below summarizes what discussed in the workshop and contents of high priority found out through interviews to IMD. Then, the relevance was examined, based on the above discussion, in terms of objectives, approach, contents of technical transfer, etc. As a result, each of applied contents from GON is necessary to increase year-round irrigated area through the improvement of the system-wide irrigation efficiency. However, in addition to improvement of on-farm water management, it is desired to target the entire system and strengthen the capability of FIMD/DOI staff working for irrigation system management.

Table 5-6-2 Relevance of Contents that DOI Staff Applied for Cooperation

Item	Proposed Contents	Relevance
Objective/ Challenge	Improvement of on-farm water management ✓ Improvement of the system-wide water management is necessary, too.	Yes, but not enough
Target Area	Terai Region	Yes
Approach	IMT ✓ Improvement of a resultant joint management after IMT.	Yes, but not enough
Target of IMT	Primarily 25 JMISs followed by FMISs ✓ The target is the 25 JMISs, and FMISs are candidates of study tour as a part of training.	Be modified
Method	Pilot project and its dissemination	Yes
Contents of Technical Transfer	On-farm water management improvement through capacity building and O&M improvement ✓ Improvement of the system-wide water management is necessary, too.	Yes, but not enough

Source: Survey team

Chapter 6 Proposed Approach of JICA's Cooperation

6-1 Policies and Needs in the Irrigation Sector

The Irrigation Policy 2013, which forms the base for development policies for the irrigation sector of Nepal, provides a vision for the implementation of year-round irrigation services and also highlights the sustainable development of irrigation sector through effective water management and empowerment of human resources. Meanwhile, ADS, the base for development policies for the agriculture sector, illustrates the strategies for irrigation development with a comprehensive package of infrastructure and capacity development for "Irrigation Area expanded equitably and viably, and improved Irrigation Efficiency and Management". One of such strategies aims at implementing IMT from GON to the WUAs of the 32 government irrigation systems, including the JMISs in Terai region.

The Survey confirmed six measures to be taken to improve the functions of the JMISs in Terai region, as follows: 1) an improvement on the ISF collection; 2) the formulation of an O&M plan of irrigation facilities; 3) the equitable water distribution; 4) an enhancement of water management skills; 5) an improvement of agriculture components; and 6) an expansion of year-round irrigated areas. Besides, a core problem/objective of irrigation development in Terai region, which was identified in the workshop held at the central-level, is stable year-round irrigation. It was also proposed in the same workshop to achieve this through an improvement on the ISF collection, the formulation and implementation of an O&M plan, the institutional development of WUAs, an enhancement of water management skills, etc. These issues are acknowledged as needs of local communities and national policy.

Though both the Irrigation Policy 2013 and ADS aim at improving agricultural productivity and production, the potential for an expansion of farmland in Nepal is low. Therefore, an increase of crop productivity in the existing land areas would be necessary. To achieve it, an expansion of the irrigated areas is considered as effective approach. According to ADS, the beneficiary areas of year-round irrigation are estimated to occupy about 18% of the total irrigated area in Nepal as of 2016, while the irrigated areas in Terai region cover 73% of the total irrigated areas of the county in 2011/2012. Thus, it is obvious that a promotion of year-round irrigation in Terai region would lead to an improvement of the productivity of farmlands at the national level. Thus, the need for such a project is high.

On the other hand, the "Country Assistance Policy for Nepal" formulated by GOJ in April 2012 targets "Poverty alleviation in rural areas" as one of the priority areas of its assistance to Nepal, and states that "Japan intends to increase the agricultural productivity and farmers' income by disseminating agricultural technology and fostering farmers' organizations". The Promotion of irrigated agriculture would contribute to an increase of agricultural productivity and hence, farmers' income. Thus, a JICA-TCP for the irrigation sector would be in line with the aforementioned priority area of Japan's assistance policy.

Structure of the main irrigation systems in Nepal

The structure of irrigation systems in Terai region, Nepal, is similar to that in other countries. There are secondary and tertiary canals under the main canal, and the water is delivered to each farmland through turn-outs established on the tertiary canals. Usually, therefore, a WUA is established for each turn-out. In some cases, the secondary canals are not established and turn-outs are established directly on the main canal.

Under the above circumstances, DOI has applied for a technical assistance to Japan in May 2016, so as to improve O&M of irrigation systems. The Survey team has confirmed with IMD through an interview that the application prioritizes O&M, including the water management, at the on-farm[32] level. In addition, in the workshop held on 14 August 2016 at the DOI central office, the participating DOI staffs have also prioritized the capacity development of WUAs, including the capacity development in the water management at the on-farm level, so that beneficiary areas of year-round irrigation could be expanded.

DOI has been implementing IMT of 25 main irrigation systems in Terai region for years and applied for a technical cooperation in form of JICA-TCP under such circumstances. As mentioned above, the priority is put on the on-farm water management in accordance with the contents of the application and confirmation through interviews. However, the system-wide approach is essential in order to improve water management of the irrigation system as a whole and expand the year-round irrigated area. Therefore, the technical cooperation through JICA-TCP has a large significance.

6-2 Proposed Cooperation Approach for an Improvement on the Irrigation O&M in Terai Region

It is proposed that the JICA-TCP which will be developed in response to the request from GON will adopt the pilot approach which is illustrated in the aforementioned section “5-4 Targets of Technical Cooperation and Possible Activities“. Relevant knowledge and technologies will be transferred to stakeholders of the irrigation systems previously selected, and utilize such selected systems as models of future dissemination. Based on lessons learnt drawn from the process and results of the technical transfer, the knowledge and technology will be widely disseminated to stakeholders of other irrigation systems.

