PROMOTING CROP DIVERSIFICATION IN RICE-BASED IRRIGATION SYSTEMS

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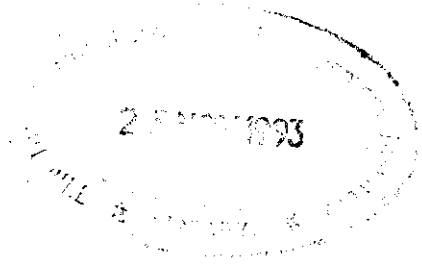
Proceedings of the Second Progress Review and Coordination Workshop of the Research Network on Irrigation Management for Crop Diversification in Rice-Based Systems (IMCD) held in Yogyakarta, Indonesia from 9 to 12 September 1991

Senen M. Miranda and Amado R. Maglinao, editors



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Cover photograph by Senen M Miranda: Workshop participants being briefed on intensive, irrigated crop diversification.

Contents

Acronyms

ADB	-	Asian Development Bank
AFA	-	Area Farmers' Association
AIC	-	Agriculture Inputs Corporation
AMDP	-	Accelerated Mahaweli Development Project
AMTEC	-	Agricultural Machinery Testing and Evaluation Center
ARPP	-	Agriculture Research and Production Project
ATI	-	Agricultural Training Institute
BADC	-	Bangladesh Agricultural Development Corporation
BAR	-	Bureau of Agricultural Research
BARI	-	Bangladesh Agricultural Research Institute
BAS	-	Bureau of Agricultural Statistics
BAU	-	Bangladesh Agricultural University
BPI	-	Bureau of Plant Industry
BPP	-	Block Production Program
BPWH	-	Bureau of Public Works and Highways
BSWM	-	Bureau of Soil and Water Management
CADA	-	Command Area Development Authority
CARP	-	Comprehensive Agrarian Reform Program
CD	-	Crop diversification
CDP	-	Crop Diversification Program
CIDA	-	Canadian International Development Agency
CIS	-	Communal Irrigation System
CLSU	-	Central Luzon State University
CPT	-	Cropping Pattern Trial
CSP	-	Cropping System Program
CTT	-	Component Technology Trials
DA	-	Department of Agriculture
DAE	-	Directorate of Agricultural Extension
DAE	-	Department of Agricultural Economics
DAM	-	Directorate of Agricultural Marketing
DAR	-	Department of Agrarian Reform
DAS	-	Department of Agrarian Services
DCIEC	-	Diversified Crops Irrigation Engineering Center
DCIEP	-	Diversified Crops Irrigation Engineering Project
DGIS	-	Directorate General of International Development (the Netherlands)
DID	-	Department of Irrigation and Drainage
DOA	-	Department of Agriculture
DOAE	-	Department of Agricultural Extension

DOST	-	Department of Science and Technology
DTI	-	Department of Trade and Industry
FAMA	-	Federal Agricultural Marketing Authority
FELCRA	-	Federal Land Consolidation and Rehabilitation Authority
FFYP	-	Fourth Five-Year Plan
FMIS	-	Farmer-Managed Irrigation Systems
FOA	-	Farmers' Organization Authority
FSRDD	-	Farming System Research and Development Division
FSSRI	-	Farming System and Soil Research Institute
FTI	-	Food Terminal Incorporated
FYDP	-	Five-Year Development Plan
GDP	-	Gross Domestic Product
GSN	-	Grama Seva Niladhari
HMG	-	His Majesty's Government
HYV	-	High Yielding Variety
IADP	-	Integrated Agriculture Development Project
IARC	-	International Agricultural Research Center
IARD	-	International Agricultural Research Department
IA	-	Irrigators' Association
ICAR	-	Indian Council of Agricultural Research
ICIMOD	-	International Centre for Integrated Mountain Development
ID	-	Irrigation Department
IIMI	-	International Irrigation Management Institute
IMCD	-	Irrigation Management for Crop Diversification
IOSP	-	Irrigation Operations Support Project
IRF	-	Integrated Rural Financing
IRRI	-	International Rice Research Institute
ISF	-	Irrigation Service Fee
JICA	-	Japan International Cooperation Agency
KSVN	-	Krushikarma Vyapti Seva Niladhari
LBP	-	Land Bank of the Philippines
MARD	-	Mahaweli Agriculture and Rural Development
MARDI	-	Malaysian Agriculture Research and Development Institute
MASL	-	Mahaweli Authority of Sri Lanka
MCC	-	Mennonite Central Committee
MMI	-	Mott MacDonald International
MOA	-	Ministry of Agriculture
MOA	-	Memorandum of Agreement
MTPDP	-	Medium-Term Philippine Development Plan
NAPHIRE	-	National Post Harvest Institute for Research and Extension
NARC	-	National Agriculture Research Council
NARRDN	-	National Agriculture and Resources Research and Development Network
NCCD	-	National Committee on Crop Diversification
NEDA	-	National Economic Development Authority
NFA	-	National Food Authority
NIA	-	National Irrigation Administration

NIACP	-	National Integrated Applied Communication Program
NIS	-	National Irrigation System
NTB	-	National Tobacco Board
O&M	-	Operation and Maintenance
PCARRD	-	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PHILRICE	-	Philippine Rice Research Institute
PPVT	-	Pre-Production Verification Trials
PTWG	-	Provincial Technical Working Group
RACO	-	Regional Applied Communication Outreach/Office
RAP	-	Rice Action Program
RID	-	Royal Irrigation Department
RRC	-	Regional Research Center
SC	-	Steering Committee
SFDP	-	Small Farmers Development Program
SFR	-	Small-Farm Reservoirs
TCDC	-	Technical Cooperation in Developing Countries
TRDP	-	Tangail Rural Development Project
UGM	-	University of Gadjah Mada
UPLB	-	University of the Philippine at Los Banos
USAID	-	United States Agency for Interational Development
USM	-	University of Southern Mindanao
WS	-	Water Supply
WUA	-	Water Users' Association

Foreword

SEVERAL KEY ISSUES on irrigation management for crop diversification in rice-based irrigation systems have been addressed in researches conducted by the International Irrigation Management Institute (IIMI) in collaboration with irrigation agencies and other national institutions in several countries. This collaboration has been further strengthened with the establishment of the Research Network on Irrigation Management for Crop Diversification in Rice-Based Systems (IMCD).

The IMCD Network has been in existence for more than two years now. One of its major activities is the annual progress review and coordination workshop to exchange information and experiences on irrigation management for crop diversification among the member countries. The first workshop, on the theme "Management Arrangements for Accommodating Nonrice Crops in Rice-Based Irrigation Systems," was held in the Philippines. During this workshop, it was decided to hold the next workshop in Indonesia with the focus on "Promoting Implementation of Crop Diversification in Rice-Based Irrigation Systems."

This second workshop was aimed at putting more emphasis on solving problems and adopting strategies to better promote crop diversification in irrigated rice-based areas. It is not surprising to observe a commonality in irrigated crop diversification among the participating countries. It is also apparent that there are differences in the strategies that these countries adopt to promote crop diversification in view of the varying situations. In some countries, there are labor shortages while in others, the landholdings are very small.

The participants from the nine member countries agreed that the farmers themselves are an important component of irrigated crop diversification systems. Most of them still have doubts and resist change. They need to have a clearer understanding of the benefits of diversification. They find that rice production is easier, requires less care or attention and low cash inputs than nonrice crops, and that it has a stable market. The question of the comparative advantages of cultivating nonrice crops in irrigation systems designed for rice should therefore be addressed.

The interrelationships among the different components in irrigated crop diversification should be better understood. Water is delivered by the irrigation agency, support services like credit and other production inputs are provided by the agricultural agencies, while the farmers use these inputs and services to produce the crops. The question is how to reorient the system so that all three components could work harmoniously. Reorientation could be effected through persuasion and negotiation among the sectors involved. Greater attention should now be given to this reorientation process.

IIMI is grateful to the Directorate General for Water Resources Development (DGWRD), and the University of Gadjah Mada (UGM), Republic of Indonesia for co-sponsoring this workshop and for making the necessary arrangements for the workshop and field trip. The assistance of Ir. Soenarno and Ir. Soedaryanto of DGWRD, Dr. Suprodjo of UGM and their staff is also gratefully acknowledged.

IIMI also extends its gratitude to all the participants for their contributions and unselfish cooperation in sharing their experiences in promoting crop diversification in rice-based irrigation systems.

Thanks are also due to several IIMI colleagues headed by the Director General, Dr. Roberto Lenton, for providing their support to the IMCD Research Network and its activities, including their attending and facilitating the workshop.

Special thanks are due to Dr. Senen M. Miranda (Senior Irrigation Specialist, IIMI and the IMCD Research Network Secretariat Coordinator) for taking the primary responsibility of organizing the workshop, and to Dr. Amado R. Maglinao, Director, Farm Resources and Systems Research Division (FRSRD), and the Philippine Council for Agriculture Forestry and Natural Resources Research and Development (PCAFNRRD), for his assistance in the preparation of the draft of the workshop proceedings.

Khalid Mohtadullah
Director for Research
International Irrigation Management Institute

OPENING ADDRESSES

Welcome Address

by

Soenarno
Director of Irrigation I
Directorate General of Water Resources Development
Jakarta, Indonesia

FIRST OF ALL, on behalf of the Organizing Committee, I would like to extend our thanks and gratitude for your presence at this workshop, which has been organized through the cooperation of the International Irrigation Management Institute (IIMI), the Faculty of Agricultural Technology of the University of Gadjah Mada and the Directorate General of Water Resources Development, Indonesia. We extend our thanks and gratitude to Gadjah Mada University which has kindly allowed this workshop to be conducted at this beautiful university.

A similar workshop had been successfully conducted in the Philippines in December 1990. This current workshop, the second in the series, aims to discuss, exchange and disseminate information on the results of research on irrigation management for crop diversification, specifically on how to promote its use.

It has long been recognized among rice-producing countries that rice, as an agricultural commodity, may no longer give sufficient benefits to the farmers. Also, competition among different uses of water is becoming keener, forcing us to utilize water more efficiently. Therefore, crop diversification has become an important topic.

Most of the existing irrigation systems had been planned, designed, constructed and managed primarily to irrigate a rice crop. When crop diversification is introduced in these systems, irrigation water management needs to be altered to suit the new requirements. Research studies have been ongoing in the member countries and this workshop aims to coordinate such activities for more efficient research efforts.

I would say that this second workshop is very timely, as, for several months, an extraordinary drought has affected most parts of Indonesia, especially the island of Java. This situation should encourage people to promote and intensify efforts towards crop diversification.

As already agreed upon during the first workshop in Manila, the theme of this workshop is "Promoting Implementation of Crop Diversification in Rice-Based Irrigation Systems."

This workshop is expected to stimulate discussion among scientists, technologists, leaders and policymakers by identifying significant issues and agreeing upon mutually beneficial solutions.

The program of activities for this workshop will consist of a three-day presentation of papers from member countries, together with contributions from other distinguished guest speakers. This will be followed by a one-day tour of field sites with activities relevant to our discussions. Besides

crop diversification, relaxation is also important and therefore participants will also be visiting interesting places such as temples, etc.

We hope that you will be able to engage in fruitful discussions and exchange of experiences through this workshop. On behalf of the Organizing Committee, I would like to extend our gratitude for your active participation in making this workshop successful.

Thank you.

Opening Remarks

by

Soenarjo Keman
Vice Rector for Academic Affairs
Gadjah Mada University, Yogyakarta, Indonesia

DISTINGUISHED GUESTS, LADIES and gentlemen, first of all, on behalf of the Rector, the staff, and the students of Gadjah Mada University, I would like to welcome all of you who are here in Yogyakarta to attend the second workshop on Irrigation Management for Crop Diversification. It is an honor for our university to jointly organize this workshop and we are very happy that this activity could be held in our campus.

On behalf of our university, allow me to express my sincere appreciation and gratitude to the International Irrigation Management Institute, which has been helping some countries, including Indonesia, to do research on irrigation management for crop diversification.

Since Gadjah Mada University is noted for its concern with the problems faced by the majority of people who live in the villages and remote areas, the workshop theme "Promoting Implementation of Crop Diversification in Rice-Based Irrigation Systems," which focuses on the "Impact of Research, Application of Research and Training, and Identification and Alleviation of Constraints to Crop Diversification," is very relevant to our mission. We will always try to improve the relevance of education, research, and extension services, to the community needs and to the development of the country.

I am convinced that this workshop would enable you to review your progress and coordination successfully. I wish you a successful workshop and I hope you enjoy staying in Yogyakarta, which is called the city of education and culture, and especially staying in our campus, which is the oldest and the biggest state university in Indonesia.

Finally, it is my pleasure to declare the second workshop on Irrigation Management for Crop Diversification officially open.

Thank you very much.

Address

by

Roberto Lenton
Director General
International Irrigation Management Institute
Colombo, Sri Lanka

MR. VICE RECTOR of Gadjah Mada University, Mr. Director of Irrigation I, distinguished guests, ladies and gentlemen.

It is a pleasure to be here at the Second Progress Review and Coordination Workshop of the Research Network on Irrigation Management for Crop Diversification in Rice-Based Systems. It is particularly pleasant to be here in Indonesia, a country with which the International Irrigation Management Institute has had very close links; at the University of Gadjah Mada, with its very distinguished record of achievements; and in the city of Yogyakarta, which I have not visited for 12 years.

I would like to take this opportunity to give special thanks to the workshop organizers, especially Mr. Soenarno (this year's Chairman) and Dr. Suprodjo and his staff at Gadjah Mada University, who have worked tirelessly in order to make this workshop a success.

I am particularly pleased to see many countries represented at this meeting. These include Indonesia, Malaysia, the Philippines, Thailand, Vietnam, India, Sri Lanka, Bangladesh, and Nepal — spanning the countries of South and Southeast Asia. I would like to extend a very special welcome to the representative of Vietnam, which only recently joined the IMCD network. I am also delighted to see so many old friends here — Mr. Soenarno, Joe Galvez, Jayantha Jayewardene, Manuel Lantin, and many others — as well as to meet new friends.

This impressive gathering is testimony to the growing importance that countries in South and Southeast Asia are attaching to the need for irrigation management for crop diversification (IMCD). IMCD is a subject of immediate topical interest to policymakers and managers, who are basically motivated by two sets of concerns: first, how to increase returns to farmers, and second, how to use scarce water resources in irrigated agriculture more effectively and efficiently. Undoubtedly, in the next several years we will be seeing many changes in irrigated agriculture in the region — including new socioeconomic relationships and increased attention to postharvest matters, services, markets, and processes. In the field that directly concerns us, we will need new ways to distribute water in irrigation systems to allow the incorporation of new cropping systems.

I am particularly pleased that this year's workshop will address policies to promote crop diversification in rice-based irrigation systems. Irrigation management for crop diversification is not simply a question of technologies or of identifying suitable technologies of water control. It

is also a question of setting the right policy environment within which irrigation management for crop diversification is considered. It is perhaps because of these complexities that IMCD has become a focus of IIMI's research, training, and extension activities for the last several years.

Most of you know that IIMI is concerned with many factors that have a bearing on the performance of irrigation systems, which include not only technologies but also management, institutional arrangements, and policies. We believe that progress involves a combination of collaborative field research, thematic research, and information dissemination and exchange. This is why IIMI has been pleased to play a catalytic role in helping this network get started and to facilitate its continued growth and development over the years.

As I mentioned earlier, the presence of representatives of different countries today is testimony to the importance of the subject and the role that this network plays in the region. We are seeing a strong expression of interest from national institutions in the region as well as recognition by international agencies. For example, the International Commission on Irrigation and Drainage (ICID) has asked IIMI and its network partners to present a paper at the next Afro-Asian meeting of the ICID in Bangkok to highlight some of the results of work on irrigation management for crop diversification. This demonstrates the growing recognition that international organizations are giving to the work of this network — which is essentially the work of all those who are here today.

In closing, I would like to specially acknowledge the role of Dr. Senen Miranda as coordinator of the IMCD network. As you know, Senen has played a very special role in getting us to where we are today. He participated in a number of activities at IIMI that laid the groundwork for the establishment of the network, including the key international workshop that was held in Sri Lanka in November 1986. He also played a key role in other workshops that were held in Thailand in 1988, Malaysia in 1989, and the Philippines in 1990. Some of you may already know that Senen accepted earlier this year a transfer to a new position in Lahore, Pakistan where he now coordinates a very important research project designed to strengthen institutions across Pakistan engaged in irrigation management research. But both Senen and the management of IIMI have agreed that he should continue to play a lead role in this network. Senen is thus still very much involved in continuing to support this network.

I, unfortunately, will not be able to be here for most of these proceedings. But I very much look forward to hearing from Senen and others about the results of this workshop. I look forward to being in touch with the network as it proceeds, and to hearing about the outcome of further meetings to share the results of research. I wish this workshop all the very best, and look forward to seeing you on other occasions.

Thank you.

