Management Arrangements for Diversifying Rice Irrigation Systems in Nepal

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INTRODUCTION

NEPAL IS **PREDOMINANTLY** an agricultural country. Its geophysical and agroecological conditions vary considerably in many aspects which have direct and specific effects in the agricultural production systems. Approximately 18 percent of the total land area is under agricultural use while pasture lands account for about **14** percent. The agriculture sector employs more than 90 percent of the country's economically active population. Livelihood is earned through farms and forests by almost 95 percent of the total population of 18 M. Contribution lo gross domestic product from the agriculture and allied sector is about 60 percent of the total national income.

The country's 147,181 sq. km. land area is physiographically divided into three distinct agroecological zones, namely mountains and highhills, midhills (including valleys) and plains (Terai and Inner Terai). Agroclimatic and socioeconomic variations between and within the agroecological zones are considerably wide especially with respect to rainfall, temperature, soils and their fertility status, sunshine hours, topography (local terrains and terraces), agroinfrastructural facilities like irrigation, agricultural support (mainly credit), inputs (seeds, fertilizers, pesticides, agricultural tools and implements), storage facilities, markets and transportation. In order to make use of these vaned situations and available facilities for the rational development of the country, it is divided into five development regions consisting of **14** administrative zones and 75 districts. **AS** the development regions

and physiographicand agroecological regionsrun perpendicular to each other, each development region consists of all three physiographic regions which provide equitable scope of all types of agro-based development. On the basis of these development regions, a specific development strategy has been adopted and the agricultural development activities are prioritized as follows:

Region	Priority areas
1. Mountains/highhills	pastures and livestock development
2. Midhills	Fruits and forest development
3. Plains	Food grain development

Out of the total cultivable land area of about 2,641,000 ha almost 85 percent is used for food grain production. Rice ranks first in area (43%) and production followed by maize (22%) and wheat **(15%).** The remaining 20 percent of the cropped area is planted to cash crops such as oilseeds, pulses, potato, jute. sugarcane and tobacco. Yield of major food crops has not been increasing in all the agroecological zones (Fig. 1). However, some cash crops like sugarcane and potato have exhibited increased yields. These show that increasing agricultural production by improving the technology and infrastructural facilities has vast potential. However, problems do exist, which impede the realization of this potential.