Through the workshop DOI gave a higher priority to the 25 main irrigation systems (JMISs) than to small and medium scale irrigation systems (FMISs): the weighing given by the participants was JMIS : FMIS = 70% : 30%. Such a prioritization is actually reasonable because the FMISs are not the target of IMT, since they are originally farmers’ property. Besides, the IMT of JMISs is more difficult due to the larger scale of their facilities.

The IMT of Irrigation systems in Nepal is in progress, and that the existing JMISs are currently jointly-managed by GON and WUAs. In order to “increase the year-round irrigated areas”, it is indispensable to address the entire irrigation systems, by targeting both the GON staff who manage the major facilities, such as the main canal, and the WUAs that manage the command areas (the tertiary and lower level canals) by and large (See Table 3-2-3 Distribution of roles in JMIS and Table 5-4-9 Distribution of Roles in the Maintenance works in the Kankai JMIS)..

Based on all mentioned above, it can be proposed that the JICA-TCP will select JMISs and subsequently, pilot areas from the selected JMISs, taking into account the criteria proposed in section “5-4 Targets of Technical Cooperation and Possible Activities” and other factors, so that outputs of the JICA-TCP can be disseminated to other irrigation blocks within the same selected JMISs.

[32] The word “on-farm” means the area where WUA members manage irrigation water by themselves, including the inside of respective farm plots where they grow crops,

The pilot areas of the JICA-TCP will be visited by representatives from other irrigation blocks and concerned government officers at a later dissemination phase. The WUAs and the DOI officers (especially, community organizers) whose capacity is developed through the implementation of the JICA-TCP are supposed to be in charge of dissemination of the JICA-TCP outputs to other blocks, by utilizing the products of the same JICA-TCP: the Joint Management Guidelines/Manual for JMISs and the methodology to replicate the joint-management system in other places.

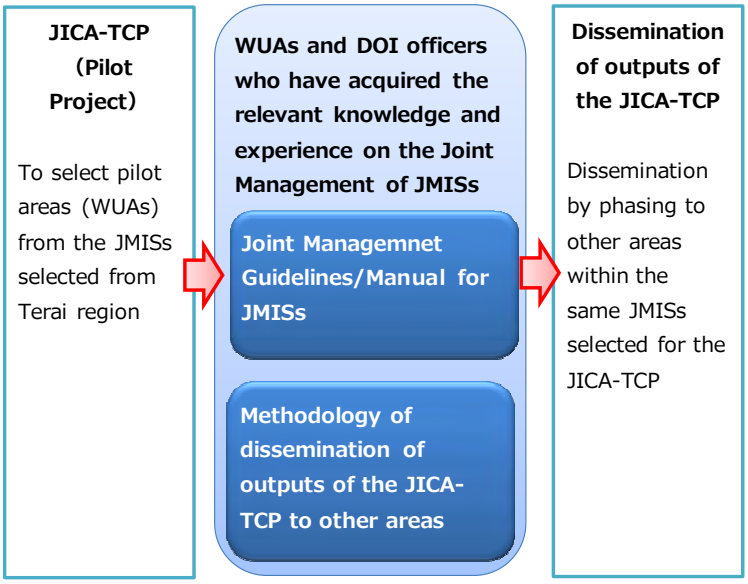


Figure 6-2-1 Procedures of the pilot project approach

Source: Survey team

Table below shows possible contents of the JICA-TCP: objectives, outcomes, activities, external conditions, etc. The project objective is proposed as that the year-round irrigated area of the targeted irrigation system increases, which was indicated as the priority challenge by the workshop participants. Under this objective, the project outcomes are classified into three categories: (a) outputs that GON staff should accomplish; (b) outputs that WUAs should accomplish; and (c) outputs that both GON staff and WUAs should accomplish, respectively, as table below shows.

Table below also shows the draft activities required to produce the outputs. . The activities are mainly trainings. In this regard, it is not the JICA-TCP but GON staffs who give trainings to WUAs. The JICA-TCP gives TOT (Training of Trainers) to GON staff so that they are able to give trainings to WUAs. Namely, GON staff of the JICA-TCP pilot areas has to participate in the TOT for WUAs, in addition to the trainings to improve on the water management at the principal facilities which should be under the GON management.

Table 6-2-1 Outline of JIC-TCP (Irrigation Part Only)

Overall Goal	Agricultural production increases in the target area.
Project Goal	**The year-round irrigated area of the targeted irrigation system increases**
Outcomes	**GON (Managing entity of principal facilities)** **1. DOI staff capacity on water management and facility maintenance are improved in the GON-responsible portion where are principal irrigation facilities.** 1.1 Facilities are sufficiently maintained in the GON-responsible portion where are principal irrigation facilities, 1.2 Water is properly and equitably delivered to the command areas (the tertiary and lower level canals) under the WUA's management , and 1.3 The amount of money and its percentage that the WUA pays to GON out of ISF collected increase.