Workshop Objectives and Expectations

Senen M. Miranda
Senior Irrigation Specialist
International Irrigation Management Institute

AS AGREED DURING the 13 December 1990 Cabanatuan City meeting of the Steering Committee of the IMCD Research Network, we are now holding this second Progress Review and Coordination Workshop at this time here in the campus of the Gadjah Mada University in Yogyakarta. The theme of the workshop, "Promoting Implementation of Crop Diversification in Rice-Based Irrigation Systems," was chosen from among four themes suggested by the participants in the Manila Workshop.

The four-day workshop, similarly structured as the last one, consists of four technical sessions and a field visit to irrigated, crop-diversified areas. In Session I, nine country reports will be presented and discussed; Session II will be devoted to small workshop-group discussions; and Session III will be used for the presentation of small workshop-group reports and for the closing ceremony.

As indicated in the workshop program, Session I will focus on the experiences and strategies of the nine countries represented here for promoting crop diversification in rice-based irrigation systems. Based on the tentative, suggested outline for writing the country reports, it is expected that government policies/programs involving measures such as research and development, extension of research findings, pilot-testing/demonstration, training, provision of support services, etc., will be presented by highlighting experienced successes and failures. Where constraints were encountered, steps in alleviating them will be of great value in evolving appropriate strategies for promoting crop diversification. Since we are engaged in a regional research network, researchable issues that should be addressed under the theme of the workshop and the role that the IMCD research network can play in addressing them will be given special attention during the general discussion of all papers scheduled for tomorrow morning.

In Session II, we will form into two subgroups, one on Research and Development, and the other on Information and Funding, to do the following:

* Identify commonalities, similarities and/or differences in experiences and strategies in promoting crop diversification in irrigation systems in the different countries.
* Come up with an action plan to address the identified issues within the overall objectives of the research network.

More specific guidelines will be provided during the briefing prior to small group discussions. In Session III, the reports of the two subgroups will be presented and discussed. Moreover, we should review the current network activities such as the annual Progress Review and Coordination

Workshop, the field visit to irrigated diversified areas as part of the workshop, the publication of the workshop proceedings, and the annual issue of the IMCD Newsletter. We should also consider the following possible network ventures:

* Country research proposals for consolidation into either generic or national projects for submission as a packaged proposal to donors.
* Possible study tours for a limited number of middle managers in dry environments where extensive crop diversification has flourished.
* Training and research fellowships.
* Action-oriented programs.

The Steering Committee's deliberation, scheduled after the field visit, will benefit very much from a clear prioritizing of activities which are to be promoted, during the general discussion.

COUNTRY REPORTS

Promoting Implementation of Crop Diversification in Rice-Based Irrigation Systems in Bangladesh

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INTRODUCTION

Irrigation and Irrigation Management

IRRIGATION IS RECOGNIZED AS A "leading input" in enhancing agricultural production in Bangladesh and it has been given a very high priority in the national plans of the country. It is estimated that 3.1 million hectares were under irrigation in 1989-90, which is about 35 percent of the country's net cropped area. The Fourth Five-Year Plan (FFYP) of Bangladesh has put greater emphasis on the improvement of irrigation facilities and the total area of irrigated land is expected to increase up to 4.8 million ha at the end of the FFYP (1994-95) (Planning Commission 1990).

An important aspect of the proposed irrigation development is that more emphasis has been placed on small-scale tubewell irrigation than on surface water irrigation. One great advantage of small-scale tubewells is that these offer management flexibilities so as to cater to the varying irrigation needs of diversified crops grown in rice-based irrigation systems (Biswas 1991).

Despite these constraints, there are unexploited potentials for expanding irrigation facilities. The move of the government, in 1987, to remove the import ban on diesel engines and then to remove duties and standardization restrictions on imports of small diesel engines created opportunities for rapid sales of tubewells and pumps to the private sector. New types of machines, (e.g., fractional pumps) are also being made available, which can be used in areas with low water tables. Private workshops, private repair facilities and users' technical knowledge about pump operation have been improved. The rural electrification program has also encouraged expansion

of irrigation. In addition, the Flood Control and Drainage Projects have had some positive impacts in creating opportunities for bringing additional lands under irrigated crop production.

Irrigated Crop Diversification

Bangladesh agriculture is highly diversified, encompassing crops, livestock, fisheries and forestry. The crop sector includes about one hundred crops grown in three different seasons of the year — *kharif-I* (April-June), *kharif-II* (July-November) and (November-March) seasons. According to the Agricultural Census of 1983-84, the total of 85 crops that were documented included 21 cereals, 10 pulses, 7 oilseeds, 7 cash crops, 31 vegetables and 9 spices (BBS 1986). But rice alone (the major cereal and staple food) occupied about 77 percent of the total cropped land.

With the expansion of irrigation facilities, the cropped area under irrigated rice and nonrice crops is also increasing. Table 1 shows that the area irrigated under rice (*Aus, Aman, and Boro*) has increased by about 48 percent over the period from 1979/80-1980/81 to 1986/87-1987/88. The irrigated area under nonrice crops increased by 22 percent over the same period. As expected, about 80 percent of the total irrigated area is devoted to rice while only 9 percent is under non-cereal crops such as pulses, oilseeds, potatoes and vegetables. It is noteworthy that crops such as

Table 1. Irrigated area under different crops in Bangladesh.

Crop	1979/80 and 1980/81 average (1,000 ha)	%	1986/87 and 1987/88 average (1,000 ha)	%	% change between the two periods
Rice	1,244	77.5	1,837	80.6	+47.7
Aus	106	6.6	141	6.2	+33.0
Aman	135	8.4	175	7.7	+29.6
Boro	1,003	62.5	1,521	66.8	+51.6
Nonrice	361	22.5	441	19.3	+22.2
Wheat	184	11.5	230	10.1	+25.0
Other Cereals	4	0.2	3	0.1	-25.0
Pulses	3	0.2	3	0.1	0
Oilseeds	4	0.2	14	0.6	+250.0
Potato	68	4.3	62	2.7	-8.8
Vegetables	42	2.6	46	2.0	+9.5
Sugarcane	10	0.6	9	0.4	-10.0
Cotton	1	0.1	4	0.2	+300.0
Others	45	2.8	70	3.1	+55.6
All crops	1,605	100.0	2,278	100.0	+41.9

Source: BBS (1990), Table 4.18, p.143.

tobacco, fruits and home-grown vegetables also receive irrigation facilities but the extent of such irrigation is not included in official statistics.

Bangladesh, by virtue of her favorable agro-ecological conditions, has had the potential for growing diversified crops in almost all irrigated areas. Nonrice crops can be grown in highlands throughout the year and in medium-scale, high- and lowlands during the season. Most nonrice crops are termed as "minor crops" in official documents and only lands which are usually not suitable for rice production are given to nonrice crops.

Lands with undulating topography such as the upland areas of Madhupur tract, and those with light textured soils such as in Kusthia, Dinajpur and Thakurgaon districts, as well as riverbanks or newly created *char* lands of coastal districts are not suitable for irrigated rice cultivation. About 27 percent of Bangladesh is composed of light textured soils (sandy loam, loamy sand and sand) which are suitable for growing nonrice crops under irrigated conditions.

There are very few countries in the world where the question of maintaining the population-food-nutrition balance is as important as it is in Bangladesh. The very low production of nonrice crops such as pulses, oilseeds, vegetables, fruits and spices has led to inadequate nutrition in the daily diet of the people. For example, local production of vegetable oil is only 1.19 kg/head/year, whereas 2.64 kg/head/year is imported. In other words, imported edible oil is about 70 percent of the total amount consumed (MOA 1991).

The acreage under pulses and its production have also been declining over the years, a phenomenon which not only affects human and animal nutrition but also adversely affects soil fertility. It may be noted that although some pulses such as lentils are imported, their prices have risen so high that the level of pulse consumption by the poorer section of the population has significantly decreased.

It is because of this background that increased attention has been given in the FFYP to accelerating the production of nonrice crops through improved production technologies. For example, Table 2 shows that the production of pulses and oilseeds is projected to increase by 22

Table 2. Land budget and production targets for nonrice crops during the Fourth Five-Year Plan period (1990-95).

Crop	Land area (1,000 ha)		Production (1,000 tons)		Projected increase in production (%)
	Benchmark (1980-90)	Projected (1994-95)	Benchmark (1989-90)	Target (1994-95)	
Sugarcane	158	182	7,310	9,500	30
Fruits	166	192	1,496	2,021	35
Vegetables (summer + winter)	275	303	975	1,326	36
Wheat	648	668	1,360	1,650	21
Pulses	749	830	555	675	22
Oilseeds	587	647	464	640	38
Spices	145	162	-	-	-

Source: Planning Commission (1990): The Fourth Five-Year Plan, 1990-95. Ministry of Planning, Government of Bangladesh, Table P.V.A.-14.

percent and 38 percent respectively, over the FFYP period. Similar targets have been set for other crops such as vegetables, spices, fruits and sugarcane.

The strategy pursued to achieve these goals of nonrice crop production involves the implementation of crop diversification programs characterized by the provision of irrigation, HYV (High Yielding Variety) seeds, fertilizers, better agronomic management practices and effective extension advisory services. As irrigation is recognized as the critical factor in pursuing crop diversification programs, changes in management practices in rice-based irrigation systems deserve consideration. In Bangladesh, where tubewell irrigation is expanding in the private sector, minor modifications of earthen field channels can be made without much trouble in order to provide irrigation to nonrice crops (Mandal et al. 1990).

PROGRAMS RELATED TO PROMOTING CROP DIVERSIFICATION

Government/Agency Programs

A number of government and nongovernment agencies/institutions are engaged in research and extension activities in relation to promoting crop diversification in Bangladesh. A brief summary of some of the major programs is presented in Table 3. These programs have been implemented at different locations with varying levels of trained manpower and logistical support, but the overall focus of each of them is to develop technologies for promoting nonrice crop production in a fashion which is suitable to farmers' conditions. One major objective is to ensure higher profitability of nonrice crops than that of competing rice crops. While some of the programs such as those under Bangladesh Agricultural University (BAU), Department of Agricultural Economics (DAE) or Mennonite Central Committee (MCC) have undergone the stages of pilot-testing, demonstration of new crops or improved production practices, others such as the Canadian International Development Agency (CIDA)-sponsored Crop Diversification Program (CDP) involving nonrice crops such as tubers, oilseeds and pulses, have only entered the implementation stage. It is therefore too early to comment on the efficacy of these programs.

Research and Development

The CIDA-sponsored crop diversification program and the two BAU projects integrate both research and extension in their respective activities. The Farming System Research and Development Project at BAU, which has its origin in the cropping system research of the early eighties, draws on the expertise of a number of BAU disciplines. It has so far evolved some feasible cropping patterns incorporating nonrice crops and has attempted to disseminate research findings through field trials. The other BAU research project on crop diversification has gathered knowledge about farmers' existing practices of nonrice crop production in tubewell-irrigated rice-based systems. Under the project, technical interventions with respect to irrigation methods, on-farm water distribution, drainage provision, accommodation of new nonrice crops, and improved tillage and agronomic practices are currently being tested in farmers' fields.

Table 3. Crop Diversification programs of government and nongovernment agencies in Bangladesh.

Agency	Program	Remarks
DAE	Multi-crop Demonstration Program: popularization of 49 non-cereal crops in different agro-ecological zones.	Moderate achievement, inadequate funding, limited performance.
CIDA, BARI, BA, DC, DAE, DAM	Crop Diversification Program: improvement of dietary diversity and food self-sufficiency; increase production and consumption of tubers, pulses and oil-seeds in 19,000 villages of 90 upazilas; benefiting 20 million people; targeted at small farmers cultivating less than 1 ha, 10-year program, first phase to be completed in March 1995.	Inception report completed in 1990; 90 target locations identified; 11 workplans developed on research, seed multiplication, extension, land use, irrigation, training, women, nutrition, marketing, credit, special workplans and surveys; some bridging activities already started.
BAU	Farming System Research and Development: develops improved production technologies for a number of nonrice crops.	Field demonstration of improved technologies; popularizing tubers and oilseed crops in low lying *Haor* areas.
	Crop Diversification Research for Improving Irrigation Water Market; diagnosis of potentials and constraints to irrigated rice and nonrice crop production in tubewell-irrigated areas.	Based on first phase survey results, technical interventions with respect to agronomy and irrigation management practices are tried in farmers' fields.
TRDP	Continuous Cropping System Management: facilitating nonrice crop production in the low water table and upland areas.	Buried pipe irrigation in undulating topography; reduced conveyance loss; achieved some success in crop diversification.
MCC	Horticulture Project for Improved Vegetable Cultivation: seed multiplication, extension advice, training, rower pump irrigation.	Target groups of poor farmers benefited from increased production of summer, winter and rainy season vegetable production.

The research component of the massive CIDA-sponsored CDP will be undertaken by the Bangladesh Agricultural Research Institute (BARI). BARI will continue its research activities on the target crops, e.g., tubers, pulses, oilseeds, wheat and horticultural crops. The major foci of these research efforts are: (i) selection or development of HYVs of these crops suitable to conditions in Bangladesh; (ii) improvement and demonstration of new crop production practices and storage, transportation, marketing and utilization/consumption of these crops; (iii) development of irrigation schedules, water distribution and application methods suitable for these crops; and (iv) development of tillage and soil drainage techniques appropriate to these crops (CIDA 1990).

Pilot-Testing and Demonstration

The Directorate of Agricultural Extension (DAE), is mainly responsible for demonstration and promotional activities in relation to diversified cropping. For oilseeds, pulses and tuber crops, DAE has a plan for setting up 6,200 demonstrations in 80 upazilas in the 1991-92 season, and 58,000 demonstrations by 1995. The wheat program also has a target of 1,200 demonstrations per year. Besides the government agencies, several NGOs also have nonrice crop demonstration programs. Mott MacDonald International (MMI), the Mennonite Central Committee (MCC) and the Tangail Rural Development Project (TRDP) have their own diversified cropping pattern trials and testing programs in their respective project areas.

Training

The training program under CDP has been designed to build up the skills and capabilities of such relevant crop diversification actors as the implementing agencies and the target farmers. For BARI, training is concentrated on the use of farming system research techniques with the aim of accelerating research in CDP crops. The training requirements of DAE are for frontline extension staff as well as for target groups of farmers. The major areas of training are: (i) agronomic practices related to CDP crop production, utilization and food preparation; (ii) irrigation management of nonrice crops and crop management under irrigated conditions; and (iii) on-farm storage of CDP crops. Training in the Directorate of Agricultural Marketing (DAM) will aim at improving the agency's capabilities to provide effective market information and promotion of CDP crops. It is useful to mention that the farmers' training on improved vegetable cultivation by MCC has proved to be very successful (MCC 1990).

Support Services

The success of CDP depends to a large extent on the provision of support services. The major forms of support services are: (i) seed multiplication and the supply of high quality breeder seed by BARI and Bangladesh Agricultural Development Corporation (BADC); (ii) demonstration and field trials by DAE; (iii) dissemination of information by DAM to target farmers with respect to price forecasts, marketing, production costs, tariff structures and inter-market and inter-season price variations of CDP crops; and (iv) a separate and accessible credit plan for CDP crops.

Problems in Promoting Crop Diversification Programs

There is a serious lack of reliable baseline and other information necessary for the planning and implementation of crop diversification programs. Some examples of the inadequacy of the information base are as follows:

1. Many viable cropping patterns that include diversified crops are not properly tested, demonstrated and established.
2. For crops or cropping patterns that proved promising from the farmer's point of view, information about crop agronomy, irrigation management, crop processing or storage, are neither systematically gathered nor disseminated.
3. Information about crop zones is weak with respect to soils, climate, irrigation water availability and marketing.
4. Information is meager as regards HYVs of nonrice crops, high-input technologies and the requirements for cash or in-kind inputs.
5. Information is absent about the wide variety of environmental parameters relating to nonrice crop promotion.

The lack of appropriate support services also limits the promotion of a crop diversification program. The prominent support services that are either inadequate or absent are: (i) supply of good quality seeds; (ii) provision of extension advisory services — partly due to the shortage of field staff and partly due to lack of initiative; (iii) appropriate support with respect to marketing, storage and utilization of diversified crops; and (iv) facilities for the processing of nonrice crops such as oilseeds.

Major problems in implementing crop diversification programs pertain to the practical difficulties faced when involving target farmers in field trials or demonstrations. The common problems are: (i) some nonrice crops give lower financial returns than does competing *boro* rice; (ii) some cropping patterns based on nonrice crops such as potato and vegetables under irrigated conditions have high returns, but very high cash requirements for growing these crops restrict their adoption especially by farmers; (iii) framers' lack of incentives also originate from risks and uncertainties due to rainfall, droughts, floods, and erratic inter-year price changes; and (iv) as regards demonstrations and field trials of suggested nonrice crops, acute problems are experienced with respect to the selection of sample farmers and plots, and the distribution of inputs in cash or in kind among the participating farmers. Additional difficulties are faced in ensuring that farmers' own inputs (labor and materials) are applied as specified.