Problems in the Agriculture Sector

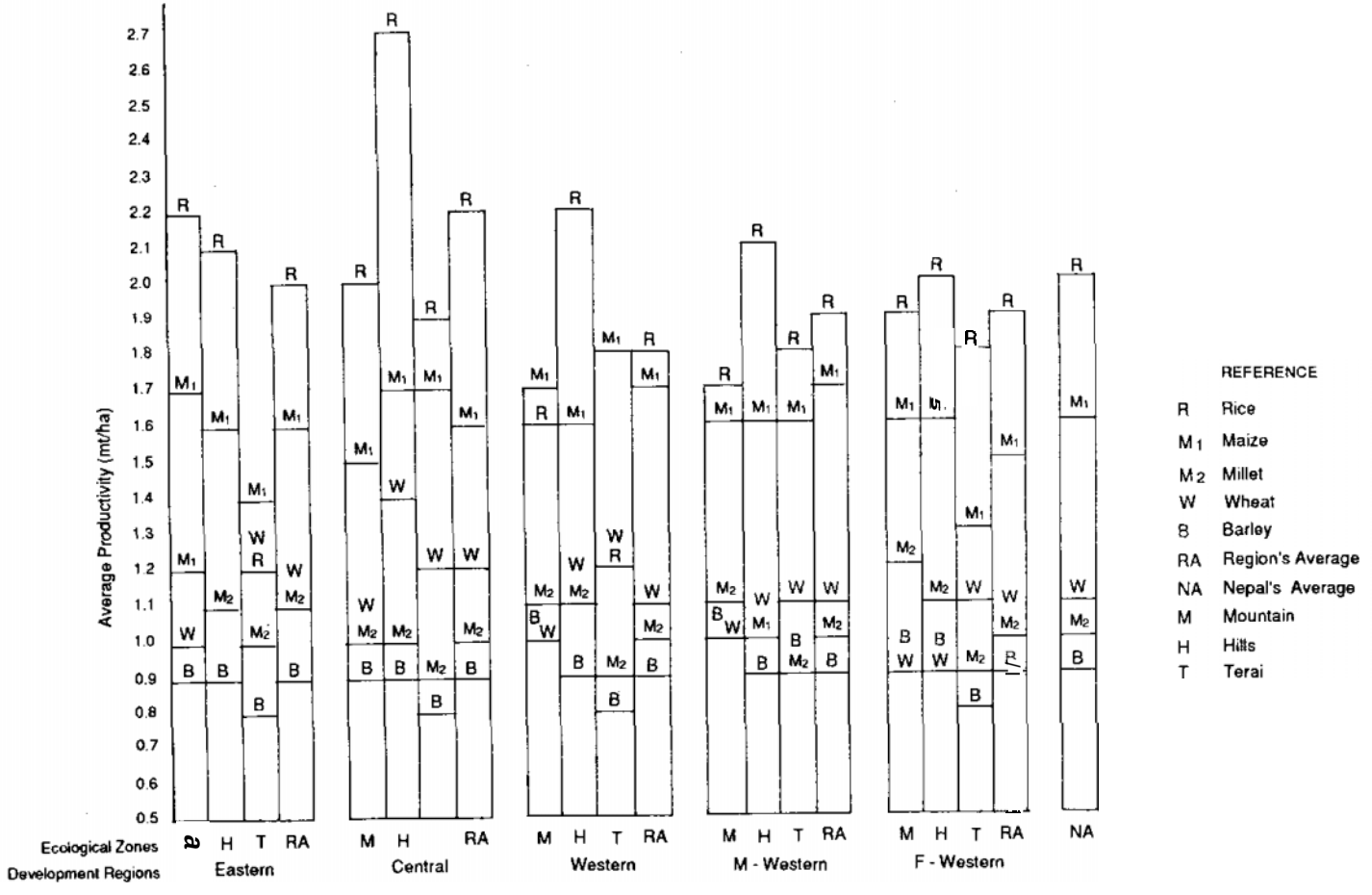
Soil fertility has been deteriorating mainly due to erosion, imbalanced use of chemical fertilizer and nonreplacement of soil nutrients including organic matter. The latter problem is found to be more acute in the hills, where animal waste is also used for fuel purposes in domestic cooking.

Irrigated areas have increased steadily, but most of the irrigation is supplemented by rain during the monsoon season thereby causing acute water shortage during dry periods (winter andsummer). It is estimated that only about 28 percent of the total cultivatedarea is at present under irrigation. Thus agriculture has remained dependent on rainfall, especially the monsoonal. In spite of these and other associated problems, the country's agricultural front appears to be marching ahead. enhancing agricultural production through the adoption of innovative farming techniques including crop diversification.

Rice-Based Farming Systems

Rice is the predominant crop grown in the country hut other crops are also grown during the dry season, following rice. In fact, this is not a new approach or innovation in Nepal. It has been in practice for several decades in most parts of the country. There are several reasons for diversified cropping practices. Some of the prominent ones can be enumerated as follows:

Figure 1. Average productivity of principal food crops, 1970-86, Nepal.



1. Almost all of the irrigation development works so far completed and/or nearing completion are rice-based and rainfall-supplemented.
2. Subsistence-level farmers cannot meet their needs from rice alone and hence adopt diversified fanning practices.
3. Coarse grained rice generally yields greater output than fine grained and scented ones. But the former is not exportable and even domestic prices are low. However, the trendappears to be changing in recent years. Farmers, therefore, like to get higher yields from the coarse rice and rotate it with other crops.
4. The possibility of exporting high yicldingrice being less and fanners' option to grow high-value scented fine rice being limited. diversification automatically follows when short-duration rice is grown.
5. Nepal's rice lands mostly fall in the upland plateau *(tars)*, Terai and lnner Terai plains, midhill valleys and river basins. These areas are climatically suitable for growing other crops including rice without disturbing the traditional rice fields. Hence, farmers naturally grow other crops for their needs and lands are not left fallow.
6. The returns from vegetables and other high value cash crops are more profitable than those from the traditional rice crops. The expenses incurred by the Nepalese farmers are mostly met through the earnings from their farms. Hence, the fanners' choice to get more from their farms by diversified cropping.
7. Fanners' movement from one place *to* another is difficult due to lack of means of transportation. Restricted and limited movement naturally compels fanners lo grow all the food commodities required by them so that their needs are satisfied from their farm produce. This has given rise to subsistence farming practices.
8. Gradually expanding irrigated areas and innovative agricultural research and extension methodologies have also greatly helped farmers adopt diversified cropping in the rice-based irrigated as well as rain-fed areas.
9. Increased literacy among the village people and the introduction of agricultural courses in the high school curricula have helped the younger generation of farming communities to know more about cereals other than rice, and vegetables and their importance in their daily diet.