	WUA (Managing entity of the on-farm area) **2. WUA's capacity on water management and facility maintenance are improved in the on-farm area where WUAs manage water.** 2.1 Facilities are sufficiently maintained in the on-farm area where WUAs manage water, 2.2 Water is properly and equitably distributed to lower-level WUGs within the command areas under the WUA's management (equitable distribution through main canal → secondary canals → tertiary canals →turn-outs), 2.3 The ISF is properly collected in accordance with the O&M plan, 2.4 On-farm canals including tertiary canals are developed, and 2.5 The application efficiency of the on-farm irrigation is improved.
	GON and WUA **3. A model site of joint-management is established** 3.1 The Cooperation between GON and the WUAs is strengthened, 3.2 Irrigation water is delivered to the entire irrigation system as planned, and 3.3 A methodology to replicate the joint-management system in other places is established.
Activities	**FOR GON Staffs Who Manage Principal Facilities** 1.1 Training on O&M of principal facilities, e.g. headworks and main canal, (lectures and practices), 1.2 Technical training on calculation of irrigation water requirement based on annual cropping plan[#1], 1.3 Technical training on water allocation planning at the main canal level in consideration of annual water demand and available water amount at the water source[#2], 1.4 Lectures and practices on rotational irrigation during drought period and for low-volume irrigation[#3], and 1.5 Lectures on the budgeting based on the facility maintenance plan [#4]. [#1] It is important to calculate the irrigation water requirement based on the water requirement in depth when one calculates the irrigation water requirement of paddies. The Penman method (Penman-Monteith method) is not as accurate as the water-requirement-in-depth method, in order to calculate the irrigation water requirement of paddies, because the Penman method was originally established to calculate crop water requirement of upland crops. [#2] Prospective contents are technical trainings and practices of the gate operation to deliver required volume of water by season. [#3] In case where an irrigation system is operated with less volume of water than that originally designed at an early stage of crop growth, it is necessary to raise the canal water level by operating the cross-regulator and to provide the training on the application of rotational irrigation by grouping tertiary canals. On the other hand, in case of water shortage, such as drought, the prioritization in water delivery to seeding and planting in downstream areas shall be examined. [#4] Trainings are regarding estimation of annual costs necessary for maintenance, formulation of a realistic facility maintenance plan based on the amount of ISF collected in past years, considering possibility to raise ISF to compensate deficit, introduction of government subsidies, and so forth.
	For WUA Members Who Manage the Command Area at the Tertiary and Lower level Canals 2.1 Training on the O&M Planning of part of the irrigation systems under the management of WUAs (lectures and practices) 2.2 Workshops, lectures and practices to calculate a proper amount of ISF based on the O&M plan 2.3 Training to farmers on the planning of tertiary and on-farm canals (lectures and practices) 2.4 Training to farmers on the construction of tertiary and on-farm canals (lectures and practices) 2.5 Training in the water management for rice paddy fields through equitable water distribution (rotation) within the areas under the management of WUAs (lectures and practices) [#1]. [#1] Mutual agreement among the members of the WUAs should be supported on rotation of water for rice paddy so that the water can be first supplied to downstream areas where water shortage frequently occurs. **NOTE: The JICA-TCP team does not directly give the above trainings, etc. to WUA members, but GON staff gives them to WUA members. Accordingly, GON staff needs to gain TOT trainings for WUA strengthening in addition to trainings and lectures concerning principal facilities.**

	For GON and WUA 3.1 GON and the WUAs together develop and share the O&M plan and the financing for the implementation of the same plan 3.2 GON and the WUAs together develop the irrigation plan of the entire irrigation system including the tertiary and on-farm canals 3.3 GON and the WUAs together develop guidelines and manuals for the joint management by IMT through the implementation of pilot projects.
External Conditions	N/A

Source: Survey team

The farmers who are members of the WUAs for the selected pilot areas are required to contribute to the JICA-TCP in forms of the payment of ISF, labor and time. The farmers' contributions are actually indispensable for O&M and the water management of the concerned JMISs, and are required even after the termination of the JICA-TCP. It is, therefore, important that an incentive mechanism for farmers to continuously make contributions in forms of the payment of ISF, labor and time, is institutionalized into the JICA-TCP framework. The figure below shows the incentive mechanism which the JICA-TCP may aim at.