APPROPRIATE STRATEGIES

Research and Extension Linkages

For a successful crop diversification program, research and extension linkages must be strengthened. A number of strategies should be pursued in this direction as follows: (i) research designs should be perfected, embodying not only what scientists hypothesize about improvement of crop

production but also what farmers think feasible in their situations; (ii) the huge volume of field data collected over the years should be properly analyzed and results should be clearly disseminated in a timely manner; (iii) adaptive research based on the knowledge of successful farmers in different areas of the country should be emphasized; and (iv) extension services should be strengthened by involving extension personnel in all stages of field research, e.g., planning, design and implementation of research projects. Above all, since there is a strong preference for rice crops, any trial or demonstration of nonrice crops should be integrated with rice-based cropping patterns. (For further discussion about how nonrice crops can be accommodated in the rice-based cropping patterns, see Mandal et al. 1990).

Appropriate Incentives

Farmers' financial incentives must be created and maintained if the desired level of crop diversification is to be achieved. BAU research results reveal that the farmers of intensively developed areas of Chandina and Comilla have had positive incentives to grow nonrice crops such as vegetables as their yields and profit margins have been high. This was largely a result of the historical spread of HYV technologies with the simultaneous development of transportation, marketing and storage facilities under the influence of the Comilla Cooperative Model. Furthermore, the promotion of irrigated nonrice crop production has led to improvements in the emerging irrigation water market in the area. The opposite, however, took place in Thakurgaon and Ghatail where there has been very little expansion of nonrice crops due to the absence of appropriate institutions and infrastructure development (Mandal and Miah 1991).

CONCLUSIONS AND RECOMMENDATIONS

Role of National Institutions and Agencies

The major national institutions/agencies are making contributions to the development and implementation of crop diversification programs despite the fact that these organizations must work under constraints such as limited funds and logistic support, and low levels of job satisfaction. The prominent institutional strength for pursuing crop diversification programs is that there are a good number of agricultural research institutes in the country. These institutes are engaged in research efforts involving rice as well as nonrice crops and have been able to develop significant technological packages for accelerating crop production. Furthermore, there exists a countrywide agricultural extension network which is gaining experience and training in the dissemination of research findings.

However, there are also important weaknesses: (i) inter-institute coordination and the exchange of research ideas and experiences are often missing; (ii) crop-specific research efforts are not always integrated in a holistic fashion; (iii) socioeconomic and cultural aspects of diversified crops are often neglected; and (iv) processing, storage, marketing or consumption of nonrice crops never get priority in the research agenda.

Other agencies such as irrigation-related agencies, credit institutions and agricultural extension departments have had historical biases towards rice, and consequently, attempts to promote nonrice crops are still generally seen as secondary activities.

Role of Other Countries and International Agencies

The inter-country flow of information and exchange of experiences on production, marketing and consumption of nonrice crops can be of immense benefit to a country like Bangladesh which is only beginning to promote crop diversification. The national crop diversification networks in various countries could be formed and federated into the IIMI-based international IMCD network, which can continue to support such information dissemination. In country-specific situations, English language IMCD newsletters could be translated into local languages and could perhaps be widely circulated. To the extent to which opportunities are available, cross-country field visits to crop diversification sites might be organized for personnel of involved agencies.

As a logical follow-up of the mutual exchange of experiences from diverse situations in different countries, it may be possible for international agencies and expertise to make contributions to the planning and implementation of national and regional crop diversification programs. One recent example is the CIDA-sponsored Crop Diversification Program in Bangladesh in which CIDA and the Directorate General of International Development (DGIS) of the Netherlands have been involved in the planning and implementation phases. The scope of collaboration has been further extended by supporting a shuttle breeding project being carried out at the Agriculture Canada Research Station in Saskatoon, Canada. This project involves crossing a number of selected lines of mustard from Bangladesh with selected Canadian lines of Canola.

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Promoting Implementation of Crop Diversification in Rice-Based Irrigation Systems in India

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INTRODUCTION

INDIA IS THE seventh largest country in the world which covers a geographical area of 329 million hectares, of which 186 million ha are cultivable. It has the largest irrigated area in the world with about 25 percent of the world irrigated area in 1986. The present gross irrigated area is 71 million ha which is projected to increase up to 84 million ha by the year 2000 (Table 1).

The average annual rainfall is about 1,170 mm, but its distribution in time and space is not uniform. As a result, some parts of the country experience drought, while floods due to excessive precipitation occur in some areas. One third of the country is drought-prone and in such areas, irrigation is essential to grow even a single crop. Thus, irrigation has been accorded high priority in the national development plans.

Irrigation has played a key role in raising agricultural production and achieving self-sufficiency in food grains in the country in the last four decades. The food grains production increased from 51 metric tons (mt) in 1950-51 to about 175 mt in 1989-90. The percentage contribution of irrigated areas to the total production went up from about 30 percent to 60 percent in the last four decades.

The government of India has invested a lot in the irrigation of rice. About one third of the country's total irrigated command, mostly in South and East India, is used for this crop. But because of the high water requirement of rice, this area consumes about two thirds of the water supplied by irrigation systems throughout the country. Rice clearly will retain an important place in India's irrigation portfolio, but consideration is increasingly being given to irrigation management options for growing upland crops during *rabi* in parts of the commands planted traditionally to rice.

Table 1. Actual and projected irrigated areas for different crops.

Crop	1970-71		2000	
	Area sown (ha)	Area irrigated (ha)	Area sown (ha)	Area irrigated (ha)
Rice	37.4	14.9	32.0	24.0
Wheat	18.2	9.8	17.5	14.9
Barley and oats	2.6	1.3	6.0	1.8
Millet	43.2	2.5	42.5	5.2
Pulses	23.1	2.0	25.0	5.4
Sugarcane	2.6	1.9	5.5	5.5
Groundnut	7.5	0.6	9.0	1.9
Other oilseeds	6.2	0.4	16.5	3.2
Cotton	7.7	1.3	11.5	7.5
Jute and other fibers	1.2	0.1	1.5	1.0
Fodder	7.0	1.4	16.5	6.5
Vegetables	3.1	1.2	8.3	4.2
Fruits	1.2	0.4	4.0	1.2
Plantation crops	2.2	0.4	2.8	1.0
Tobacco	0.4	0.1	0.6	0.4
Flowers and misc. crops	1.5	0.2	0.8	0.3
Total	165.1	38.5	200.0	84.0

The National Commission on Agriculture has considered some reduction in the area under rice in Andra Pradesh and Tamil Nadu, where the yields are low or water is not utilized to the best advantage, by replacing rice with another crop. It is envisioned that in due course, crops like wheat and sugarcane would be grown under irrigated conditions.

Below is a description of the crop diversification potentials of the different states in India. These are considered desirable under the prevailing cropping patterns in irrigated areas. The change can be gradual as more area is brought under irrigation.

Andhra Pradesh. The main irrigated crop in the state is rice which accounts for 79 percent of the irrigated cropped area. There is a need to grow more irrigated cotton, millet, and oilseeds. These require less water than rice. Their areas could be increased by a corresponding decrease in the area under rice.

Assam Rice is the main crop and should continue to be so, as rainfall conditions are favorable for this crop. However, more fodder, vegetables, fruits and plantation crops should be raised.

Bihar. Rice and wheat are the dominant irrigated crops and would continue to be so. They cover 67 percent and 26 percent of the irrigated area, respectively. The area under vegetables, fruits, sugarcane, pulses and other crops is insignificant and needs to be substantially increased. Practically no irrigated fodder is grown in the state which has a large number of ill-fed cattle. To improve this condition, there has to be sufficient fodder and this should be an important crop in canal commands.

Karnataka. Rice and millet are the main irrigated crops and cover 51 percent and 16 percent of the irrigated cropped area, respectively. In order to spread the benefits of irrigation to a larger area, the rice area needs to be reduced and the area for millet, pulses and oilseeds, which require less water, should be increased. The black soils in the state are very suitable for cotton and therefore, the cotton area should be substantially increased. The areas planted to fodder, sugarcane, vegetables, fruits and plantation crops should also be increased.

Kerala. Rice is the main crop in the state and occupies 83 percent of the irrigated area. The rest of the irrigated area is under vegetables, fruits, spices, condiments and plantation crops. From the national point of view, the irrigated area under crops other than rice would need to be increased but on full development, the area under rice need not necessarily be below its present level.

Orissa. Rice occupies 87 percent of the irrigated area. There is a need to grow more fodder, vegetables and fruits which may bring down the percentage of rice in the areas irrigated in future. Cotton and oilseed cultivation should be encouraged.

Tamil Nadu. About 71 percent of the irrigated cropped area is under rice. Not all of this is grown in good soils or under rainfall conditions. Hardly any irrigated fodder is grown in the state. The proportion under cotton for which soils are suitable is very low. Therefore, the area under irrigated fodder, sugarcane, banana and cotton should be substantially increased by reducing the area under rice.

West Bengal. There is a good potential for the development of groundwater in this state. Groundwater is more suitable for low water-intensive crops like wheat, fodder, vegetables, fruit, etc. With more emphasis on the low water-requiring crops, the percentage of land under rice for further development of irrigation may decrease substantially from the present 90 percent. The area under wheat should be increased; already this crop is catching on. The area under irrigated fodder is negligible at present and should be increased to improve cattle production. Also, the cultivation of cotton and oilseeds should be encouraged.

India has become self-sufficient in food grain production but is deficient in oilseeds, cotton and pulses. It is necessary that these crops be grown under irrigated conditions by reducing the area under rice which consumes more water.

PROGRAMS RELATED TO PROMOTING CROP DIVERSIFICATION

Research and Development

The Indian Council for Agricultural Research is carrying out coordinated research projects on water management in about 32 centers throughout the country, in collaboration with state agricultural universities. One aspect of the research is on cropping systems in irrigated commands. In Tamil Nadu State, under the *Periyar-Vaigai* command, the farmers usually raise two crops of rice followed by pulses. Lately, however, they have not been able to successfully raise the first crop of rice due to shortage of water. Hence, an experiment was initiated to find out a suitable nonrice crop to replace the first rice crop. It was shown that a groundnut-rice-blackgram pattern

consumed less water and gave the highest net return per ha (Table 2). The benefit-cost ratio was also highest among the cropping systems tried.

Table 2. Cropping systems trial in Periyar-Vaigai Command, Tamil Nadu.

Cropping system	Water used (cm)	Net return (Rs)	Profit (Rs/m^3 of water)	Benefit-cost ratio
Rice-Rice-Blackgram	242	14,079	0.58	1.16
Groundnut-Rice-Blackgram	189	17,414	0.92	2.3
Sorghum-Rice-Blackgram	186	14,086	0.76	1.7

The cropping system research conducted in Karnataka State revealed that rice-mustard or rice-sesamum gave the highest net return and benefit-cost ratio as compared with the rice-rice system which is being followed in the canal irrigated area of Zone 3 (Table 3). Growing nonrice crops has not only reduced the water requirement but also increased the net return.

Table 3. Cropping system in Kartanaka.

Cropping sequence	Labor (mandays/ ha/yr) (Rs/ha)	Cost of culti-vation	Gross return (Rs/ha)	Net return (Rs/ha)	Benefit-cost ratio
Rice-Rice	602	12,329	19,625	7,296	0.59
Rice-Sunflower	505	10,375	21,808	11,433	1.10
Rice-Sesamum	515	10,422	22,881	12,459	1.20
Rice-Mustard	570	10,135	22,605	12,470	1.23
Rice-Bengalgram	470	9,131	14,889	5,758	0.63
Rice-Maize	515	9,356	17,328	7,972	0.85
Rice-Wheat	505	9,624	19,907	10,286	1.07

The field studies conducted in the Orissa State (1990) revealed that growing two rice crops in *kharif* and *rabi* seasons are not profitable to the farmers. However, if groundnut is grown during the *rabi* season, the productivity and income per unit of water is increased ten times (Table 4). In addition, producing groundnut in irrigated commands had a favorable effect on the succeeding rice crop. Groundnut cultivation adds nitrogen to the soil and helps break down toxic products through the aerated soil structure. An upland crop also breaks the cycle of certain insect pests and diseases of rice. Thus, appropriate upland crops in place of *rabi* rice actually benefit overall rice production.

Table 4. Comparison of water use and income for rice and groundnut.

Crop	Irrigation application	Water supplied (cm)	Yield (t/ha)	Yield/unit of water (kg/m^3)	Income/m^3 of water (Rs/m^3)
Rice	20 mm/day x 100 days	200	5.0	0.25	0.45
Groundnut	10 cm x 3	30	2.0	0.67	5.33
	10 cm x 4	40	2.0	0.50	4.00
	10 cm x 6	60	2.0	0.33	2.67

In the Tamil Nadu State, the productivity per unit of water was worked out for rice in various districts. Rice productivity varies from 0.076 kg/m^3 to 0.304 kg/m^3 of water (Table 5).

Table 5. Rice productivity per unit of water in various districts of the Tamil Nadu State.

District	Rice yield (kg/ha) (mm)	Water requirement	Productivity kg/m^3 of water
Chengalpet	2,902	1,434	0.202
South Arcot	3,538	1,207	0.293
North Arcot	2,641	1,287	0.205
Dharmapuri	2,926	1,252	0.234
Salem	3,260	1,367	0.238
Coimbatore	3,735	1,258	0.298
Periyar	3,820	1,258	0.304
Trichy	3,820	1,228	0.248
Pudokottai	2,080	1,279	0.162
Thanjavur	2,737	1,119	0.245
Madurai	2,800	1,358	0.276
Dindigul	3,752	1,358	0.206
Ramnad	842	1,097	0.076
Kamarajar	2,090	1,097	0.143
Pasumpon	1,569	1,097	0.143
Tirunelveli	2,575	1,330	0.194
V.O.C.	2,824	1,330	0.212
Kanyakumari	1,912	1,090	0.175

The variation is due to climatic factors like the distribution of rainfall, cloudy weather prevailing during crop growth and the availability of irrigation water. The productivity per unit of water is very high for sugarcane, banana and other crops compared with rice (Table 6). In order to utilize the available water more efficiently, it is advisable to diversify the crops in rice based systems. In the case of rice, it can be concentrated in regions where productivity is high.

Table 6. Productivity of crops per unit of water; the Tamil Nadu State.

Crop	Yield (kg/ha) (mm)	Water requirement	Productivity kg/m^3 of water
Rice	3,162	1,250	0.253
Sorghum	1,801	500	0.360
Pearl millet	2,083	450	0.463
Finger millet	2,743	500	0.549
Maize	1,858	600	0.310
Sugarcane	110,100	1,800	6.100
Banana	37,656	1,800	2.092
Cotton (lint)	469	650	0.072
Groundnut	1,722	450	0.383
Gingelly	491	250	0.196
Tobacco	1,390	600	0.232
Sunflower	1,041	400	0.260
Chili	481	650	0.074
Onion	11,062	400	2.766

Pilot-Testing and Demonstration

The All India Coordinated Research Project on Water Management is conducting research on several aspects of water management throughout the country. The salient findings of the research project are passed on to the irrigation and agriculture departments for adoption. Pilot-testing of these research findings is now being conducted in the irrigated command on a compact area of 250-300 ha to serve as demonstrations for farmers. In addition, the Indian Council for Agricultural Research has established National Demonstration Centers in each state run by the agricultural universities. The objective of these centers is to demonstrate the improved production techniques in farmers' fields. The varieties of new crops and their performance are also demonstrated for farmers in these centers.

Training

In many countries, training programs have become an integral part of irrigation development. Programs which aim at improved management and operations may be important tools for development.

Governments, donor agencies and project implementation agencies now recognize the importance of training. As a result, training courses and materials are being generated worldwide. Crop diversification has been included as one of the courses in training schedules. The training programs are conducted in an inter-disciplinary form and the trainees are drawn from the departments of Irrigation, Agriculture and the Command Area Development Authority. The trainers who have been trained abroad or locally, are also drawn from the various departments. In India, eleven states have Water and Land Management Training Institutes with financial

assistance from USAID and the World Bank. Apart from the training of personnel engaged in irrigated agriculture, the farmers are also educated and trained on improved water management. There is also a proposal to set up a National Irrigation Management Institute as an apex body at the central level, to coordinate the activities of the state level institutes in order to meet the growing needs for trained personnel in the water resources sector.

Support Services

To implement crop diversification in rice-based systems, support services are necessary. The government of India has launched a Special Foodgrains Production Program for the year 1989-90 with the focus on crops like rice, wheat, maize and pulses. The program has been implemented in 169 districts in 14 states. Areas with good irrigation have been selected and the possibility of increasing productivity through increased use of fertilizer has been explored. This program had a significant effect on the food grains production in the country.

The sugar industry, particularly in South India, is thriving very well due to the support given to the farmers in all aspects of its cultivation. The government of India has special programs for increasing the production of oilseed, cotton and pulses. Sunflower and soybean cultivation receives special support from private and public sector industries for increasing oilseed production.