Sectors/Agencies Involved in Crop Diversification.

In general, farmersthemselves are the principal agents involved in crop diversification as it has been an age-old practice in the country. However, systematic and organized government agencies involved in this program are the farming systems and research outreach divisions under the National Agricultural Research Committee (NARC) and various other crop commodity research programs including Pakhribas and Lumle Agriculture Centers. Agricultural Development Bank/Nepal (ADB/N) also participates in the program by providing loans to the farmers for diversified cropping in rice-hased and other areas. Other foreign donor agencies engaged in the agricultural research and extension sector and rural and community development activities are directly or indirectly involved in helping fanners grow diversified crops with a view lo modifying and improving the existing cropping practices.

Table 2. Status and potentiality of crop diversification in large irrigation projects of Nepal.

Project name	Irriga-tion capacity	Present NCA (ha)	Present irrigated cropped area (ha)			Present C.I.	Water availability	Upper lir cropped ar		)
			Spring	Mon-soon	Winter			Spring	Sum-mer	
1. Kankai (Jhapa-EDR)	YR/ID	5,000	3,000	4,000	1,200	1.64	Low winter flow	3,750	4,750	
2. Sunsari-Morang (EDR)	MS/ED/ID	68,000	6,400	30,000	6,400	1.43	Adequate	16,000	59,600	
3. West Koshi (Saptari-EDR)	MS/YR/ID	31,000	–	20,000	14,000	1.70	Low winter flow in Chandra canal	14,000	31,000	
4. Kamala (Sirha Dhanusa EDR & CDR)	MS/ED	25,000	–	10,000	4,000	1.40	Low winter flows	7,500	22,500	
5. Manusmara (Sarlani-CDR)	YR/ID	5,200	–	5,000	1,000	1.02	Adequate	2,000	5,000	
6. Narayani (Parsa, Gara, Rautahat-CDR)	YR/ID	55,300	–	22,600	12,300	1.56	Inadequate	–	33,500	
7. Chitwon I.P (Chitwon-CDR)	YR/ID	10,000	500	9,600	800	1.10	Adequate	4,000	9,600	
8. West Gandak Nawal-parasi-WDR)	YR/ID	15,400	900	6,000	3,500	1.73	Adequate	3,500	12,000	
9. Bandanda (Taulihawa-WDR)	MS/ID	5,800	–	5,000	1,300	1.26	Low winter flows	2,200	6,200	
10. Pathraiya (Kailali-FWDR)	MS/ID	2,133	–	1,300	200	1.15	Low winter flows	–	2,000	
11. Mahakali stage (Kancnanpur-FWDR)	YR/CAD	5,200	–	5,200	4,700	1.90	Adequate	–	5,200	
12. SL-Ground water project (Rupandehi-WDR)	YR/ID	7,600	–	7,550	7,000	1.91	Adequate	–	7,600	

Notes:

YR	=	Year-round
ID	=	Intensive development
MS	=	Monsoon irrigation capacity
ED	=	Extensive development
CAD	=	Command area development
NCA	=	Net command area
CDR	=	Central development region
WDR	=	Western development region
FWDR	=	Far-Western development region
IP	=	Irrigation project
CI	=	Cropping intensity
EDR	=	Eastern development region.