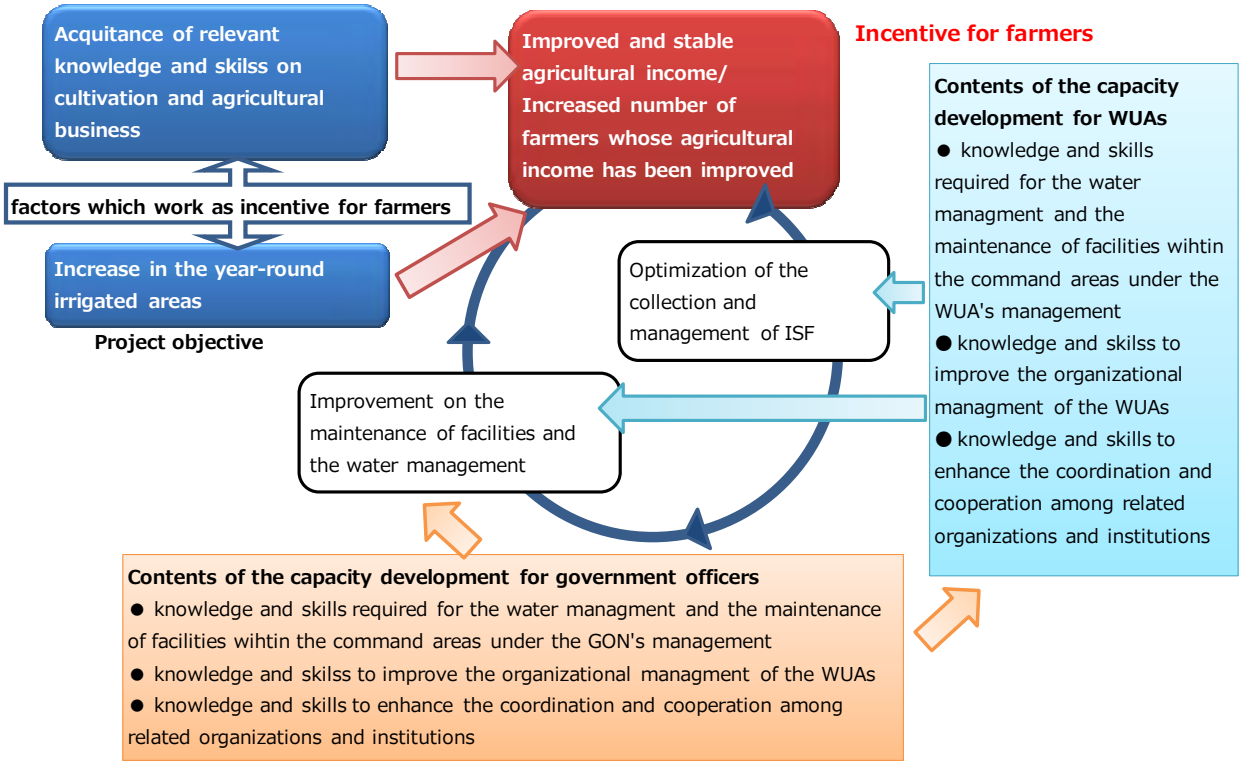


Figure 6-2-2 Approach of the JICA-TCP: Incentive mechanism for farmers

Source: Survey team

The knowledge and skills on the water management and O&M which will be transferred to the WUA members through the implementation of the JICA-TCP will surely work as incentive for farmers. However, in order to ensure continuous contributions from farmers, improved and stable agricultural income should be sought. The objective of the JICA-TCP, expanded year-round irrigated areas would directly lead to an increase of agricultural income, first of all, it is important to attain the project objective through the implementation of the JICA-TCP.

The implementation of the agricultural component to be described later, has not been included into Table 6-2-1, since it is understood that further discussion will be required to determine whether such a component should be included into the JICA-TCP framework. Nonetheless, if the knowledge and skills of cultivation and agricultural business can be disseminated to farmers simultaneously with the implementation of the JICA-TCP, the possibility to attain improved and stable agricultural income will be elevated, and the number of farmers who can benefit from both the components. Therefore, positive results of the feasibility analysis of the agricultural component are expected.

Figure 6-2-3 shows the possible JICA-TCP framework developed based on the request from GON. An improvement on O&M, especially, an improvement on the water management in the command area under the WUA's management, in addition to the measures against the central problems identified in the workshop: the year-round irrigated areas have not been expanded. The figure shows the principal challenges, solutions to the identified challenges, possible technical assistance to be provided and possible outputs through the implementation of the JICA-TCP.