PROBLEMS IN PROMOTING CROP DIVERSIFICATION PROGRAMS

Information on Crop Diversification Technologies

Information on upland crops to be grown in irrigated commands is limited. Each irrigation command has advantages and disadvantages for growing upland crops. Field studies are lacking to determine suitable crops, irrigation intervals and drainage needs for each system. Such information is required well ahead before introducing nonrice crops in a rice-based system. Introduction of new crops into the irrigated command requires production techniques which are mainly dependent on climate, soil and other environmental factors. The influence of these factors is inadequately studied, and modified techniques to address these factors are not available yet. Therefore new and more appropriate irrigation management practices are needed.

Support Services

For most upland crops, support services from the government and other agencies are not available. Some upland crops are more remunerative to the farmer than rice, provided there exists a satisfactory market for the crop and farmers can produce it efficiently. Frequently, these assumptions are not met, and initial efforts to produce upland crops are not satisfactory.

Socioeconomic Incentives

The production risk for nonrice crops is one important consideration in crop diversification. From the farmers' perspective, the risk could be due to water scarcity, excess water, pests and diseases, market problems, labor shortage, etc. The factors associated with risk, however, vary from year to year, and from location to location in an unpredictable manner. Farmers should be given incentives in all aspects of producing nonrice crops. Subsidies for major inputs like seed, fertilizer and pesticides may be given in addition to the support price for the produce.

APPROPRIATE STRATEGIES TO PROMOTE CROP DIVERSIFICATION

Research-Extension Linkage

The existing research as well as extension strategies concentrate only on the package of technologies of individual crops and their cropping systems. As such, not much emphasis is given to the transfer of irrigation management and crop diversification-oriented technologies. The problems or limitations could be grouped as follows:

1. ***Research***
    i) Lack of suitable technologies on crop diversification in a rice-based cropping system.
    ii) Non-availability of research information for evaluating the benefit-cost ratio of available cropping systems in relation to irrigation availability and irrigation requirement.
2. ***Extension***
    i) Lack of strategies for the transfer of appropriate crop diversification technologies in rice-based cropping systems.
    ii) Lack of emphasis on the adoption of appropriate irrigation management technologies.
    iii) Lack of an integrated approach in crop production planning, giving due importance to the irrigation requirements and irrigation management.

STRATEGIES TO PROMOTE CROP DIVERSIFICATION

The following are suggested strategies for promoting crop diversification in rice-based cropping systems.

a) Research on identifying and analyzing the present status of a rice-based cropping system.
b) Research on the implications of crop diversification on the socioeconomic environment of the rice-based cropping system.
c) On-farm testing of new technologies on crop diversification at different selected locations.
d) National-level demonstrations of research results at different zones and centers.
e) Organizing national- and state-level workshops and seminars on crop diversification packages with the extension personnel and research scientists.
f) Developing an integrated crop diversification program and implementing it in different states.
g) Conducting training programs for extension personnel on the appropriate location-specific crop diversification technologies.
h) Training of farmers and conducting awareness campaigns.
i) Exploiting the mass media like the All-India Radio, the television and the press for the transfer of technologies.
j) Involving Water Users' Associations or irrigation societies or any farmers' organizations in the process.
k) Frequent interaction and discussion meetings between research and extension personnel.
l) Creation and provision of market support to the farmers for their produce.

Appropriate Incentives

Farmers are hesitant to diversify in a rice-based system unless it is proven beyond doubt that the benefit derived from a nonrice crop is high and less risky. In South India, the sugar industry provides incentives to the farmers by way of inputs like good seed material, plant protection measures, and high prices being offered for the cane. The industry arranges credit facilities for the farmers from banks. Cash incentives are given for transport of cane from the field to the factory. A farmer who raises two crops of rice in one acre (2.47 ha) is able to get Rs 4,000/annum, and from a banana crop Rs 18,000/annum, from the same land. Production incentives for farmers will motivate them to diversify in the initial stages. Once the nonrice crop is stabilized, the incentives can be withdrawn.

CONCLUSIONS AND RECOMMENDATIONS

There are good reasons for crop diversification with upland crops in a rice-based irrigation command. To promote crop diversification, certain pre-conditions as requirements for success are identified. These include a reasonable market for the crop so that it can be produced at a profitable level at least equal to that of rice. This, in turn, assumes agricultural extension advice through training, visits and similar projects for farmers to learn appropriate production techniques. It is also

assumed that the effort to produce an upland crop would only be undertaken during seasons when conditions are most favorable.

The key aspects that must be planned are the crops to be grown, intervals between irrigations, duration of irrigations, and all aspects of farm production and marketing. The staff from the Agriculture Department should have an important role in these matters. But the Irrigation Department and Command Area Development Authority (CADA) staff also need to be consulted to be sure that the plans are workable. For this reason, it is important to establish a coordinating committee composed of appropriate staff from these agencies and possibly from the local agricultural universities. This committee should do advance planning, discuss the plans with selected farmers, and take any other steps necessary for the success of crop diversification. Each member of the committee would see to it that this agency acts as called for in the plan. To resolve possible matters of policy, it is also advisable that the committee relate to a higher body such as a state-level committee chaired by an appropriate secretary. Finally it is up to the concerned government officers to formulate the plan, discuss it with farmers, and then carry it out with as much discipline and commitment as possible. In this, the National Irrigation Management Institute, which is going to be set up will coordinate the activities of the state-level committee to promote crop diversification.

In cooperation with international agencies and other countries, the technical aspects of irrigation management for crop diversification can be shared. International agencies like IIMI, IRRI, etc. , may assist those countries which need technical and financial help in implementing the crop diversification program in rice-based systems.

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Irrigation Development and Management Strategies to Support Rice-Based Crop Diversification in Indonesia

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INTRODUCTION

FOR THE LAST two decades, the Indonesian economy has been characterized by progressive structural changes and growth of the agricultural sector. One of the important sources of growth is rice production. A very remarkable progress has been achieved partly due to government policies involving investment in irrigation, research and extension programs in new technologies, and favorable input and output pricing policies.

The importance of irrigation development in the whole context of agricultural development is reflected in the increasing share of irrigation investment in the total government expenditure for the agricultural sector. During the third and fourth "five-year development" (*pelita*) periods, the government invested 43.1 percent and 49.1 percent, respectively, of the government budget in the agricultural sector. This high share of expenditure indicates the importance of rice in agricultural production. The impact of rice self-sufficiency is quite substantial, particularly in terms of labor absorption.

There are at least two challenges in the future development of irrigated agriculture: a) the need for new resources for agricultural growth to meet the increasing demand for food, and b) the sustainability of agricultural development. In the second long-term development plan of Indonesia, the agricultural sector is not simply a producer of raw materials, but also a complex contributor to achieving a number of desired outcomes. As a consequence of increased income,

the demand for food will increase and shift toward greater consumption of protein and vitamins which require food crop diversification. Likewise, the various activities in producing food commodities in irrigated areas are continually expected to provide a significant share of labor absorption. The increasing need for sustainable development requires greater intersectoral linkages and greater participation of rural communities in various development processes.

The investment that has been made along with other policies such as research and extension of new technologies and inputs, and favorable input and output pricing policies, have undoubtedly contributed to an improved food situation, although the performance of many irrigation systems from both production and other economic perspectives have fallen short of expectation. As the expenditure per hectare of new investment increases and problems related to the performance of irrigation systems become more apparent, there is a growing need to improve investment and management strategies in supporting greater interest in food crop diversification in irrigated areas.

This paper provides a sense of the complexity of the issues and of the efforts being made to address them.

IRRIGATION INVESTMENT POLICIES

Since the colonial period, the development of irrigation systems has been designed to serve three major commodities: rice, sugar cane, and secondary food crops. In the later stage of development, greater emphasis has been given to the sustainable growth of rice production. As a consequence of the effort to achieve rice self-sufficiency, resource endowments were based toward rice.

In the last few years, however, there has been a considerable slowdown in the rate if growth of rice yield from over 5 percent in the early 1980s to below 2 percent in the late 1980s. There are several reasons for this declining trend. First is the reduction of the area in Java for intensified production which cannot be directly compensated by a corresponding area increase outside Java. Second, is the declining rates of input use.

PERFORMANCE OF IRRIGATION INVESTMENT

Four programs have been implemented since the first Five-Year Development Plan in 1969: a) rehabilitation of the existing irrigation systems, b) river training and flood control, c) development of new irrigated land, d) reclamation of tidal swamp ares. Table 1 shows that, except in the tidal swamp reclamation program, government expenditures per hectare increased substantially in the other programs. The annual expenditure for rehablitation, however, increased faster than that for new irrigation development. For example, annual expenditure per hectare for rehabilitation in the first Five-Year Development Plan was about 39 percent of that of new irrigation development. In the Fourth Five-Year Development plan, this increased to 74 percent. Additional new components in the rehabilitation program and a low maintenance cost are possible reasons for the faster rate of increase.

Over a two decade period, the government expenditure per hectare for the reclamation of tidal areas increased by only 11 percent in real terms. This implies that there are still plenty of tidal

swamp areas available for extensive reclamation at a relatively low development cost. Efforts to protect agriculture and irrigation systems form external disturbances, as reflected by the annual expenditure on river training and flood control, become very costly due to the construction of large reservoirs in several river basins.

During the fourth FYDP (1984-89), 24 percent and 29 percent of the total government expenditure for the water resources subsector were allocated for rehabilitation, and river training and flood control programs, respectively. About 42 percent of the total expenditure was allocated for new irrgation development, and only 5 percent for tidal swamp reclamation. Even though the biggest portion of the government expenditure was allocated for new irrgation development, the performance of this program in terms of additional area irrigated has fallen short of expectation.

The food crop productivity of the new irrigated area is generally low. Most of the irrigation systems are in the early stage of development with relatively low irrigation efficiency. At this stage, production activities and suitable technologies that are available are limited. This situation is also true for the tidal swamps development program, although the experimental station results indicate quite a promising yield potential with proper soil water management.

Table 1 Average government expenditure for irrigation subsctor by type of development (US$), fixed price 1989.

Plan period	New construction	Tidal/ swamp	Irrigation rehabilitation	Flood control	Total of subsector
Pelita I	343	479	132	59	183
	(259)	(363)	(100)	(44)	(138)
Pelita II	976	479	450	580	606
	(739)	(363)	(340)	(439)	(459)
Pelita III	1,345	206	1,144	703	831
	(1,019)	(156)	(866)	(533)	(629)
Pelita IV	2,731	535	2,027	1,443	1,766
	(2,069)	(405)	(1,536)	(1,093)	(1,338)

Note: Value within brackets is the expenditure index relative to Pelita I rehabilitation expenditure (Pelita I = 100). Rate of conversion: US$1 = Rs 1,790.

Source: Central Bureau of Statistics.

While the major food crop production areas in Java and Sumatra have benefitted from irrigation development, the drier area in the eastern part of Indonesia where the scope for gravity irrigation is quite limited has not received its share of irrigation investment. Consequently, farm incomes in this part are significantly lower than those in the more intensely irrigated areas in Java and other parts of western Indonesia. An increased concern with eliminating poverty and reducing income gaps, combined with the recognition of the potential for rapid agricultural development through

groundwater development for irrigation, has encouraged the government and donors to pursue programs to develop increased irrigation supplies through the introduction of pumps.

In general, where the government has taken the lead, the investment has involved large subsidies in capital and, in many cases, in operation and maintenance costs. In contrast, private investments by farmers have not involved any subsidies. This is also true for small-scale, run-of-the-river diversion systems developed by local communities.

There have been government interventions, however, both directly and indirectly, in farmer-managed irrigation systems. Direct interventions occurred when the government rehabilitated farmer- managed irrigation systems and then took over their administration through the public irrigation agency. In recent years, however, there has been increasing concern to turn over small-scale irrigation systems of less than 500 ha to the water users' associations.

Indirect government interventions were made when the village communities utilized the subsidies given by the central government to rehabilitate or upgrade their own irrigation systems without reducing financial and managerial autonomy. The village subsidy program is an example of the regional financing mechanism which has been used to induce small-scale irrigation system improvement and development. In 1979, a study of Indonesia's village subsidy program calculated investment inducement coefficients of 4.4 and 5.4 for two village irrigation systems based on the ratio of total investment to government subsidy (Hafid and Hayami). This study indicates that, of the locally mobilized resources, 64.8 percent and 74.7 percent were communal labor. In a 1985 study of data from 107 villages in Sukabumi, West Java, by Wirawan et al., it was found that the inducement coefficients varied from 1.8 to 2.2 between 1979 to 1983 and that mobilization of communal labor varied from 58.4 percent to 70.9 percent.

There has also been a growing concern on the part of NGOs to help farmers in the operation and maintenance of both gravity irrigation and pump irrigation systems, although, usually, there has been some implicit subsidy in the capital investment as well as in the services of the NGO staff.

In the present situation where financing irrigation investment is placing a large and increasing burden on agricultural sector expenditures, more rational investment policies need to be assessed. Food crop diversification in irrigated areas as a means of improving farmers' income has not been given due consideration nor has there been adequate attention given to investment in software development for design and irrigation management. A related issue is the institutional and organizational adjustment needed to link various processes such as design, physical construction, land development, irrigation management, and agricultural production.

MANAGEMENT POLICIES

A reorientation of management policies has been taking place during the past few years. These changes include a gradual turnover of government-managed, small-scale systems of less than 500 ha to water users, assessment of the funding for operation and maintenance, introduction of service fees, and institutional strengthening of both farmers and government support systems. While these policy instruments have to be tested properly prior to widespread implementation, they are conducive to promoting food crop diversification in irrigated areas.

Turning over of government systems to the local community will integrate the water allocation function of irrigation systems into community activities. By turning over small-scale systems to local water users' associations, the pressure on the government O&M budget is expected to be

reduced and the performance of irrigation systems may be improved by assuming that farmers are financially and organizationally ready to assume ownership and/or management (Vermillion 1991). In addition, increased autonomy in management is expected to induce the farmers to choose irrigated crop mixtures suitable to their own decision-making criteria.

Introduction of irrigation service fees in large-scale government irrigation systems can be used to improve the performance of irrigation systems through a more efficient use of water. Since nonrice crops need much less water than rice, irrigation service fees can also be used as a policy instrument to promote food crop diversification. At present, however, due to limitations in physical facilities and arrangements in water delivery, such a policy is particularly designed to support its financial function, more specifically to meet the cost recovery for O&M. A report of the Ministry of Home Affairs on the Irrigation Service Fee (ISF) Pilot Project indicates that the key issue is to assess when a system is ready for ISF introduction from the standpoint of technical, administrative and socio-political factors. One of the criteria is that cropping arrangements and intensities should have no significant equity problems. Furthermore, as learned from experience, it is best to introduce ISF when special maintenance activities are almost completed, and the system is becoming efficient in operation and maintenance.

One of the policy issues related to institutional strengthening is whether there is a need to provide legal status to the existing water users' associations. This issue is particularly relevant to the implementation of other policies such as those on turnover and irrigation service fees, which are important in supporting food crop diversification in irrigated areas. However, those opposed to the idea of providing legal status to water users' associations argue that the latter's activities are only an integral part of the overall village activities.

Although this issue has not been resolved yet, there is a need to assess the performance of water users' associations in Indonesia in relation to the stage of irrigation development, to provide a stronger basis for the future direction of these associations.

PERFORMANCE OF FOOD CROP DIVERSIFICATION

Diversification can be narrowly defined as broadening the production of commodities other than rice. The expansion of nonrice crop production is expected to create new economic opportunities not only for the farm households but for rural areas as well. Agricultural diversification has been considered as one of the major efforts in implementing agricultural sector development in Indonesia. However, commodity-based programs such as rice intensification has weakened the process of diversification in irrigated areas.

In some irrigation systems in Java, diversified cropping has been practiced for quite some time supported by well-established water management rules and practices. The management tools used and the underlying principles are reported in the Proceedings of the IMCD Research Network of 1988. These include the management constraints to bridging the gap between systems at the early and advanced stages of development (Pasandaran et al. 1989).

There are at least three important constraints to diversified cropping in irrigation systems: a) system design, b) technical information, and c) production technologies. The system design of existing on-farm canals is inflexible and therefore unable to serve the seasonal changes in irrigating nonrice crops. The technical information available is inadequate to operate irrigation systems efficiently, so are the production technologies suitable for specific agro-ecological zones.

Suprodjo and Sunarno (1990) suggested minor improvements to enable irrigation systems to provide better services for nonrice crop cultivation. These include improvement of drainage facilities at the tertiary level, and improvement of data management related to hydro-meteorology and water requirement.

In addition to rice, five major food crops planted in irrigated areas are, corn, cassava, sweet potato, peanut, and soybean. These nonrice crops are generally planted during the dry season. Depending on the availability of water, these crops may be planted right after the rainy season rice crop or following the dry season rice crop. There are five patterns of crop diversification which reflect both the spatial and temporal dimensions of crops as related to water availability. A description of each pattern has been reported by Hutabarat and Pasandaran (1987).