IRRIGATION PLANNING AND OPERATION FOR RICE-BASED SYSTEM

Table 2 shows the present status, potential and possibilities of crop diversification, especially in the large irrigation project areas of the country. As explained in the table, the area under the large irrigation projects has been classified as year-round. Other classifications indicate intensive development, monsoon irrigated, extensive development, command area development, etc. All of these projects are located in the Terai plains where rice is a base crop but the growing of crops other than rice during winter and spring is possible and farmers have been growing crops on the basis of available water and their food grain requirements. However, subsistence-level farmers do grow crops other than rice even in rain-fed conditions rather than keeping land fallow.

Nepalese farmers are not free from technical, socioeconomic and institutional difficulties because agricultural production is a combined process of irrigation and crop management. These activities are handled by two different ministries. These two government agencies, the Ministry of Water Resources (MOWR) and the Ministry of Agriculture (MOA) do not have a similar organizational setup which has resulted in several coordination problems.

Hence, irrigated farming is not fully coordinated. Better results can be expected and obtained when the two most important components (agricultural research/extension and irrigation development/management) for agricultural production are interlinked and activities work in smooth coordinated fashion. In fact, Nepalese farmers are still unable to realize the genetic yield potential of the crops they have been growing. The water resources need to be harnessed and utilized for crop production in a more efficient manner.

CONSTRAINTS TO AND OPPORTUNITIES FOR CROP DIVERSIFICATION

Technical Constraints

1. Irrigation projects may not have been designed to match the fanners' cropping practices.
2. Manpower for irrigation development is inadequate.
3. Farmers' awareness of their need is not guided by competent technical back-stopping.
4. Training programs for the farmers as well as for the technicians of both irrigation and agriculture sectors are insufficient.

Socioeconomic Constraints

1. Landholdings are fragmented, scattered and marginal.
2. Land reform policy is not effectively implemented resulting in unequal distribution of agricultural lands.
3. The younger generation's negative attitude to the farming profession and agriculture.
4. Returns from farm produce are low and it is difficult to maintain the minimum economic status of the fanning community. Price control of various agricultural commodities has lo be instituted and implemented.
5. Personnel engaged in the agricultural and irrigation project planning, development and implementation are not motivated in their respective professions.
6. The waterrights need to be well-defined and equitable distribution has to be assured and implemented at different points.

Institutional/Managerial Constraints

1. Linkages and coordination among the various institutes and fanners engaged in agricultural production systems are ineffective and weak.
2. Fanners do not have a sense of ownership of the irrigation projects that benefit them.
3. Water Users' Groups are not treated as legal entities.
4. Voluntary participation of beneficiary fanners in the management of the irrigation and agricultural system is not widely accepted.
5. Donors' and recipients' interest5 are not identical to the development of the system in totality.
6. Specialized skills and knowledge of the respective government departments are not properly delivered to the field level to ensure better production.
7. Human resources, which constitute a key element, are not given due consideration in the developmental and managerial activities.
8. The management of the scarce resources to the optimum level, to increase agricultural production as a key element is not given due emphasis.

Opportunities

With a view to solving the constraints of different magnitudes and nature, the concerned government agencies have taken various steps. Some of these are as follows:

Agriculture Sector

The Department of Agriculture (DOA) has set up regional agricultural training centers in the five development regions. These are separate for the bills and the Terai. In addition to the 5 regional agricultural directorates and 75 district agricultural offices the Farming

Systems and Outreach Research Division (FSORD) arid crop commodity research programs have been separately and in collaborationhelping farmers by conducting training, field days, fairs and field trials to demonstrate the improved technology on agricultural production including crop diversification in irrigated and rain-fed areas. The Agricultural Development Bank/Nepal (ADB/N) and the Agricultural Inputs Corporation (AIC) have also been paying special attention to those areas with high production potentials and crop diversification arid cooperating with DOA's activities formaximizing and diversifying agricultural production. The ADB/N's Small Farmers' Development Program (SFDP) has become the most popular and beneficial institution especially in areas where subsistence-level fanning has been the only profession of the people. In fact, the SFDP has been able to penetrate and extend its activities into far arid remote areas of the country. Formation of cultivators' groups in different units has helped SFDP to expand its program and linked it to farmer group formation and loan distribution for production and marketing.