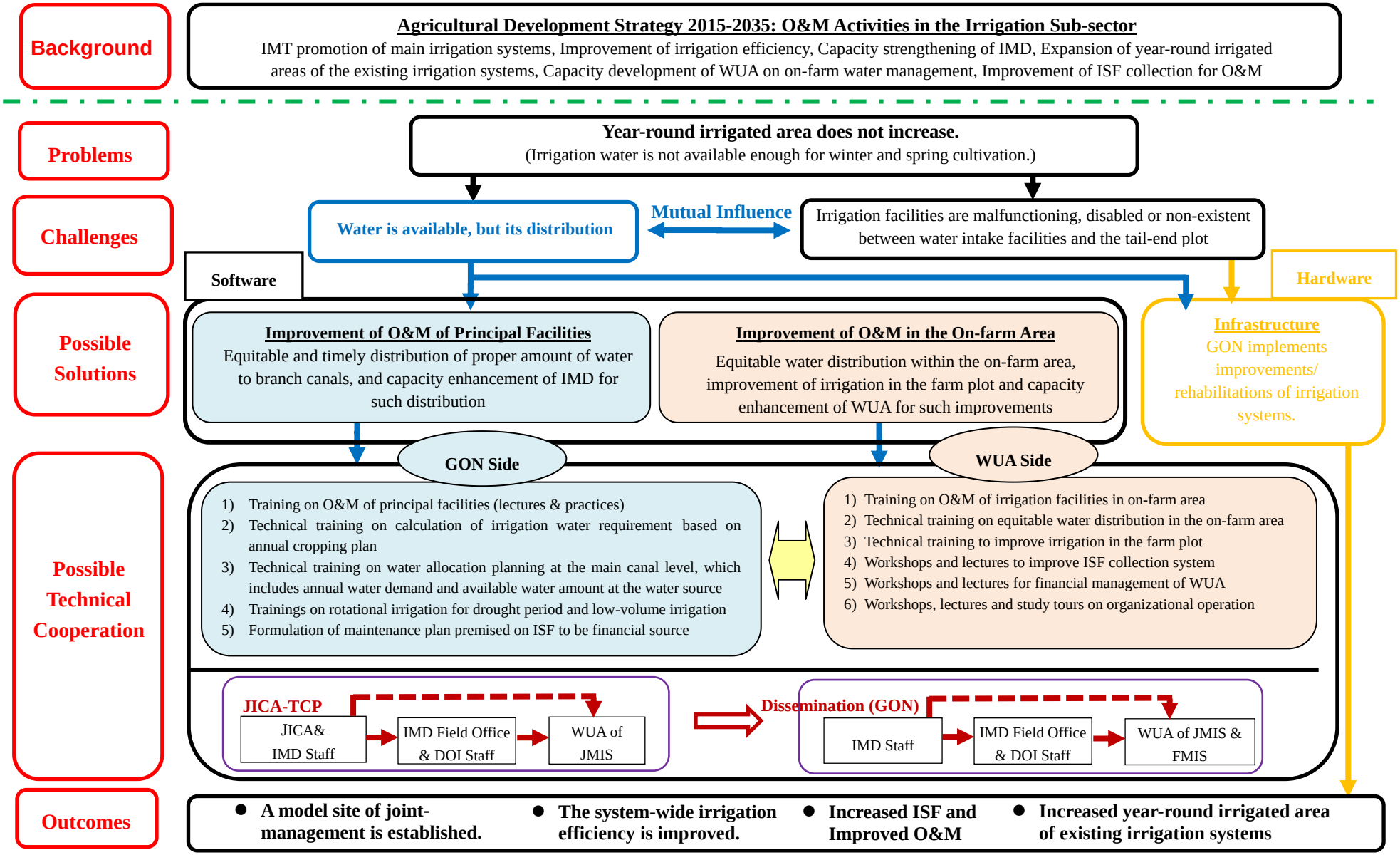


Figure 6-2-3 Proposed Framework of JICA Technical Cooperation Project

Source: Survey team

6-3 Suggestion to Introduce the Agricultural Component

The application from GON does not mention about agricultural component at all. The government officers who attended the workshop did not indicate the necessity for assistance to the agricultural component, either. However, the IMT process usually involves assistance in agricultural component[33], in order to achieve not only an increase in agricultural income through year-round irrigation, but also the proper collection of ISF. Moreover, assistance in agricultural components may work as incentive for farmers to take the increased burden due to IMT, including the maintenance of the irrigation facilities in the command areas of WUAs, the ISF collection from the WUA members, etc.

In order to assure the self-sustainability of the transferred irrigation systems, it is important for WUAs to collect ISF after seeing an improvement on agricultural profit of the members, and to save part of the collected ISF for periodical and future large scale rehabilitations as well as for emergency rehabilitations, and for other WUA activities. In other words, it is important that each of the WUA members improves his/her own economic situation by increasing the production of current crops or by cultivating and marketing more cash crops, and as a result, he or she can remain capable to pay proper ISF. In consideration of all this above mentioned, the Survey team proposes the incorporation of the agricultural component into the prospective JICA-TCP, although it has not been included in the requests from GON so far.

Example of farm ditches built by farmers (Terai region)

Source: Survey team

For instance, the need for technical support in the rice cultivation would be increased in the Kankai Irrigation System, shortly after the construction of on-farm canals by farmers, as the rice production is popular among them. Farmers grow different varieties of paddy rice by season: a variety called Sanamonsuli which takes 100 to 120 days to grow in the rainy season, and another variety which takes 90 days to grow in spring. The yield of those varieties are about 4.8ton/ha. Since it is said that farmers show less interest in the production of spring rice, technical support for the cultivation of spring rice as incentive for farmers may be considered.

Seedling transplanted is 30-45 days old.

Source: Survey team

The introduction of young seedlings in rice cultivation (to be implemented as a pilot project): Rice seedlings of more than 30 days old are transplanted to paddy fields in in Terai region. Such old seedlings have a reduced potential for tillering, which may bring about a reduced yield. In order to increase the yield per unit area, the

[33] Agricultural component includes cultivation technology including water-saving cultivation, soil diagnosis & management, cropping, introduction of quality seeds, mechanization, post-harvest processing and marketing, etc.

introduction of younger seedlings (seedlings of 21 to 24 days old) together with paddy-field leveling, and the introduction of the technique to transplant a fewer seedlings per planting spot may work. In this regard, the System of Rice Intensification (SRI), which promotes the transplantation of only one seedling per spot, is not recommendable in those paddies where the surface is not leveled and drainage capacity is not high.

6-4 JICA-TCP Pilot Projects and Dissemination

The JICA-TCP implements pilot projects in a few irrigation blocks under the WUA's management in selected JMIS(s) (Actually, most of them are on the tertiary canals). Since the entire JMIS is too big to be a pilot project site, it is reasonable that the JICA-TCP implements the pilot project at an irrigation block which is the area irrigated by a branch canal in a JMIS. It is desired that three WUAs are selected in the upstream, mid-stream and downstream zones respectively in a single JMIS.

The upstream WUA tends to over-irrigate by taking water more than requisite amount. The downstream WUA has water shortage frequently compared to the up- and mid-stream WUAs. The mid-stream WUA is located between them. Accordingly, selecting theses 3 WUAs gives GON the opportunity to enhance its coordination capability. Respective WUAs distribute water within their own responsible areas after receiving water from DOI at the most upstream point, which is the management interface between WUA and DOI. However, what is very important to improve the system-wide irrigation efficiency is that the JICA-TCP targets WUAs from the upstream to the downstream.

The JICA-TCP conducts workshops and trainings at its project sites. Then, DOI field staff in other irrigation systems/districts visits the pilot project sites, and learns how to manage principal facilities so as to make equitable water distribution as well as know-how of on-farm water management that is equitable water distribution amongst WUGs in a WUA. After that, they go back to irrigation systems/districts and disseminate what they learned.

6-5 Possibility for the Distribution of Roles and Collaboration among the JICA-TCP and Other Donors' Projects

6-5-1 Sharing Roles

As mentioned in the Chapter 3, CMIASP-AF and IWRMP-AF has divided Nepal into 2 zones and been implementing sub-projects targeting FMIS. The IWRMP-AF is conducting IMT at three main irrigation systems in Terai region: Sunsari-Morang, Narayani and Mahakali. The JICA-TCP targets Terai region, which is the major food-producing area of Nepal, because GON has requested the area through the application to Japan. Consequently, it is possible to avoid overlapping if JICA-TCP targets irrigation systems that are neither CMIASP-AF sub-projects nor IWRMP-AF sub-projects.