Table 2 shows the harvested area of secondary crops in Indonesia from 1985 to 1989. The overall growth of area harvested was 2.47 percent annually, with an average harvested area of about 6.4 million ha. The rate of growth in areas outside Java is 5.5 percent with only 0.67 percent in Java. Of the total area planted to secondary crops, the share of the secondary crops planted in the wetland area is only 21.7 percent. In the last four years, outside Java, there has been a faster rate of growth of secondary crops planted in irrigated and wet land areas than in the dry land. In Java, however, there has been a negative rate of growth of secondary crops planted in irrigated areas, and only a slight increase in the area planted to secondary crops in the dry land.

The reduction of area planted to secondary crops in the irrigated area of Java was due to the reduction in the area for maize, with a reduction rate of about two percent annually (Table 3). There was also a reduction in the area for this crop outside Java at a rate of more than three percent a year (Table 4).

There has been a significant increase of the area planted to soybean particularly outside Java (more than 10 percent a year), both in dry and wet land areas. A special effort has been made by the government to promote the production of soybean in the last few years to reduce importation.

There has been a shift in the concentration of secondary crops from Java to other areas, with the irrigated and wet land areas marking the highest rate of shift (Table 5). This tendency is also true for rice where the harvested area increased by a rate of more than two percent a year outside Java (Table 6). Despite a significant increase in the area planted to secondary crops in other areas of the country, the share of Java is still more than 60 percent of the total area of secondary crops in Indonesia.

Table 2. Area of secondary crops in Java, 1985-89 ('000 ha).

Year	Maize	Cassava	Potato	Peanut	Soybean	Total
Dry land						
1985	1,404	767	59	246	239	2,714
	(51.7)	(28.3)	(2.2)	(9.1)	(8.8)	(100)
1986	1,366	743	54	259	339	2,762
	(49.5)	(26.9)	(2.0)	(9.4)	(12.3)	(100)
1987	1,413	472	48	233	281	2,448
	(57.7)	(19.3)	(2.0)	(9.5)	(11.5)	(100)
1988	1,502	809	59	241	295	2,906
	(51.7)	(27.9)	(2.0)	(8.3)	(10.1)	(100)
1989	1,442	770	53	276	296	2,836
	(50.8)	(27.1)	(1.9)	(9.7)	(10.4)	(100)
Average	1,425	712	55	251	290	2,733
	(52.1)	(26.1)	(2.0)	(9.2)	(10.6)	(100)
Growth (%)	0.67	0.10	-2.79	2.87	5.34	1.10
Wet land						
1985	542	26	40	124	379	1,110
	(48.8)	(2.3)	(3.6)	(11.1)	(34.1)	(100)
1986	553	27	42	133	407	1,162
	(47.6)	(2.3)	(3.6)	(11.4)	(35.0)	(100)
1987	322	25	39	119	281	786
	(41.0)	(3.2)	(35.0)	(15.1)	(35.7)	(100)
1988	615	14	46	117	371	1,163
	(52.8)	(1.2)	(4.0)	(10.1)	(31.9)	(100)
1989	499	30	40	130	393	1,092
	(45.7)	(2.7)	(3.7)	(11.9)	(36.0)	(100)
Average	506	24	42	125	366	1,063
	(47.6)	(2.3)	(3.9)	(11.7)	(34.5)	(100)
Growth (%)	-2.09	3.97	-0.09	1.28	0.94	-0.41

Note: The percentage of the total is given within brackets.

Source: Central Bureau of Statistics.

Table 3. Area of secondary crops outside Java, 1985-89 ('000 ha).

Year	Maize	Cassava	Sweet Potato	Peanut	Soybean	Total
Dry land						
1985	878	456	145	127	233	1,840
	(47.7)	(24.8)	(7.9)	(6.9)	(12.7)	(100)
1986	1,062	385	135	147	293	2,023
	(52.5)	(19.0)	(6.7)	(7.3)	(14.5)	(100)
1987	999	448	125	161	369	2,103
	(47.5)	(21.3)	(6.0)	(7.7)	(17.6)	(100)
1988	1,142	507	118	164	375	2,307
	(49.5)	(22.0)	(5.1)	(7.1)	(16.2)	(100)
1989	1,055	566	123	158	371	2,272
	(46.4)	(24.9)	(5.4)	(7.0)	(16.3)	(100)
Average	1,027	473	129	152	328	2,109
	(48.7)	(22.4)	(6.1)	(7.2)	(15.6)	(100)
Growth (%)	4.58	5.43	-4.24	5.46	11.58	5.28
Wet land						
1985	68	6	14	46	81	216
	(31.7)	(2.6)	(6.6)	(21.4)	(37.7)	(100)
1986	81	9	19	60	127	296
	(27.3)	(3.0)	(6.4)	(20.4)	(42.9)	(100)
1987	67	11	13	48	118	257
	(26.3)	(4.2)	(4.9)	(18.7)	(45.9)	(100)
1988	90	17	32	71	146	356
	(25.2)	(4.7)	(9.1)	(20.0)	(41.1)	(100)
1989	59	10	19	541	46	288
	(20.6)	(3.3)	(6.7)	(18.6)	(50.7)	(100)
Average	73	10	19	56	124	282
	(5.9)	(3.7)	(6.9)	(19.8)	(43.8)	(100)
Growth (%)	-3.52	13.77	7.70	3.77	14.71	7.27

Note: The percentage of the total is given within brackets.

Source: Central Bureau of Statistics.

Table 4. Area of secondary crops in and outside Java, 1985-89.

	Dry land ('000 ha)	(%)	Wet land ('000 ha)	(%)	Total ('000 ha)	(%)
Java						
1985	2,714	71.0	1,110	29.0	3,824	100.00
1986	2,762	70.4	1,162	29.6	3,924	100.00
1987	2,448	75.7	786	24.3	3,234	100.00
1988	2,906	71.4	1,163	28.6	4,069	100.00
1989	2,836	72.2	1,092	27.8	3,928	100.00
Average	2,733	72.0	1,063	28.0	3,796	100.00
Growth (%)	1.10		-0.41		0.67	
Outside Java						
1985	1,840	89.5	216	10.5	2,055	100.00
1986	2,023	87.2	296	12.8	2,318	100.00
1987	2,103	89.1	257	10.9	2,359	100.00
1988	2,307	86.6	356	13.4	2,662	100.00
1989	2,272	88.7	288	11.3	2,561	100.00
Average	2,109	88.2	282	11.8	2,391	100.00
Growth (%)	5.28		7.27		5.50	
Indonesia						
1985	4,553	77.5	1,326	22.5	5,879	100.00
1986	4,784	76.6	1,458	23.4	6,243	100.00
1987	4,551	81.4	1,042	18.6	5,593	100.00
1988	5,213	77.4	1,519	22.6	6,732	100.00
1989	5,108	78.7	1,380	21.3	6,489	100.00
Average	4,842	78.3	1,345	21.7	6,187	100.00
Growth (%)	2.87		1.01		2.47	

Source: Central Bureau of Statistics.

Table 5. Share in the total area of secondary crops harvested in and outside Java, 1985-89.

	Java ('000 ha)	(%)	Outside Java ('000 ha)	(%)	Indonesia ('000 ha)	(%)
Dry land						
1985	2,714	59.6	1,840	40.4	4,553	100.00
1986	2,762	57.7	2,023	42.3	4,784	100.00
1987	2,448	53.8	2,103	46.2	4,551	100.00
1988	2,906	55.8	2,307	44.2	5,213	100.00
1989	2,836	55.5	2,272	44.5	5,108	100.00
Average	2,733	56.4	2,109	43.6	4,842	100.00
Growth (%)	1.10		5.28		2.87	
Wet land						
1985	1,110	83.7	216	16.3	1,326	100.00
1986	1,162	79.7	296	20.3	1,458	100.00
1987	786	75.4	257	24.6	1,042	100.00
1988	1,163	76.6	356	23.4	1,519	100.00
1989	1,092	79.1	288	20.9	1,380	100.00
Average	1,063	79.0	282	21.0	1,345	100.00
Growth (%)	-0.41		7.27		1.01	
Indonesia						
1985	3,824	65.0	2,055	35.0	5,879	100.00
1986	3,924	62.9	2,318	37.1	6,243	100.00
1987	3,234	57.8	2,359	42.2	5,593	100.00
1988	4,069	60.5	2,662	39.5	6,732	100.00
1989	3,928	60.5	2,561	39.5	6,489	100.00
Average	3,796	61.4	2,391	38.6	6,187	100.00
Growth (%)	0.67		5.50		2.47	

Source: Central Bureau of Statistics.

Table 6. Harvested wet-land area of rice and yield of rice, 1969-87.

Year	Wet-land area ('000 ha)			Yield (mt/ha)		
	Java	Outside Java	Total	Java	Outside Java	Total
1969	3,933	2,611	6,544	2.57	1.88	2.25
1970	3,947	2,732	6,679	2.70	2.01	2.38
1971	4,037	2,856	6,893	2.81	1.99	2.42
1972	3,992	2,610	6,602	2.76	2.09	2.45
1973	4,226	2,838	7,064	2.86	2.20	2.56
1974	4,434	2,906	7,340	2.94	2.27	2.64
1975	4,379	2,955	7,334	2.95	2.24	2.63
1976	4,203	3,026	7,229	3.15	2.37	2.78
1977	4,115	3,087	7,202	3.00	2.57	2.79
1978	4,447	3,251	7,698	3.29	2.43	2.89
1979	4,393	3,282	7,675	3.40	2.53	2.99
1980	4,507	3,316	7,823	3.86	2.66	3.29
1981	4,763	3,428	8,191	4.07	2.83	3.49
1982	4,488	3,385	7,873	4.39	3.00	3.74
1983	4,479	3,508	7,987	4.53	3.12	3.85
1984	4,852	3,695	8,547	4.55	3.17	3.91
1985	4,965	3,704	8,669	4.59	3.50	4.08
1986	4,986	3,827	8,813	4.59	3.50	4.08
1987	4,971	3,866	8,837	4.73	3.24	4.04
Growth (%)	1.30	2.18	1.67	3.39	3.02	3.25

Information on the productivity of secondary crops across regions and agro-ecological zones, however, is quite limited. Some case studies indicated that the productivity of secondary crops in irrigated areas is higher than in dryland areas. The productivity of secondary crops in Java, as in the case of rice, is higher than that outside Java (Figures 1, 2, and 3).

The overall cropping intensity of food crops is higher in irrigated lands. Data from Table 7 indicate that only 29 percent of the total irrigated and wet-land area has been planted to secondary crops, and 62 percent to rice.

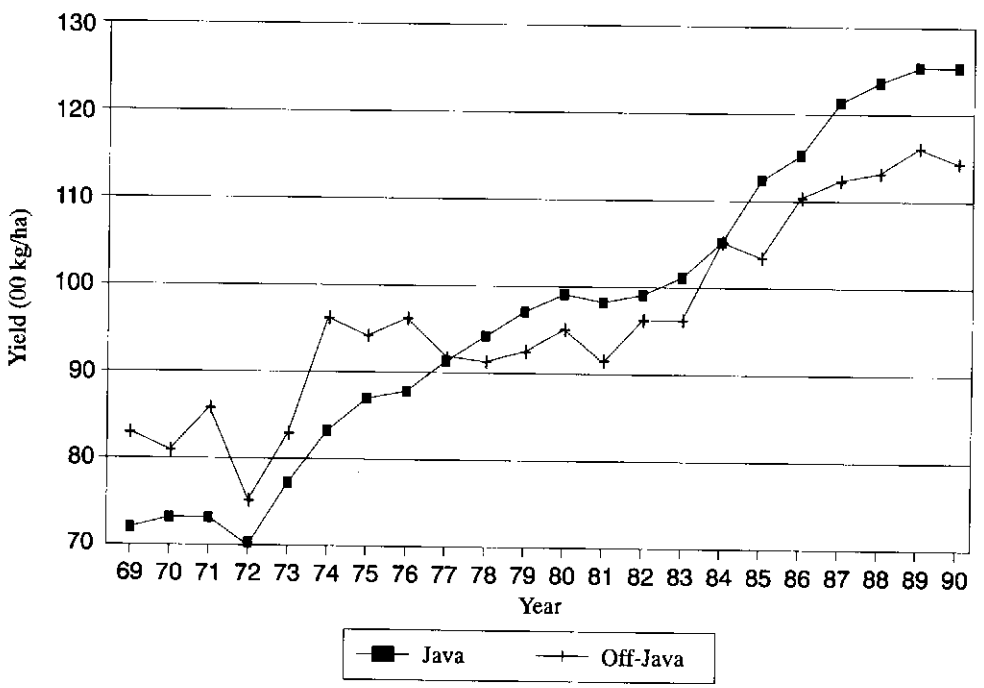
In response to the shift of concentration of secondary food crops in irrigated areas from Java to other areas, there is a need to identify irrigation management variables that have to be manipulated to improve the performance of food crop diversification both in terms of area and productivity. These management variables, however, have to be assessed as an integral part of the food crop diversification process in irrigated areas. Further steps are needed on institutional development of irrigation management in supporting food crop diversification.

Table 7. Gross area, harvested area and cropping intensity by type of land, 1985.

	Gross irrigated area ('000 ha)	Service area ('000 ha)	Rice harvest area ('000 ha)	Secondary crop harvest area ('000 ha)	Cropping intensity		
					Rice	Secondary crops	Total
Irrigated							
Technical	2,237	1,650	2,988	-	1.81	-	-
Semi-technical	1,202	850	1,434	-	1.69	-	-
Simple	974	584	929	-	1.59	-	-
Village	1,036	851	1,353	-	1.59	-	-
Total irrigated	5,449	3,935	6,704	-	1.70	-	-
Rain-fed	673	673	748	-	1.11	-	-
Total wet land	6,122	4,608	7,452	1,326	1.62	0.29	1.90
Tidal/swamp	-	1,167	1,217	-	1.04	-	-
Dry land	-	11,873	1,163	4,553	0.10	0.38	0.48
Total	6,122	17,648	9,832	5,879	0.56	0.33	0.89

Source: Rosegrant and Pasandaran (1990).

Figure 1. Yield of Cassava, 1969-1990.



Source of data: Central Bureau of Statistics.

Figure 2. Yield of Corn, 1969-1990.

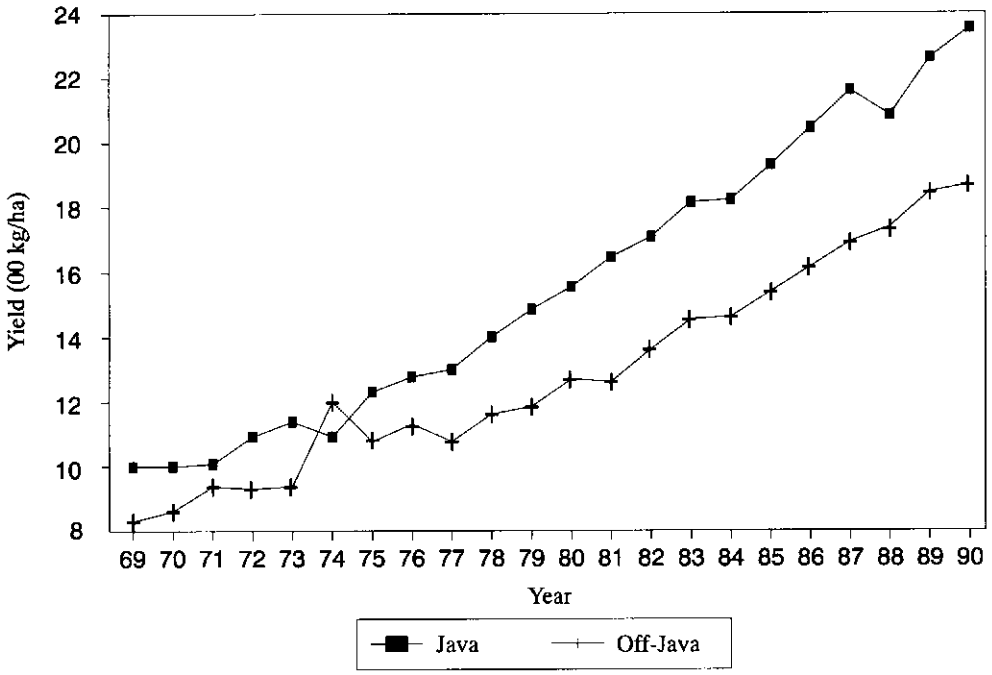
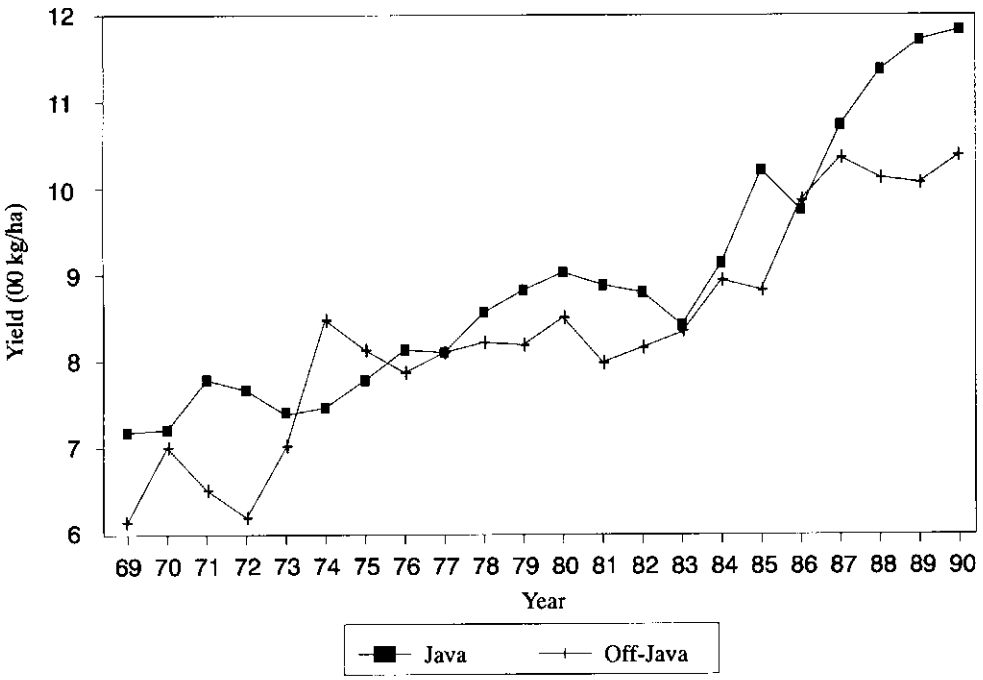


Figure 3. Yield of Soybean, 1969-1990.