Irrigation Sector

In the past, the government organization for irrigation was scattered in various ministries. Different ministries were handling irrigation development programs and the end users were not deriving the full benefits of these developments due to lack of coordination. Realizing this fact, His Majesty's Government (HMG) restructured its bureaucratic organizations in 1987and put all the.units responsible for the development of irrigation facilities under the direct administrative control of the MOWR and the Department of Irrigation (DOI) is now the responsible government agency for the institutionalized irrigation development in the country. In addition lo 5 regional irrigation directorates, 75 district irrigation offices (DIO) have been established for irrigation system development and management. Farmer-Managed Irrigation Systems (FMIS) also get due technical as well as financial support. At present, a bottom-up approach in the irrigatioii projects' planning is being followed which provides farmers' participation in selecting the irrigation projects and sharing the cost of construction through Water Users' Groups (WUG). Demand-driven irrigation projects are prioritized if these projects are technically feasible. The DOI has created a Research and Training Branch (RTB) and a System Management Branch (SMB) to provide guidance and to technically train and help the farmers financially in irrigation research, training and management activities in line with the MOA's crop research, management and farmer training. A central coordinating committee consisting of DOA, ADB/N and DOI has been formed in order to monitor and provide integrated guidelines for the irrigation and agricultural agencies in formulating and implementing action-oriented, nerds-based agricultural and irrigation programs.

STRATEGIES TO ADDRESS CONSTRAINTS/OPPORTUNITIES

Issues

Most of the irrigation schemes in Nepal have been designed and constructed to supplement the rainfall for monsoon rice. In the last few decades, efforts have been made to persuade the farmers to grow wheat as a second crop in winter (dry season) and the operation of the systems has been adjusted and/or amended accordingly. Donor agencies assisting in the development of irrigation schemes during the last ten years have been insisting on the need to adopt cropping patterns for year-round irrigation except during canal closures for maintenance works. This has been planned for a few schemes where a continuous water supply is assured.

The costs of production for rice and wheat are higher than the farm gate prices of the products, and the profit margin for the farmers has declined in recent years. This has resulted in noncultivation of a second or third crop during the dry season. However, subsistence farmers are still encouraged to grow crops that suit the condition. It is necessary now to introduce profitable cash crops like sugarcane which have a ready market.

In Nepal, most of the cultivable land has already been brought under cultivation. Demographic pressure in the hills has pushed migration of people from the hills to Terai creating a problem of forest encroachment for cultivation. On the other hand, most farm lands are not utilized to the extent possible for intensified cropping. The agencies concerned need to intensify their efforts to prevent encroachment of the forest and the underutilization of the cultivated lands. There is also a greater need being felt to optimize the farm income from the existing land and available water supply. The question is how to use the land year-round. The concensus is that wherever the soil and climate are suitable, the introduction of nonrice crops must be encouraged if the farmers' socioeconomic conditions are favorable.

The following issues need to be addressed to encourage fanners to grow nonrice crops during the dry period under existing irrigation systems:

1. Farmers should be assured of the water supply required from the canal.
2. Economic price support and markets must be available for the agricultural products.
3. Special technology and extension services should be made available.
4. In many systems, dry-season water availability is generally inadequate and so the water supply has to be augmented. Conjunctive use of groundwater and surface water is a possibility.
5. The available water supply needs to be operated and managed through the conveyance system which would need more control structures to raise full supply levels in order to divert water into the offtaking canals or tertiaries to irrigate diversified crops.
6. Most systems lack on-farm development works which have to be completed for proper water management.
7. Water User Groups have to be formed or weaker organizations strengthened to encourage adoption of diversified crops in an organized manner.

Prospects

In Nepal, out of the total cultivated land of 2,641,000 ha only 2.06 M ha is potentially irrigable (groundwater irrigation included) evidently due to mountainous terrain and difficult geography. At present about 930,000 ha is under some kind of irrigation. Traditional farmer-managed irrigation systems (FMIS) irrigate 670.000 ha whereas government-operated systems irrigate 260,000 ha. Besides, farmer-operated shallow tubewells (STWs) irrigate 64,000 ha and government-operated deep tubewells (DTWs) irrigate 16,000 ha. It is estimated that there are over 17,000 FMIS, 16,000 STWs and 220 DTWs.