6-5-2 Collaboration Possibility

The Survey team discussed the possibility of collaboration between JICA-TCP and CMIASP-AF and also between JICA-TCP and IWRMP-AF with concerned parties during the Survey period. As a result, the following items are listed as possible collaboration.

- ✓ Sharing training contents for strengthening capacity of WUA and DOI staff,
- ✓ Sharing training contents regarding on-farm water management for WUA and DOI staff,
- ✓ Sharing information on the ISF collection,
- ✓ Sharing methodologies for improving the ISF collection rate, and
- ✓ Sharing information collected regarding irrigation facilities and WUAs in Terai.

6-6 Considerations for Future Surveys and Implementation of the JICA-TCP

6-6-1 Recommendations on Land Ownership issues

As seen in Section 3-1-3, there are by and large three challenges for farmers of Terai region regarding the land ownership as follows:

1. Continuous and frequent amendment to the Land Related Act and weak enforcement of the same act
2. Inadequate diffusion of the information on the land registration and the land ownership (a low level of recognition and understanding of the land registration system)
3. A significant proportion of the rented land area to the cultivated land area (approximately 25%); that of the farmers farming by renting land in Terai region to all the farmers of the country (approximately 36%); and, that of the farmers who do not have their own land to cultivate to all the farmers in Eastern and Central Development Regions (approximately 10%).

A summary of possible impact of these challenges on the prospective JICA-TCP, together with possible measures to be taken in future surveys and in the implementation of the JICA-TCP project in order to cope with or mitigate such an impact are compiled in the following table.

Table 6-6-1 Challenges around the land ownership and their possible impact and mitigation measures

No.	Challenge	Possible impact on the prospective JICA-TCP	Possible measures to be taken	
			In future surveys	In the implementation of the prospective JICA-TCP
1.	Frequent amendment to the Land Related Act and weak enforcement of the current act	If the current act is actually enforced on the ground, the farming land will be fragmented. This could cause confusion among the WUA members and could result in changes of the membership of WUAs.	✓ To confirm progress and perspective of the land reform ✓ To conduct a sample survey on the current situation of land registration in the selected irrigation blocks to understand the situation	✓ To keep following the land reform process and direction and when necessary, to share the information with the WUA members ✓ To facilitate the WUAs to include rules of member change into their constitutions or regulations through discussion and agreement among the members

No.	Challenge	Possible impact on the prospective JICA-TCP	Possible measures to be taken	
			In future surveys	In the implementation of the prospective JICA-TCP
2.	Inadequate diffusion of the information on the land registration and the land ownership (a low level of recognition and understanding of the land registration system)	(1) In some cases of land dispute, farmers who actually cultivate such land should leave from the land as results of the mediation process. If there is land which is not registered properly within the targeted irrigation systems, there remains a risk of changes of the WUA members during or after the implementation of the JICA-TCP. (2) When the irrigated area is expanded due to improved O&M and on-farm water management, new land dispute could arise on the area to be newly irrigated.	✓ To conduct a sample survey on the current situation of land registration in the selected irrigation blocks to understand the situation ✓ To understand the customary and legal process of mediation of land dispute cases.	✓ To provide the counterpart officials and WUA members with access to the information on the land registration system and merits of the registration.

No.	Challenge	Possible impact on the prospective JICA-TCP	Possible measures to be taken	
			In future surveys	In the implementation of the prospective JICA-TCP
3.	A significant proportion of the rented land area to the cultivated land area	(1) When there is no agreement between the landowner and tenants on the cost sharing and decision-making for the O&M activities, it may cause a delay in the O&M activities. (2) If all the landowners are not involved in the WUAs, necessary decision-making by the landowners on the O&M activities cannot be made timely.	✓ To conduct a sample survey on the current situation of rented land in the selected irrigation blocks to understand the situation. ✓ To understand the distribution of roles between a landowner and a tenant on a rehabilitation/improvement of facilities on the rented land, stipulated by laws and customary laws. ✓ To confirm what tells the existing WUA constitutions or regulations on the distribution of power and responsibilities between landowners and tenants for a rehabilitation and/or improvement of the facilities on the rented land.	✓ To facilitate the WUA members to reach an agreement with their landowners regarding the cost sharing and decision-making responsibility on the O&M activities. ✓ To facilitate the WUA members in the establishment of communication channels with landowners regarding the O&M activities

Source: Survey team

6-6-2 Recommendations on Ethnic issues

1) Recommendations for future surveys

In future surveys, it would be important to confirm whether different ethnic and social groups, such as Madhesi and Tharu, among others, can have an equal access to benefits from the prospective JICA-TCP or not, as well as whether there is an enabling environment for different ethnic and social groups to work together and to share necessary costs and burdens, including the payment of ISF. For this purpose, it is recommended to include the following issues in surveys.

(1) WUAs

There are 25 JMISs in Terai region and the information on the location and irrigated area for each of them is available. However, there is no information on the total number of the FMISs with their respective locations. Therefore, as part of the coming survey, a sample study on the FMISs would be conducted in conjunction with IDD officers in charge. The WUA or representatives from the beneficiary farmers of each of the FMISs, whose existence is registered to the IDD, would be interviewed to collect relevant information on FMISs. It is important to bear in mind that there are two types of the FMISs: some FMISs managed by the officially registered WUAs and others

managed by the beneficiary groups which have not been registered.