Figures 2 and 3; source of data: Central Bureau of Statistics.

CONCLUSIONS

To expedite the process of food crop diversification in irrigated areas in Indonesia requires reorientation of irrigation investment strategies. Greater attention should be given to investment on software development to include improvement of system design, irrigation management and institutional adjustment, to link various activities from design to production.

The reorientation of management policies such as turning over of the small-scale irrigation systems to water users and introduction of irrigation service fees is expected to further induce the process of food crop diversification. Priority should be given to areas outside Java in relaxing various constraints to improve the capacity of irrigation systems and further induce the process of diversification.

There is a need to identify irrigation management variables to respond to the shift of concentration in the area of food crop diversification and the corresponding institutional development of irrigation management.

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Promoting Implementation of Crop Diversification in Rice-Based Irrigation Systems in Malaysia

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INTRODUCTION

CROP DIVERSIFICATION (CD) IN Malaysia will be concentrated on the non-granary areas, which can be classified as either irrigated or rain-fed. To implement this program, the Ministry of Agriculture (MOA) adopted the following measures:

a) Assess the location and extent of the areas involved.
b) Identify the CD potentials of these areas.
c) Monitor and evaluate changes in the rice areas.
d) Increase awareness and knowledge on CD among farmers, project implementors and decision makers.
e) Formulate appropriate implementation plans.

Considering the extensive hectarage of the non-granary areas, it was decided that initial efforts should be focused on the irrigation schemes since basic data are already available and investments have already been made for their development.

This paper outlines Malaysia's efforts to promote the implementation of crop diversification in the non-granary irrigated areas. Programs and activities as well as problems encountered and measures to overcome them are discussed. Although *irrigation management* is the main subject of the Research Network, promoting CD requires deliberations on nontechnical issues which are inter-related. Such issues, where appropriate, are included.

STATUS, PROGRAMS AND ACTIVITIES

In order to fully assess the magnitude of CD activities in the non-granary irrigated areas and subsequently identify their CD potentials, the study, Rationalization and Crop Diversification in the Non-Granary Irrigated Areas, was carried out under a Technical Cooperation Program between the governments of Japan and Malaysia. This 20-month study, completed in October 1990, managed to create an inventory of all the 924 irrigation schemes totalling 130,122 hectares. A computerized information system to monitor land use and changes in each scheme was also developed.

The study has identified 8 different categories of diversified land use. Of relevance to the Research Network are two categories, namely, (i) outright conversion to high-value annuals, and (ii) rice-nonrice rotation. The former has 144 schemes covering an area of 9,930 ha, while the latter has 46 schemes with 4,619 ha.

CD is not new in the country. In 1987, 6 percent of the total irrigated area was already diversified. In this area, appropriate adjustments were made by the farmers and systems operators to suit the cropping patterns (Wong, Shahrin and Mohd Adnan 1990).

Apart from the rationalization exercise, the study carried out feasibility studies in three regions. The procedure applied in the feasibility study can be adapted for similar studies in other areas.

To promote the implementation of CD, a National Seminar on Crop Diversification was held in August 1990. The main objectives of this seminar were to create awareness of the need to diversify, its problems and issues, and to disseminate the results of the crop diversification study to policymakers, program implementors and the private sector.

Following this, briefings were given to the top management of the MOA, senior federal and state government officers and to policymakers in the respective states.

Brochures explaining the background to the study were distributed to relevant departments/ agencies and the public. A physical model representing diversified cropping in a rice irrigation scheme was displayed at various major exhibitions.

On training, the National Water Management Training Center (NWMTC) which was set up primarily for rice irrigation, is currently undertaking a joint project under a Technical Cooperation Program between Japan and Malaysia to develop training modules on irrigation and water management for diversified crops and the setting up of demonstration farms. The training program is expected to be ready by early 1992. The planning and design of a demonstration farm is in progress.

IMPLEMENTATION STRATEGIES AND PROGRAMS

In order to promote and facilitate CD program implementation, a national committee will be formed. This committee, to be chaired by the MOA, also intends to merge the idle Rice Land Rehabilitation Committee and the Fruit Industry Committee. At the project level, an integrated multidisciplinary team will be set up.

To implement the program during the Sixth Malaysia Development Plan (1991-95), a special fund has been created for infrastructure rehabilitation and adjustments. For a start, Ringgit 5 million (US$ 1.7 million) has been allocated.

Initially, the strategy is to implement pilot projects in schemes where feasibility studies have already been carried out. Apart from providing knowledge and experience on the various aspects of a CD project, the pilot farms can also act as nucleus projects which can be expanded in the same locality or replicated elsewhere.

On Research and Development (R&D), the areas identified for implementation under the Sixth Plan include water management techniques, on-farm distribution methods, drainage techniques, soil management, cropping systems, mechanization, and varietal development. Admittedly, the field of irrigation management for crop diversification in rice-based systems (IMCD) is a new experience for both the Malaysian Agriculture Research and Development Institute (MARDI) and the Department of Irrigation and Drainage (DID). As a consequence, the two agencies have forged an understanding to collaborate in IMCD activities, particularly on the monitoring and evaluation of existing systems, and the pilot projects.

As a matter of strategy to improve the sustainability of CD projects, the government encourages the support of group farming rather than individual smallholders. The lead role in organizing the farmers is through the Area Farmers' Association (AFA). The project could then be managed by the AFA as a mini-estate. As an incentive, such projects are eligible to apply for loans under the Special Agricultural Loan Scheme managed by the MOA through the Agriculture Bank. To qualify, the projects must first be approved by the Farmers' Organization Authority (FOA) and then endorsed by the MOA. Infrastructure development will be undertaken by DID and financed by grants from MOA upon project approval. Technical backup services can be provided by MARDI upon request.

Other than the AFAs, the Department of Agriculture (DOA), the National Tobacco Board (NTB), and the Federal Land Consolidation and Rehabilitation Authority (FELCRA) are also involved in organizing farmers and managing projects as mini-estates. Currently, efforts are being undertaken to encourage the private sector to participate in CD projects.

CD activities should be based on a multidisciplinary approach similar to the implementation model of the Integrated Agriculture Development Projects (IADP). The strategy here is to implement nucleus or demonstration projects to serve as models for area development. Infrastructure and land clearing costs are totally provided for in the form of grants. When such projects are initiated by the government for demonstration purposes, funds may even be provided for mechanization services, seeds, fertilizers and chemicals during the initial stages of project operation.

The IADP is a successful model of a multidisciplinary and a total approach to the development and implementation of agriculture projects in Malaysia. It is an integrating/coordinating body for multiple agencies such as DID, MARDI, the Federal Agricultural Marketing Authority (FAMA), DOA and FOA, which are involved in the development process. The District Land Office is also involved in facilitating activities like land acquisition for the establishment of infrastructure.

The DOA conducts extension programs, but MARDI, although a research agency, is also involved through its Technology Promotion arm. Under the IADP, therefore, the linkage between research, extension and clientele is direct. As for projects implemented by the AFAs, technical services can be obtained direct from either MARDI or DOA upon request. Such direct linkages have proven to be effective so far.

FAMA provides the marketing services. However, the strategy employed is to acquire supply contracts before embarking on the enterprise. In the case of a rice-tobacco system, contract farming is well established. The tobacco curers, while fully committed to purchasing the leaves, also extend credit to the farmers.

PROBLEMS IN PROMOTING CD PROGRAMS

The present scale of CD is small and scattered such that the impact on irrigation system management is minimal (Wong, Shahrin and Mohd Adnan 1990). However, recent development suggests concerted, large-scale CD activities, beginning with pilot farms, on contiguous areas within irrigation service or command areas. Therefore it is recognized that there are complexities in system planning, design, implementation and operation. Appropriate design standards and criteria, and operational and management techniques are factors of utmost concern.

Production technology is also a matter of concern, particularly the management of heavy clay soils for rice cultivation, water management techniques (requirement, conservation, application, removal), and varietal development and mechanization. Fortunately, a lot of information and experience in these fields are available within this region. It will therefore be a matter of reviewing and selecting potentially suitable technologies for direct adoption or modifications.

The Malaysian agriculture sector is suffering from a labor shortage problem. As it stands, rice production has, through contract mechanization services and direct seeding, successfully reduced labor dependence to about 55 mandays/ha (Anon. 1990). Annual crops on the other hand are very labor-dependent. For example, cabbage, chili and asparagus would require 180, 326 and 5,750 manday/ha, respectively (Anon. 1990). This situation would demand that mechanization be a prerequisite to successful CD. The institutionalization of the concept of mechanized production in CD activities and cultural practices will be a serious challenge.

CD would require intensification of on-farm water management. The cost of a rice-vegetable system has been computed to be around M$9,300/ha (US$3,320/ha) (Anon. 1990). This development cost will be borne by the government. However, the production cost will have to be covered through bank loans. In order for the project to begin, applications for both financial provisions must be successfully completed, which sometimes may not be the case.

Rice is a traditional crop with a guaranteed market and a heavy subsidy. Moreover, the rice farmers are not familiar with annual crops, thus giving rise to apprehension or skepticism that is compounded by the uncertain market and the lack of subsidies. Resistance to CD is therefore anticipated, at least initially.

CONCLUSIONS AND RECOMMENDATIONS

Malaysia is ready for a full-scale implementation of CD. The development models will be based on, if not similar to, the existing approaches such as those for the idle rice land rehabilitation and fruit industry development models which have proven to be effective so far.

Malaysia lacks experience in IMCD technology. Expert services from IIMI would be appreciated in defining suitable methodologies for monitoring and evaluating existing systems as a basis for developing design criteria and standards. IIMI's cooperation is also useful in pilot projects from the design to the implementation stages with the focus on technology development and assessment.

Production technologies such as those for soil management and mechanization are already available, although local verification is still needed. Similarly, policy matters seem to be on a sound foundation. Nevertheless, a forum such as this workshop can effectively facilitate the introduction of new inputs and new perspectives through the sharing of experiences. This forum and the IMCD network must be sustained.

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Promoting Implementation of Crop Diversification in Rice-Based Irrigation Systems in Nepal

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INTRODUCTION

FARMING WILL REMAIN as the main economic activity in the foreseeable future in Nepal. At present 93 percent of the population is engaged in agriculture, producing 67 percent of the Gross Domestic Product (GDP) and 80 percent of export earnings. The agricultural resource base is severely limited by the physiographic features of the country, especially in the hills, where, despite the population pressure, only 14 percent of the physical area is under cultivation. The man-land ratio is very high and the agricultural practices are greatly influenced by the diversified agro-ecology and complex farming systems (Figure 1).

The bulk of the agricultural production is made up of food grains, which contribute 60 percent of the agricultural GDP. Rice, maize, and wheat together contribute 96 percent of the cereal production in the country. The contribution of livestock to the agricultural GDP and the overall GDP are 25 percent and 15 percent, respectively.

IRRIGATION AND IRRIGATION MANAGEMENT

Nepal is endowed with enormous potential for water resources development including irrigation. There are three major river systems (Koshi, Gandaki and Karnali) and numerous tributaries from

the Himalaya, the Mahabharat and the Siwalik foothills (Figure 2). Nepal could be considered as one of the richest countries in "hydro-dollars" if its vast potential of water resources could be harnessed to the fullest extent. There could be several multipurpose hydro projects in the country to provide power and irrigation. However, there is no such project at present. Discharge of major rivers is computed to be 150 billion m^3 per year which is enough to irrigate about 8-10 million hectares.

Out of Nepal's total cultivated area of 2.653 million ha, 1.375 million ha is in the Terai and 1.278 million ha in the hills. Of this total cultivated area, 1.766 million ha is estimated to be potentially irrigable, although the total irrigated area at present is less than 1 million ha. An inventory of some potential irrigation projects with command areas of more than 3,000 ha is shown in Table 1.

The irrigation systems are managed either by the irrigation agency, by agency-assisted farmers or by the farmers themselves.

The Department of Irrigation with five Regional Irrigation Directorates and seventy-five District irrigation Offices and semi-government and nongovernment organizations are presently involved in irrigation management. The farmers themselves have likewise been very deeply involved in the construction, operation, maintenance and management of irrigation systems. Farmer-managed irrigation systems (FMIS) cover about 70 percent of the total irrigated area in Nepal (Table 2).

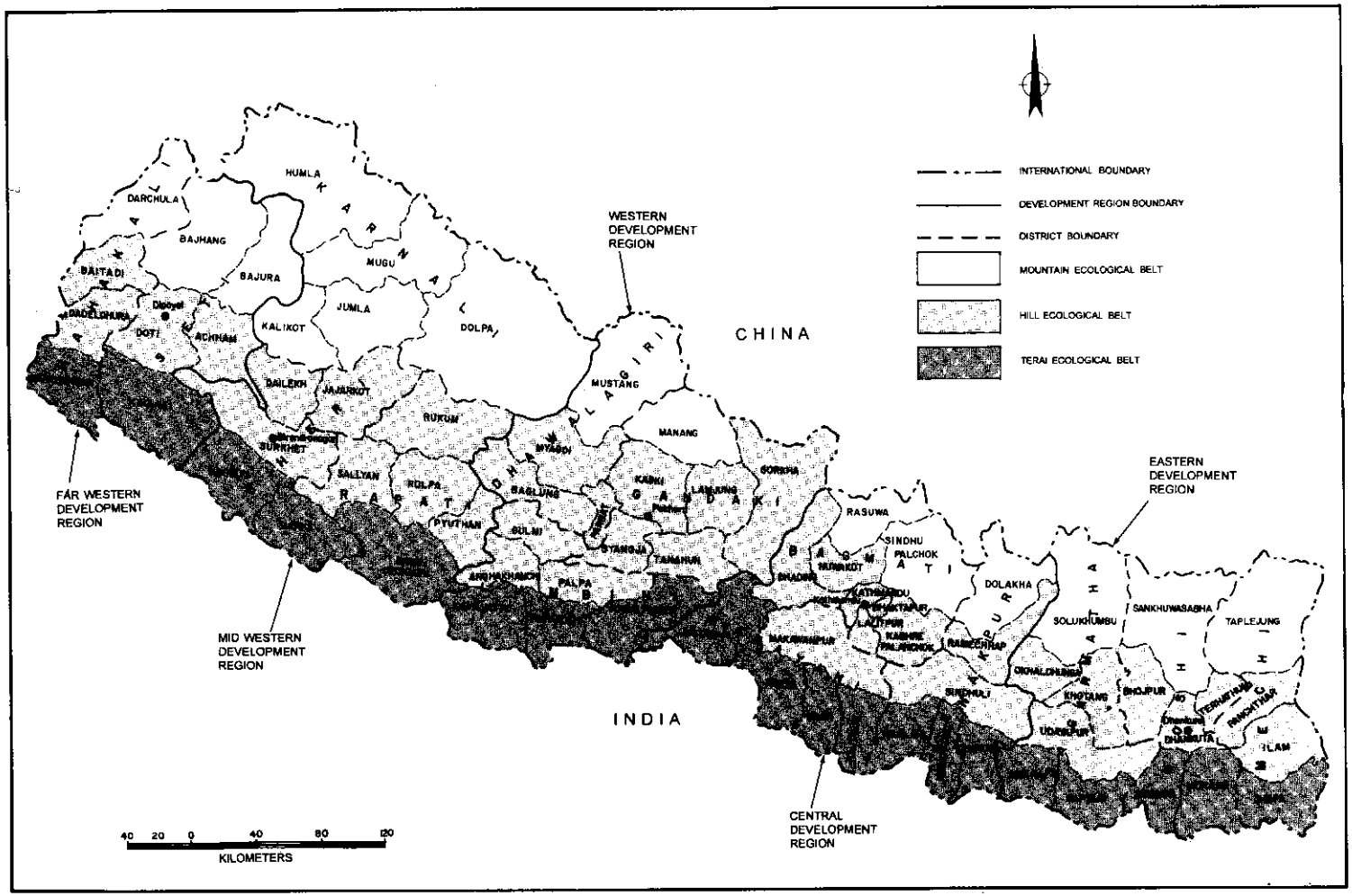
About 50 percent of the irrigated area could be provided with year-round irrigation. This area has complete control over the water supply, and the winter and spring crops are grown with a full (on-demand) supply of irrigation water. The other 50 percent has an adequate water supply only during the monsoon season and the winter crops are grown under partial irrigation or rain-fed conditions.