The FMIS still play a very vital role in irrigated agriculture as these systems produce almost 45 percent of the grain (cereal) needs of the country. These systems operate and perform better than the government-operated systems which are generally of large and medium scale. Efforts are now being made to improve the performance of such systems through users' organizations, and involvement of beneficiaries in the management and operation of the schemes. But the country's terrain, remoteness and transport problems are constraints in attracting farmers to increase the cropping intensity. Existing marketing and prices for the products also hinder the introduction of nonrice crops.

Although the dry-season flow available in most irrigation canals can merely cover 25-35 percent of the command area, nonrice dry-season crops can easily be planned. However, this will need suitable adjustment in water management and O&M schedules. The increase in cropping intensity will create labor employment opportunities during nonrice seasons and population migration and encroachment of forest areas will be decreased.

To start pilot projects for diversified cropping, tubewell irrigated areas are best-suited because of better management and control of water. The following characteristics make them suitable for piloting:

1. The canals are small; similar to a water course or a tertiary.
2. Demand-based operation is possible.
3. Individual farms can grow designed crops. Water can be managed in each farm. The uninterested farmer will not be bothered with water deliveries as is the case with traditional flooding type of irrigation.

Action Required

Before any program is launched or attempted some questions need to be addressed: for example, "How much area in the existing scheme is suitable for low water requirement crops?" and "What additional facilities or regulating structures are needed to be installed to operate the system?" Besides agronomical aspects, like what crops are suitable for the soil and for the season and whether that would attract farmers motivated by profitability, should also be considered. Before any extensive program is launched, the introduction of diversified crops should be tested first on pilot levels like in the Farming Systems Research (FSR) sites.

Strategy

In order to introduce diversified crops in rice-based irrigation systems, action research is needed to establish appropriate irrigation methods and procedures and to bring awareness to the government officials and the farmer community of the vital need for diversified cropping in the context of Nepal's land constraint where there is no more scope for expanding croplands. The only viable option for the country is to intensify the cultivation of existing croplands, most of which are being cultivated by small and poor farmers.

The research would also provide guidance to the irrigation managers for planning the O & M and management of irrigation and drainage systems that have potential and prospects for cultivating suitable diversified crops.

DIRECTIONS OF CROP DIVERSIFICATION

The government of Nepal has been considering for a long time the diversification of cropping practices in view of the existing crop production situation in the country. Nepal has been encouraged by the research and experience gained by the national program in the country, namely, the **FSORD** under the NARC and the research findings of other countries that have proved that with assured irrigation water, two to four crops could be grown successfully in a unit of laud in a given year. To augment the program of crop diversification. the objectives and priorities set by the government are as follows:

1. To grow different varieties and types of crops in different parts of the country on the basis of suitability based on soils, climate, available irrigation, transportation, export potential and local market.
2. To increase agricultural production by growing two or more crops, mixed, relayed or rotated.
3. To increase the land productivity by diversified cropping practices.
4. To help farmers upgrade their economic status by raising their living standards.

Priorities for Crop Diversification

In order to achieve these objectives, His Majesty's Government (HMG) has been allocating funds and facilities lo further enhance and develop research capability and generate compatible innovative technology.

Research and development

The formal government program on crop diversification was initiated by the Cropping Systems Program (CSP) of the Integrated Cereals Project (ICP) funded by the United States Agency for International Development (USAID) through the International Agricultural Development Services (IADS) in 1972. This was the first systematic government approach under the DOA to initiate and introduce cropping system studies in selected hills and Terai sites lo test component technology basically for rice-based cropping systems in irrigated and rain-fed conditions. The CSP has evolved several rice-based cropping patterns for the different levels of production potential for irrigated and rain-fed Terai and hill conditions and FSORD is testing the diversification possibility for the hills. (Appendices 1 and 2).

At present, Nepal's agricultural research activities are handled by NARC through its several crop and vegetable research programs. In addition to the **FSORD** and its various location-specific testing sites in the hills and in the Terai, prominent research programs operating at present are for rice, wheat, maize, potato, sugarcane, jute, oilseeds, pulses and grain legumes. The FSORD also closely collaborates with national research programs for rice, wheat, vegetables, potato, etc., to evolve newer technology for crop diversification. FSORD is the main government organization responsible for the crop diversification research activities and its principal mandate is lo generate compatible technology for diversified rice-based cropping systems. The main thrust of FSORD has been to institutionalize the Farming Systems Research (FSR) approach to help develop and disseminate environment-specific technologies relevant to farmers' socioeconomic needs and priorities.