Table 6-6-2 (1) Possible items to be studied with JMISs to address ethnic issues

No.	Possible Items to be studied	Possible information Source
1	The proportion of the ethnicities/castes of the WUA members of the 25 JMISs in Terai region	Officials of the FIMD / IDD
2	A comparison of the proportion of the ethnicities/castes in the WUA executive committee with that in the entire WUA members	Officials of the FIMD / IDD
3	Relationship between each ethnic and social group and the FIMD/IDD	✓ Officials of the FIMD / IDD ✓ Representatives from each of the WUAs
4	Positive or negative impact of having different ethnic and social groups within the same WUA , and possible measures to be taken to mitigate or reduce negative impact, if any	Representatives from each of the WUAs
5	The existence and application of the constitution/regulations of WUA, and conditions for the membership stipulated in the WUA constitution/regulations	Representatives from each of the WUAs
6	Relationship among the WUAs of other FMISs/JMIS which share the same main canal or water source	Representatives from each of the WUAs
7	Challenges of the management of the WUA and needs for capacity development	Representatives from each of the WUAs

Source: Survey team

Table 6-6-2 (2) Possible items to be studied with FMISs to address ethnic issues

No.	Possible Items to be studied	Possible information Source
1	Details of the FMIS（Canal network, Irrigated area, Cropping practices, Availability of delivered water through the year, Existence of rules for water distribution and irrigation system maintenance, etc.)	Representatives from each WUA or alternative organization with similar functions
2	Roles played by the WUA or alternative organizations, Existence of the constitution and/or regulations, organizational structure, the number of the WUA members (beneficiary farmers), conditions for the membership, the proportions of ethnicities /castes in the members	
3	A comparison of the proportion of the ethnicities / castes in the WUA executive committee with that in the entire WUA members	
4	Reasons for not having registered officially as WUA, if it is the case, and whether they are interested in the registration	
5	Relationship with the FIMD/IDD in charge or any other public entities (including local governments)	
6	Relationship among the WUAs of other FMISs/JMIS which share the same main canal or water source	
7	Challenges in the management by the WUA or alternative organizations and needs for capacity development	

Source: Survey team

(2) Lessons from previous projects

The Ministry of Internal Affairs of the GON and the United Nations Development Programme (UNDP) have been jointly implementing a project to strengthen security at the community level, called "Armed Violence Reduction and Strengthening Community Security (AVRSCS)" from 2014 to 2016 in the nine districts of Terai region: Kanchanpur, Kailali, Bardiya, Banke, Parsa, Bara,

Dhanusha, Saptari, and Morang. The major activity of the project is to strengthen the functions to maintain security of the National Police, and the emergence of trust between community people and the police through the implementation of the project has been confirmed.

If there is a case where trust has been built between the protest groups and the police, as part of results of this project, it would be worthy to analyze the case in order to identify contributing factors for such a result. Moreover, it would be possible to draw lessons for the prospective JICA-TCP to enhance the participation of different ethnic and social groups in the project. In the forthcoming survey, the AVRSCS's results and approach could be confirmed with officials of the Ministry of Internal Affairs and UNDP, as well as community people and the police at the project sites, in order to draw lessons.

(3) Relationship among residents

The information on the relationship, conflict and power balance among different ethnic and social groups in Terai region should be also collected. If there is an imbalance of powers among residents, it would be important to take necessary measures on the ground to prevent decision-makings only by powerful people for the implementation of the prospective JICA-TCP.

2) Recommendations for the implementation of Prospective JICA-TCP

It would be important to assure that there is equity among beneficiary farmers from different ethnic groups with regard to the benefits and costs (burden) of the O&M of irrigation facilities.

2.1) Selection of the project sites

In order to assure equity in benefits and burden among different ethnic and social groups, the proportion of ethnic groups in possible project sites should be confirmed prior to the selection of project sites (irrigation systems). The concentration of benefits only on one specific group should be avoided. If the situation allows, the project will consider the selection of a location (irrigation system) where different ethnic and social groups would work in collaboration to achieve common goals.

If there is an irrigation system in those places where the emergence of trust between communities and the police is confirmed through the implementation of the aforementioned AVRSCS, it can be considered to include such a system in the project sites.

On the other hand, those locations where conflicts are on-going or most likely conflicts will occur near future, the timing of the commencement of project activities needs to be examined. It is necessary to analyze the updated information on security which is collected from the implementing agencies, local governments of possible project sites, police, JICA Nepal Office, Japanese Embassy in Nepal, etc. to select the project sites.

2.2) Selection of beneficiaries

It is important to make a balance in the distribution of benefits among different ethnic and social groups and avoiding a concentration of benefits only on a specific group, as proposed earlier. When there are seen internal separations and conflicts within a group, it is also important to take it into account to select beneficiaries in order not to exacerbate the situation.

2.3) Reduction of negative impact

A delay in the implementation of a project or any changes in the contents of project activities could deepen mistrust of people in Terai region against the GON. Such mistrust could cause a delay or suspension of a part or the entire project activities.

It is important for both the implementing agencies and JICA to make the project operation plan realistic, and take necessary measures to assure the allocation of budget and human resources for the implementation of the project, so that the project can be implemented smoothly as planned.

2.4) Observations for the implementation of the prospective project

Taking into account that Nepal is one of the conflict affected countries, a PNA for the targeted area or a PNA for the project should be conducted at the project formulation, so that the project can be designed not to worsen instability factors and to utilize or enhance stability factors. During the implementation period, the PNA should be updated periodically, and the project should be allowed to be flexible to modify its contents, including the re-location of the project sites, when necessary. It is also important for all the institutions involved in the project implementation to agree that the security of beneficiaries and of people who are engaged in the project implementation should be prioritized at any time, as well as measures to be taken in case of emergency.

DOI is the government agency in charge of the development and O&M of irrigation systems, and the majority of its officers are engineers. However, they are also socially sensitive by facilitating the participation of oppressed people in the decision-making process of WUAs in accordance with a statement in the Irrigation Policy 2013: “there shall be proper representation of Dalit, Downtrodden, and Backward ethnic communities is such association”. DOI is working with all farmers in an equitable manner, since they should be equal, having the same rights as WUA member. In addition, DOI is promoting the democratic management of WUAs.