Problems encountered in the development and management of irrigation systems in Nepal are related to economic, technical and social (institutional) aspects. In all these aspects, Nepal's position is not very strong. As regards economic problems, internal resources are not enough to develop and maintain larger systems and the management, allocation and mobilization of these resources are difficult. Inadequate manpower, weak water user groups (WUGs), ineffective water allocation and water right fixation, and lack of coordination and cooperation among the different agencies for a unified approach to develop and manage a system are some of the main technical and institutional problems.

IRRIGATED RICE-BASED FARMING SYSTEMS AND CROP DIVERSIFICATION

In Nepal, all the areas that have been irrigated are basically rice-based. Many of the irrigation projects (large and medium) so far constructed are usually meant to supplement irrigation for the main season rice crop during the monsoon. Thus, farming, although varying from one agro-ecological zone to another, is mainly rice-based.

Figure 1. Physiographic and agri-ecological divisions of Nepal.



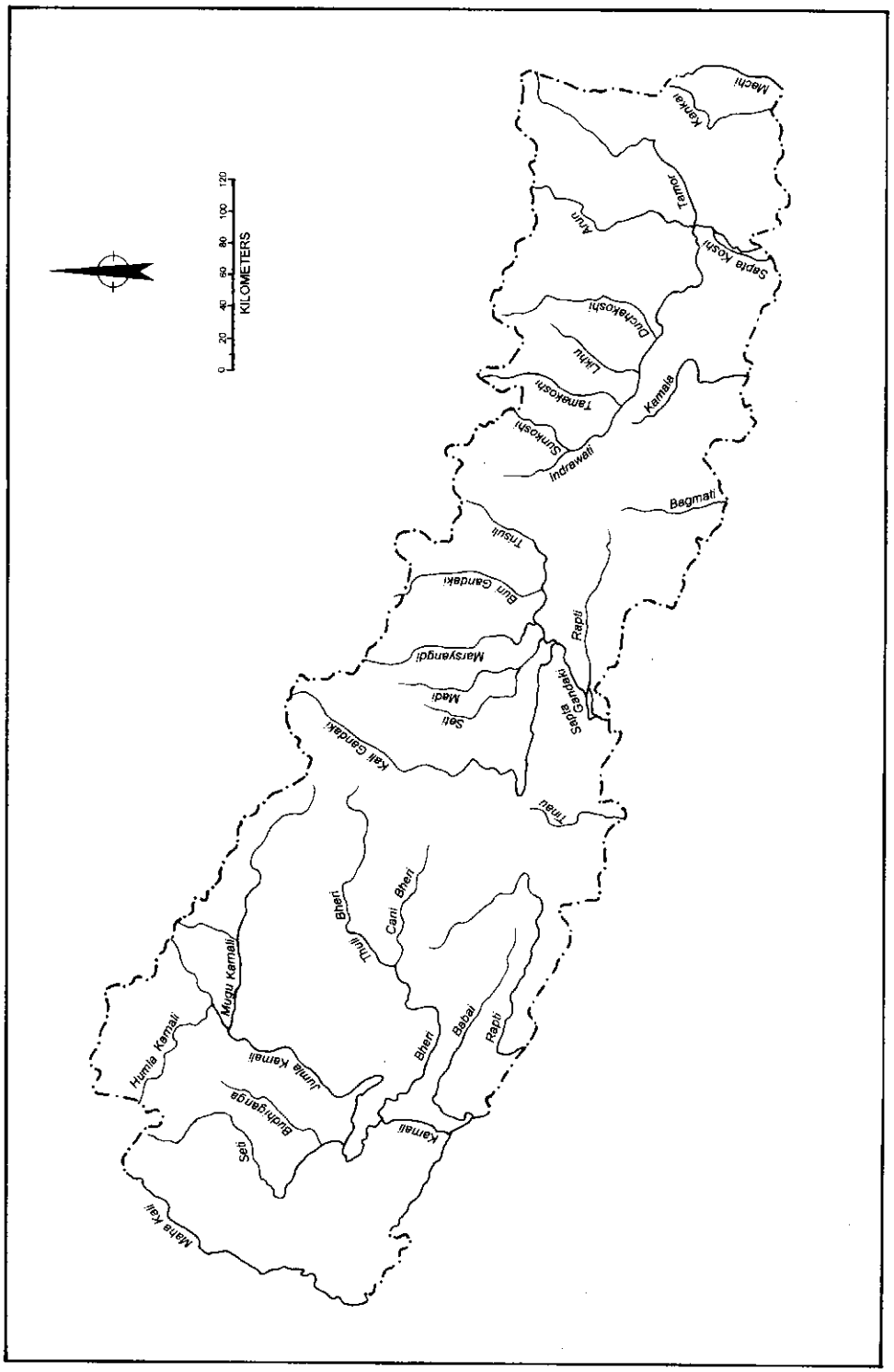


Figure 2. Major rivers of Nepal and their main tributaries.

Table 1. Inventory of some of the potential irrigation projects with a net command area greater than 3,000 ha.

Project (River)	Type	Command area (ha)	Development responsibility	Water source
Bhery-Babai I.P.	New	35,000	DOI	Bhery and Karnali
Geruwa Island I.P.	Impr.	15,000	DOI	Karnali
Jamuar Nala I.P.	Impr.	13,600	DOI	Karnali
Bagmati M.P.	New	122,000	DOI/NEA	Bagmati
Kankai M.P.	Extension to current 8,000 ha	57,500	DOI/NEA	Kankai
Sunkoshi-Kamala Diversion M.P.	Expansion of existing 25,000 ha Kamala I.P.	150,100	DOI/NEA	Sunkoshi and Kamala
East Rapti I.P. (Phase II)	New	6,800	DOI	Mahakali/ GW
Babai I.P.	New	13,500 (with 3 FMIS of 7,000 ha)	DOI	Babai
Marchwar Lift I.P (Phase I)	CAD	4,400	DOI	Tinau
Khutia I.P. (Phase II)	New	3,500	DOI	Khutia
Rato I.P.	New	3,200	DOI/WUG	Rato Nadi
Groundwater Development Project	New	76,910	DOI	Ground water

Notes: I.P. = Irrigation Project. M.P. = Multipurpose Project.
CAD = Command Area Development. Impr. = Improvement.
DOI = Department of Irrigation. NEA = Nepal Electricity Authority.
WUG = Water User Groups.

Table 2. Estimated net command area of irrigation schemes in Nepal.

Irrigation			Terai		Hills		Mountains		Total	
Intensity	Capability	Management	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)
Extensive	Monsoon/	DOI	33	84,830	59	8,968	4	333	96	94,131
	year-round	DOI	0	0	2	794	0	0	2	794
Intensive	Monsoon	DOI	4	38,823	15	2,155	0	0	19	40,978
		FMIS	-	234,607	-	86,514	-	16,582	-	337,803
Intensive	Year-round	DOI	16	70,261	6	2,808	0	0	22	73,069
		FMIS	-	234,606	-	86,514	0	16,582	0	337,702
Command	Monsoon/	DOI	1	6,000	0	0	0	0	1	6,000
Area	year-round	DOI	10	52,339	0	0	0	0	10	52,339
Total			-	721,466	-	187,753	-	33,447	-	942,716
		DOI	-	252,253	82	14,725	4	333	141	267,311
		FMIS	-	469,213	-	173,028	-	33,164	-	675,405

A land resources mapping project has categorically defined and described four principal farming systems in the cultivated area of the country. These are as follows:

1. The Main Terai farming system (45 percent of the total cultivated area).
2. The Dun Valley farming system (8 percent of the total cultivated area).
3. The Middle Mountain farming system (39 percent of the total cultivated area).
4. The High Mountain farming system (8 percent of the total cultivated area).

The Main Terai farming system is mostly rice-based with about 50 percent of the area irrigated and 50 percent rain-fed. The Dun Valley is relatively newly cultivated and mainly rain-fed and maize-based. In the Middle Mountain, 80 percent of the area is rain-fed and maize-based and the remaining 20 percent is irrigated and rice-based. In this ecological zone, sometimes, triple cropping is practiced in irrigated areas. The High Mountain farming system is more livestock-based.

A recent study revealed that rain-fed farming occupies almost two thirds (64%) of the total cultivated land area including areas with both rice-based and maize-based cropping patterns depending upon the agro-ecological conditions. Irrigated farming accounts for about one third (36%) of the cultivated area.

However, its share in the total grain production is estimated to be more than 50 percent. The following are some successful crop rotations in Nepal:

1. Crop rotation in hill terraces

Summer *(kharif)*	Winter *(rabi)*	Spring *(zaid)*
1. Maize	Soybean	Mustard
2. Maize	Millet	Oats or barley (fodder)

2. Crop rotation in irrigated land in the jute area (lowland + upland hills)

Jute	Wheat	Barley (for fodder)
Green manure/	Barley for fodder-	
Jute	Potato or mustard	
Jute	Wheat	
Rice/potato	Jute	
Rice	Wheat-mung	
Jute	Rice-berseem	
"Baishaki" mung	Jute-rice/potato	

3. Crop rotation in irrigated land Terai

Jute	Rice	Wheat
Jute	Mung	Wheat
Jute	Rice	Peas
Jute	Rice	Potato
Jute	Mung	Mustard

4. Crop rotation with tobacco in irrigated areas of Siraha, Dhanusha Mehotari and Sariahi

1st year		2nd year		3rd year		4th year		5th year	
Kharif(K)	Rabi(R)	K	R	K	R	K	R	K	R
Maize	Tobacco	Linseed	Tobacco	Wheat	Rice	Wheat	Maize	Tobacco	Rice,
Legume crop									

5. Crop rotation with sugarcane in Morang District, under irrigation

Jute - rice - sugarcane - tuber crop, oilseed crop

Green manure - rice - sugarcane

6. Crop rotation with oil crops, under irrigation, in Nawalparasi, Rupandehi and Kapilwastu districts in the Western Region

Sugarcane + corriander - mustard + sugarcane (mixed) (ratoon) two-year crop rotation.

Two-year rotation	1st year	maize + soybean - mustard
	2nd year	maize + soybean - wheat
	3rd year	rice - chili

7. Crop rotation with rice and vegetables under irrigated conditions in the Kathmandu Valley

Summer	Winter	Spring
Rice	-	Onion or garlic
Rice	Cauliflower	Onion or garlic
Rice	Cabbage	-
Rice	Green onion or green garlic	Cauliflower
Rice	Cauliflower	Potato

8. Crop rotation with cotton in irrigated areas in Bardia, Banke, and the Mid-Western Region of Nepal

	Summer	Winter
1st year	Cotton	Black gram (moong)
2nd year	Cotton	Black gram (moong)
3rd year	Green manure - mustard and gram	Cotton planted later
-	Maize + soybean, Mustard + gram	

PROGRAMS RELATED TO PROMOTING CROP DIVERSIFICATION

Under His Majesty's Government's (HMG's) Ministry of Agriculture, the two main units at the national level that directly or indirectly share the responsibility of crop diversification are the Agriculture Department and the National Agriculture Research Council (NARC). NARC addresses the research aspects of crop diversification and provides information on suitable varieties of cereals, cash crops, legumes, potato and vegetable crops that fit various macroclimates, and crop rotation and diversification, so that the farmers get the maximum profits from the commodities. The Agriculture Department, with its five Regional Directorates and 75 District Agriculture Development Offices, extends such information and technologies to the farmers.

Research and Development

From 1952 to 1976, the Agronomy Division of the Agriculture Department was indirectly responsible for crop diversification. This period was devoted to the development of improved varieties of cereal, cash crops, oil-seed and leguminous pulse crops to meet the needs of the nation. Rice is the main crop during the rainy or kharif season followed by wheat in the winter. Where water is limited, upland rice or maize is grown in the rainy season. In winter, the farmers grow

either mustard or wheat depending on the market demand in the district. Farmers whose land is near the main township of the Terai area prefer winter maize which gives higher yields and has a ready market (for fresh green cobs).

In 1977, the Department of Agriculture started the Cropping System Program (CSP) to carry out extensive testing of technologies for crop development programs. The integrated Cereal Development Project of Winrock International, IADS and USAID/N had helped the national programs of rice, wheat and maize for a period of four years, beginning in 1972, by putting together technological packages that were economically and socially acceptable.

The Cropping System Program (CSP) initially established two sites in the summer of 1977, in Parsa (Parsa District) and Pumdi Bhumdi (Kaski District). Later, in the winter season of 1977-78, three more sites, Chaurjahari (Rukum District), Lele (Lalitpur District), and Khanduari (Sankhuwasabha District) were added. Ratna Nagar (Chitwan District) was established in the winter season of 1980-81.

Socioeconomic surveys were carried out to better understand farmers' practices. Experiments were conducted in farmers' fields to develop cropping system technologies. The technologies were then introduced to farmers in all six sites through pilot production programs. These packages were also tested in other areas of Nepal by the agriculture extension agents of the Department of Agriculture in the District Agricultural Development Offices, through the Pre-Production Verification Trials (PPVT). Simple manuals were also published giving both the methods and the recommended technology, in detail. In 1983-84, based on the results of these verification trials and pilot production programs, the Block Production Program (BPP) was started in an area of 17,000 ha in the Terai by the Department of Agriculture. The program now covers 100,000 ha (1986-87) in 20 Terai districts and 8 hill districts. The CSP was expanded to form the Farming System Research and Development Division (FSRDD) so that farm research can be conducted for other components as well.

In recent years, it was felt that various research activities and agriculture extension activities could not be effectively done. Researches were either duplicated or were academic in nature and did not benefit the farmers. So, a National Agriculture Research and Service Center was established by HMG with the help of USAID/N and Winrock International.

In 1991, the National Agricultural Research Service Center was organized as the National Agriculture Research Council (NARC), with the mandate of helping achieve the national goal of increasing agricultural production and productivity by implementing coordinated components of Nepalese agriculture. To fulfill this mandate, the Farming Systems Research and Development Division was transferred from the Department of Agriculture to NARC. This division takes care of the crop diversification activities. The commodity programs and disciplinary divisions of NARC are as follows:

Commodity Programs

1. National Citrus Development Program, Dhankuta.
2. National Grain Legumes Improvement Program, Rampur.
3. National Hill Crops Improvement Program, Kavre.
4. National Maize Development Program, Rampur.
5. National Oil Seeds Development Program, Sariahi.
6. National Potato Development Program, Khumaltar.
7. National Rice Improvement Program, Parwanipur.
8. National Sugarcane Development Program, Jitpur.

9. National Temperate Horticulture Development Program, Marpha.
10. National Tobacco Development Program, Dhanusha.
11. National Wheat Development Program, Bhairahawa.

Disciplinary Divisions

1. Agricultural Marketing Research and Economic Analysis, Lalitpur.
2. Central Disease Investigation and Research Laboratory, Kathmandu.
3. Central Livestock Development Center, Khumaltar.
4. Division of Agriculture Botany, Khumaltar.
5. Division of Agriculture Engineering, Khumaltar.
6. Division of Agronomy, Khumaltar.
7. Division of Animal Breeding, Khumaltar.
8. Division of Animal Nutrition, Khumaltar.
9. Division of Entomology, Khumaltar.
10. Division of Plant Pathology, Khumaltar.
11. Division of Pasture and Fodder, Khumaltar.
12. Division of Soil Science and Agricultural Chemistry, Khumaltar.
13. Farming Systems Research and Development Division, Khumaltar.
14. Farm Management Division, Khumaltar.
15. Seed Testing and Improvement Program, Khumaltar.
16. Socioeconomic Research and Extension Division, Khumaltar.