Information dissemination and exchange

The Agricultural Communication Division (ACD) of the MOA is the principal organization responsible for information exchange and technology dissemination. The Central Agricultural Training Division and Manpower Division have a distinct role in the agriculture sector while the RTB and SMB are extension-oriented programs in the irrigation sector. Apart from this, regional agricultural directorates and district agricultural offices have very sound information dissemination systems. However they are still to be developed and strengthened in the regional irrigation directorates and district irrigation offices as these are relatively newer ones. However, with the passage of time, RTB and SMB are expected to pick up these responsibilities at a faster pace and in more extensive areas.

Funding

Various international donor and lending agencies and domestic services like HMG, ADB/N have been allocating enough funds for research and extension of crop diversification undertaken by FSORD, RTB, SMB for technology generation and dissemination through farmer training and system management. As discussed, the crop diversification activities in Nepal in the future will be a much bigger program, possibly with IIMI's research network assistance.

SUMMARY

The paper tried to visualize the existing situation in the country, practices being followed at present and efforts being made to improve and modify them in the changing context of agricultural crop research and irrigation development and management and extension of both the sectors.

The industrialization and urbanization processes are on the rise in the plains. The pressure on land for industries and agriculture is more in the Terai than in the hills due to population migration. On the one hand, cropping intensity is far less than the actual potential even in irrigated areas. Therefore, the govcrunient's efforts to maximize cropping intensity arid diversify cropping practices are very much a felt need today than ever before. On the other hand, it is an urgent need to protect the environment. maintain and increase the soil fertility by checking erosion and land degradation and create the necessary atniosphere so that the people could realize and feel the government's effort for the balanced development of all the regions, especially with irrigation and crop management facilities.

In order to meet the increasing needs of the farmers in the rural areas. the government's efforts to implement the changed irrigation development and management policy through the participatory and sectoral approach and crop research and diversification and its extension through farming systems and outreach research approach will go a long way in achieving the goals by addressing the farmers' problems and constraints and solving them in a coordinated and integrated manner, especially in the field of irrigation management in the rice-based crop diversification activities.

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Appendix 1

Some of the recommended cropping patterns under different levels of production potentials for irrigated and rain-fed areas, in both Terai and hill conditions.

A. Terai

1. Rain-fed lowlands with low production potential
   a) Rice-wheat-fallow
   b) Rice-lentil-fallow
   c) Rice-mustard-fallow
   d) Rice-chickpea-fallow

2. Irrigated lowlands with high production potential
   a) Rice-mustard-maize
   b) Rice-maize-maize
   c) Rice-maize-mungbean
   d) Rice-wheat-mungbean
   e) Rice-wheat-dhaincha
   f) Rice-wheat-Callow
   g) Rice-wheat-ricc

B. Hill

1. Rain-fed lowlands with low production potential
   a) Rice-broadbean-fallow
   b) Rice-oat-fallow

2. Rain-fed lowlands with medium production potential
   a) Rice-wheat-fallow
   b) Rice-fallow-maize
   c) Rice-broadbean-maize
   d) Rice-oat-maize

3. Rain-fed lowlands with high production potential
   a) Rice-wheat-makc
   b) Rice-potato-maize

4. Irrigated lowlands with high production potential
   a) Rice-wheat-rice
   b) Rice-wheat-mungbean
   c) Rice-wheat-fallow

Appendix 2

Cropping pattern trials being undertaken by FSORD at different **FSR** sites for the identification of component technology for crop possible diversification.

Location	Cmpping Pattern
Patan in Baitadi (Far-western hill)	Rice-wheat-fallow
Kotjahari in Rukum (Midwestern hill)	Rice + maize-wheat + mustard
Pumdibhundi in Kaski (Western hill)	Maize/finger millet-mustard
Naldung in Kavrr (Central hill)	Rice-wheat-fallow
Khandari in Sankhuwasabha (Eastern hill)	Rice-wheat-seshania spp. and rice/lentil-maize

Note: These are the improved and modified practices introduced over the farmers' existing patterns.