In the existing JMISs in Terai region, the WUA members are beneficiary farmers, although WUAs are under the establishment process in some JMISs. Both those farmers who have the ownership of agricultural land and practice agriculture, and others who are renting the agricultural land in a legally or customarily effective manner and practice agriculture can be members of a WUA. Those irrigation systems with WUAs composed only of large scale farmers cannot be selected as project sites, but the proportion of socially oppressed people of the target WUAs may not be fully controlled by the project, since it depends on the situation of land ownership, and the scales of farmers who are renting the farming land within the project sites.

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General	Informal Sector Service Center	2015	Human Rights Year Book 2015	http://www.insec.org.np/pics/publication/1429808399.pdf
General	KARKI, Budhi & EDRISHINHA, Rohan	2014	The FEDERALISM debate in Nepal: Post Peace Agreement, Constitution Making in Nepal Volume II	http://www.np.undp.org/content/dam/nepal/docs/projects/UNDP_NP_SPCBN_the-federalism-debate-in-nepal.pdf
General	Ministry of Environment	2010	Climate Change Vulnerability Mapping for Nepal	http://www.nccsp.gov.np/publication/2010ClimateChangeVulnerabilityMappingforNepal.pdf
General	JICA Nepal Office	2011	Nepal NGO Handbook (Japanese)	https://www.jica.go.jp/nepal/office/about/ngodesk/materials/ku57pq00000qqi4x-att/NGO_Handbook01.pdf
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Policies/ Plans	Council of Ministers	N/A	Irrigation Policy, 2060	http://doi.gov.np/wp-content/uploads/2015/10/IrrigationPolicy2060-EnglishFinal.pdf
Policies/ Plans	Ministry of Agriculture Development	2015	Agriculture Development Strategy (ADS) 2015-2035	http://www.moad.gov.np/downloadfile/final%20ADS%20report_1440476970.pdf
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Policies/ Plans	National Planning Commission	2013	AN APPROACH PAPER TO THE THIRTEENTH PLAN (FY 2013/14 – 2015/16)	http://faolex.fao.org/docs/pdf/nep150783.pdf
Policies/ Plans	National Planning Commission	2015	Sustainable Development Goals 2016-2030 National (Preliminary) Report	http://www.np.undp.org/content/dam/nepal/docs/reports/SDG%20final%20report-nepal.pdf

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Policies/ Plans	National Planning Commission	2010	The Food Security Atlas of Nepal	http://documents.wfp.org/stellent/groups/public/documents/ena/wfp223377.pdf?_ga=1.128096972.1357272805.1475940085
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Statistics	Central Bureau of Statistics	2013	STATISTICAL YEAR BOOK OF NEPAL 2013	http://cbs.gov.np/image/data/Publication/Statistical%20Year%20book%202013_SS/Statistical-Year-book-2013_SS.pdf
Statistics	Central Bureau of Statistics	2014	POPULATION ATLAS OF NEPAL 2014	http://cbs.gov.np/atlas/
Statistics	Central Bureau of Statistics	2014	STATISTICAL POCKET BOOK OF NEPAL 2014	http://cbs.gov.np/image/data/Publication/Statistical%20Pocket%20Book%202014.pdf
Statistics	Central Bureau of Statistics	2015	Nepal - National Sample Census of Agriculture 2011-2012	file:///C:/Users/hiro-yashiki/Downloads/ddi-documentation-english-53.pdf
Statistics	Department of Roads	N/A	ROAD NETWORK DATA	http://www.dor.gov.np/documents/5.%20Road%20Network%20Data.pdf
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Japanese Government's Policy	株式会社国際開発センター	2013	ネパール国別評価（第三者評価）報告書	http://www.mofa.go.jp/mofaj/gaiko/oda/shiryo/hyouka/kunibetu/gai/nepal/kn12_01_index.html
Japanese Government's Policy	外務省	2012	対ネパール連邦民主共和国 国別援助方針	http://www.np.emb-japan.go.jp/jp/pdf/odapolicy.pdf
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Laws/ Regulations	ARYAL, Ravi Sharma	2011	THE LAW ON OWNERSHIP AND RIGHT TO WATER IN NEPAL	http://www.jvs-nwp.org.np/sites/default/files/Water%20Right%20and%20Ownership%20in%20Nepal.pdf
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Laws/ Regulations	WaterAid Nepal	2005	Water Laws in Nepal: Laws Relating to Drinking Water, Sanitation, Irrigation, Hydropower and Water Pollution	file:///C:/Users/hiro-yashiki/Downloads/water%20laws%20in%20nepal%20(1).pdf
Laws/ Regulations		1964	The Lands Act, 2021(1964)	http://faolex.fao.org/docs/pdf/nep6239.pdf
Laws/ Regulations		1992	WATER RESOURES ACT, 2049 (1992)	http://www.wecs.gov.np/uploaded/Water-Resources-Act-2049-english.pdf
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Laws/ Regulations		2000	Irrigation Rules, 2056 (2000)	http://faolex.fao.org/docs/pdf/nep27488.pdf
Laws/ Regulations		2008	Good Governance (Management and Operation) Act, 2064 (2008)	http://faolex.fao.org/docs/pdf/nep137755.pdf
Laws/ Regulations		2015	The Constitution of Nepal	http://www.nepalembassy-germany.com/pdfs/Constitution_full_english.pdf

*The date of the last access to all the references was October 9, 2016.