Farms/Stations

1. Bhairahawa Agriculture Farm, Bhairahawa.
2. Bhairahawa Fisheries Development Center.
3. Central Goat Farm, Bandipur.
4. Dhankuta Agriculture Station, Dhankuta.
5. Doti Agriculture Farm, Doti.
6. Fishery Research and Training Center, Janakpur.
7. Hardinath Agriculture Farm, Hardinath.
8. Indra Sarowar Fisheries Development Research Project, Kulekhani.
9. Jumla Horticulture Farm, Jumla.
10. Kabre Agriculture Farm, Kabre.
11. Karnali Sheep Farm, Jumla.
12. Khumal Agronomy Farm, Khumaltar.
13. Kirtipur Horticulture Research Center, Kirtipur.
14. Mushroom Production Program, Khumaltar.
15. Nepalgunj Agriculture Station, Nepalgunj.
16. Nucleus Potato Seed Farm, Nigale.
17. Parwanipur Agriculture Station, Parwanipur.
18. Pokhara Fisheries Development Center, Pokhara (including Ginger Program).
19. Pokhara Horticulture Research Center, Pokhara.
20. Pokhara Livestock Development Center, Pokhara.
21. Rampur Agriculture Station, Rampur.
22. Rasuwa Horticulture Farm, Rasuwa.

23. Rasuwa Pasture Development Farm, Dhunche.
24. Sariahi Horticulture Station, Sariahi.
25. Surkhet Agriculture Station, Surkhet.
26. Tarahara Agriculture Station, Tarahara.
27. Trishuli Fisheries Development Center, Trishuli.
28. Vegetable Research and Seed Production Center, Khumaltar.

Pilot-Testing and Demonstration

The FSRDD was created in November 1985 in the Department of Agriculture with the main objective of identifying environment-specific technologies by integrating different components of the Nepalese farming system (crops, horticulture, livestock and agro-forestry) for the benefit of small and resource-poor farmers.

FSRDD, in 1987/88, had five sites, each roughly representing the mid-hills of 5 development regions. The mid-hills are emphasized because until very recently, little attention could be given to research and technology development for hill farming due to accessibility problems and variable agro-ecological conditions in the hills. The five sites are:

1. Khandbare in Sankhuwasabha District (Eastern Region).
2. Naldung in Kavre District (Central Region).
3. Pumdi Bhumdi in Kaski District (Western Region).
4. Kotjari in Rabum District (Mid-Western Region).
5. Patan in Baitadi District (Far-Western Region).

In addition to these sites, work has also been initiated at the Rampur Agriculture Station (Chitwan District) and Belachapi Farm of the National Tobacco Development Program, Janakpur to demonstrate the farming system approach.

FSRDD (now called the Central Farming Systems and Outreach Research Division), has begun many studies at the five sites such as Component Technology Trials (CTTs), Cropping Pattern Trials (CPTs) and group-visit studies.

In collaboration with crop programs and the disciplinary divisions, the Component Technology Trials are conducted to identify specific technologies (varieties/fertilizer rates/pesticide use, etc.), which can fit into the farmers' cropping systems. The trials are replicated within and/or across farms. They are conducted under the direct supervision of the technical staff. The CTTs provide an opportunity for testing and verifying at a given location the new technology generated by the research stations. The technology identified is further tested in CPTs before final recommendations are made.

The objective of CPTs is to increase and sustain the annual production and the total income of small farmers from a given area by introducing component technology into their cropping systems. The cropping pattern trials include both improved versions of existing cropping patterns and alternative cropping patterns, that are usually made more intensive by introducing additional crops to the existing patterns and/or by introducing new technology not currently practiced by the farmers.

The CPTs are usually conducted in 500-1,000m^2 areas. Trials (demonstrations) are conducted in five farms, using each farm as one replication depending on the crops and land types. The crop in each cropping pattern is grown in sequence in the same parcel of land during the year by testing new technology (variety/fertilizer/pesticide, etc.). The results from these trials are compared with the farmers' traditional pattern to verify the socioeconomic feasibility of the improved practices. It is important to assess how the farmers will adopt the improved technology. The CPTs are normally managed by farmers under the supervision of site staff. The agronomic and economic performance of some improved practices are shown in Tables 3, 4, and 5.

Table 3. Cropping-pattern performance at Khandbari under a partially irrigated lowland ecosystem, spring, summer and winter crops, 1989-90.

Cropping pattern	Farmers' practice	Improved practice	
	R-W-Fallow	R-W-Dhaincha S. canabina	R-W-Dhaincha S. rostrat
Spring			
Variety	-	S. canabina	S. rostrata
Fertilizer (NPK kg/ha)			
Grain yield (kg/ha)			
Green biomass (kg/ha)	-	19,500	8,130
Summer			
Variety	Manipure local	Khumal-4	Khumal-4
Fertilizer (NPK kg/ha)	0:0:0	40:20:0	40:20:0
Grain yield (kg/ha)	2,169	29,998	2,702
Straw yield (sun dried) (kg/ha)	2,991	3,914	3,344
Winter			
Variety	UP262	UP262	UP262
Fertilizer (NPK kg/ha)	60:30:0	60:30:0	60:30:0
Grain yield (kg/ha)	1,475	1,771	1,847
Straw yield (sun dried) (kg/ha)	2,614	3,137	33,450
Annual total yield (kg/ha)	3,644	4,769	4,549
Economic analysis			
Gross return (Rs/ha)	26,265	34,454	32,591
Material cost (Rs/ha)	2,127	3,510	3,510
Labor and power cost (Rs/ha)	10,465	10,855	10,855
Total variable cost (Rs/ha)	12,592	14,365	14,365
RAVC (Rs/ha)	13,673	20,089	18,226
% Change in RAVC		46%	33%
MBCR		4.6	3.56

Notes: R = Rice.
W = Wheat.
RAVC = Return above variable cost.
MBCR = Marginal benefit-cost ratio.

Table 4. Agronomic and economic performance of the cropping pattern tested at Naldung, 1989-90.

Cropping pattern	Farmers' practice Rice-wheat-fallow	Improved practice Rice-wheat-fallow
Summer	Rice	Rice
Variety	Taichung 176	Khumal - 4
Fertilizer (NPK kg/ha)	20:30:0	60:30:0
Grain yield (ton/ha)	1.70	3.32
Straw yield (ton/ha)	2.50	4.50
Seed rate (kg/ha)	50	50
Winter	Wheat	Wheat
Variety	RR - 21	Annapurna - 1
Fertilizer (NPK kg/ha)	40:0:0	80:40:0
Grain yield (ton/ha)	1.48	3.62
Straw yield (ton/ha)	1.58	4.09
Seed rate (kg/ha)	150	130
Economic Analysis		
Gross return (Rs/ha)	16,340	32,520
Material cost (Rs/ha)	1,643	2,990
Labor & Power cost (Rs/ha)	3,360	3,360
Total variable cost (Rs/ha)	5,003	6,250
RAVC	11,336	26,270
% change in RAVC		131.72
MBCR		12.97

Notes: RAVC = Ratio above variable cost.
MBCR = Marginal benefit-cost ratio.

Table 5. Cropping-pattern performance at Patan under lowland irrigated conditions : Winter and summer crops, 1989-90.

Cropping pattern	Farmers' practice R - W - F	Improved practice R - W - F	R - W - F
Winter	Wheat	Wheat	Wheat
Variety	RR 21	RR 21	Annapurna-1
Fertilizer rate (NPK kg/ha)	53:16:0	80:40:0	80:40:0
Grain yield (kg/ha)	2,320	2,465	3,126
Straw yield (kg/ha)	3,480	3,650	3,625
Summer	Rice	Rice	Rice
Variety	Paunji	Paunji	Khumal-4
Fertilizer (NPK kg/ha)	21:6:0	80:30:0	80:30:0
Grain yield (kg/ha)	4,249	4,980	5,647
Straw yield (kg/ha)	6,800	6,142	6,890
Economic analysis			
Gross return (Rs/ha)	22,222	24,775	29,747
Total variable cost (Rs/ha)	1,673	3,720	3,720
RAVC/Rs/ha	20,550	21,054	26,027
MBCR		1.24	3.67
Increase in RAVC (%)		2.00	26.00

Notes: R = Rice
W = Wheat
F = Fallow
MBRC = Marginal benefit-cost ratio
RAVC = Ratio above variable cost

Training

Middle-level workers/officials are trained in crop diversification, agriculture extension and other aspects of crop production by the Central Agriculture Training Center under the Department of Agriculture. Some staff members are trained at workshops and seminars in other countries. The training is more on farming systems than on crop diversification per se.

Support Services

The Agriculture Inputs Corporation supplies the fertilizer, pesticides, fungicides, and agriculture equipment through its branch and sub-branch offices in the districts. The Agriculture Development Bank with its branch offices supplies credit to the farmers in general for various commodities such as crops, livestock, horticulture, etc. In some districts, the farmers become members of the local cooperative societies which could have easier access to credit, fertilizers and markets. However, not all cooperative societies are functioning well. Farmers with little capital and small parcels of land are organized into Small Farmer Groups under the Small Farmer Development Program of ADB and they get their credit and other agriculture inputs through this organization.

This program has been quite successful in Nowakot, Rupendehi, Nawalparasi and other districts where it has been launched.

PROBLEMS IN PROMOTING CROP DIVERSIFICATION PROGRAMS

To promote crop diversification, markets and adequate labor should be available. In townships like Janakpur, Birgunj, Bhadrapur, Biratnagar and Nepalgunj, winter crops such as maize (for green cob) is grown profitably by the farmers. Wheat or mustard is also grown depending on profitability. The farmers definitely need to be guided each year as to which crop will be more profitable. This is especially true for the Terai districts next to the Indian border where such a service is lacking.

In areas such as Bhairawa and Kapilvastu, where land and irrigation water are available to the farmers, the limiting factor for a second crop or crop diversification is the unavailability of adequate manpower during the peak period of harvesting and preparing the land, and sowing the second crop. The farmers in this area are dependent on migrant laborers from India.

The major problems facing crop diversification in Nepal are: (i) limited irrigated area in the country; (ii) inadequate manpower where land and water resources are available; (iii) lack of proper marketing and forecasting services for suitable second crops; (iv) weak inter-departmental cooperation in areas where irrigation is available; and (v) absence of appropriate arrangements for better research on crop diversification in the different locations.

APPROPRIATE STRATEGIES TO PROMOTE CROP DIVERSIFICATION

Crop diversification in agriculture is the need of the day. Some of the strategies to promote crop diversification are:

1. Development and implementation of a proper cropping-system plan to maximize cropping intensity.
2. Development of appropriate mechanization techniques to address labor shortages during times of peak labor requirements.
3. Better coordination between the staff of the Departments of Irrigation and Agriculture to implement crop diversification programs. This coordination and integration should start at the village level and extend up to the national level.
4. Arrangements to address marketing problems. Where a crop diversification program has yielded good results, arrangements should be made whereby the farmers will get the maximum farm-gate prices. Improved marketing, transport, and storage facilities are very important factors in promoting crop diversification.
5. Supply of agricultural inputs such as seeds, fertilizers, plant protection materials and equipment where and when the farmers need them.

6. Provision of adequate manpower and transport facilities for researchers in the farming system research, and socioeconomic research and extension divisions.
7. A definite identification of the demand for certain agricultural commodities and consideration of crop diversification in a rice-based irrigation system to meet that demand.

Research-Extension Linkages

From the above strategies, it is quite clear that extension staff need to know the demands and the problems faced by farmers. The research staff should be able to address these needs. There has to be better linkages between researchers and extension staff in Nepal.

The two agencies involved in extension and research are the Agriculture Department and NARC, respectively. At the field level, the farms and stations under NARC (given in Table 4 above), have their outreach programs in command areas surrounding the farms. The Agriculture Department has Agriculture Development Offices in all 75 districts. There is a need for better linkages at this level, at the regional level and at the departmental level. At the Ministry level, there should be clear-cut policies for providing water for the second and third crops. Some major irrigation channels and systems are closed for repairs when there is a critical need for water for the second and third crops. Policies should be formulated in such a manner that repairs and maintenance of irrigation channels should be done between the irrigation of the second and third crops.

To improve the research-extension linkage in the field, there are monthly meetings between research and agriculture extension staff. At the district level, there are also monthly meetings of the Production Committee where research findings and farmers' field programs are discussed.

At the regional level there are quarterly program reviews where both research and agriculture extension staff from all regions are present. Annually, there is a budgeting and program planning workshop attended by national level staff both from the Department and the Ministry. This too is conducted in all five regions.

At the national level, two workshops are held in summer and in winter, in which the latest research findings on all agriculture crop commodities are presented in the presence of representatives from all farms and stations; national, regional and district level staff of agriculture extension divisions; and consultants and foreign experts working on various projects. At such workshops, programs are planned for the next fiscal year and budgeting is done according to these programs. The Agriculture Information Division of the Ministry of Agriculture further strengthens the research-extension linkage by publishing research material in simple language. They also produce video films on agriculture and other audiovisual products. Every morning, there is a 15-minute radio program on seasonal commodities over Radio Nepal, for farmers. Experiences of successful farmers are highlighted in interviews with them and agricultural events of major significance are given publicity over the radio.

CONCLUSIONS AND RECOMMENDATIONS

There should be better coordination between the Ministries of Water Resources and Agriculture. This coordination should be improved at the departmental, regional, district and field levels. Wherever water is provided for irrigation, the farmers must be encouraged to increase their cropping intensity. Depending upon local market needs, crop diversification should be adopted in such a manner that the farmers would be able to readily sell their produce and reap high profits. Programs or projects with the above-mentioned criteria have a high chance of success.

Role of National Institutions and Agencies in Crop Diversification

NARC provides technological packages of practices but does not do extension work. The Agriculture Department conducts agriculture extension programs in all the 75 districts of the Kingdom. These two organizations are assisted by the Agricultural Development Bank (ADB) through cooperatives, and the Small Farmers' Development Program (SFDP), to supply the credit. The Agriculture Inputs Corporation (AIC) provides various agriculture inputs. Each of these national institutions has its own strengths and weakness in promoting crop-diversification in rice-based irrigated systems.

NARC is an autonomous organization created to expedite research activities in Nepal. It has ample funds and relatively adequate facilities provided by its donors such as Winrock International and USAID. However, it is relatively new and is still short of manpower.

The Department of Agriculture is a well-established organization, covering every district of the country. It has successfully implemented various projects over the past three decades. However, it has not been able to keep up production with the population growth of the country.

The ADB has two decades of experience in providing credit to the farmers of Nepal. With the observation that only rich farmers who had plenty of resources got credit, the SFDP was organized and implemented in several locations of the country. The ADB has facilities to train its staff to be more effective in their job.

The AIC has experience in supplying various agricultural inputs to various parts of the Kingdom for approximately two decades. However, there has been complaints by farmers at times about the timing of fertilizer supply for major crops. Farmers have also complained about the quality of seeds supplied.

Role of Other Countries and International Agencies

There are several international agencies supporting Nepal in its agriculture development projects. Those that are involved in agronomy or crop diversification are as follows:

1. Asian Development Bank.
2. International Maize and Wheat Improvement Center.
3. International Rice Research Institute.
4. International Development Research Center (Canada).
5. International Institute of Tropical Agriculture.

6. German Agency for Technical Cooperation.
7. Overseas Development Agency of U.K.
8. United States Agency for International Development/Nepal.
9. Winrock International Institute for Agriculture Development.
10. Food and Agriculture Organization, Rome.
11. United Nations Development Program/FAO for Nepal.
12. United States Department of Agriculture, USA.
13. World Bank.

These agencies have helped Nepal in agricultural development work such as developing infrastructure and manpower, providing germplasm of various crops, doing base-line studies in various districts, monitoring programs and evaluations, developing information management systems and repairing and maintenance of buildings and equipment.

More specific for farming system research and crop diversification, the Agriculture Research and Production Project (ARPP) funded by Winrock International Institute for Agricultural Development and USAID/Nepal has helped in addressing the goal of increasing the sustainable productivity of small Nepalese farmers. This approach seeks to increase whole farm production, including livestock, agro-forestry, and the important food and cash crops. In order to achieve this goal, farmers must have access to improved technologies. For this purpose, the technologies must be developed, updated, adapted and disseminated effectively.

At the national level, ARPP has helped NARC in improved administration and management of the overall agricultural research system through comprehensive support to research planning, coordination and management as well as by developing operational and development plans for research stations.

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Promoting Implementation of crop Diversification in Rice-based Irrigation Systems in the Philippines

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INTRODUCTION

THE PHILIPPINES IS basically an agricultural country with 70 percent of the population living in the countryside and depending on agriculture and agriculture-related activities for their livelihood. Agricultural production, however, is traditionally concentrated on a few main crops. Rice and corn are the major food crops while coconut and sugarcane are the major commercial crops which constitute the important export commodities.

Rice contributes a substantial portion of the country's gross national produce, accounting for an average of 15.19 percent of the total value of the nation's agricultural production in the last nine years. Production grew at an average of 2.8 percent per annum from 1970 to 1990. From 1981 to 1990, a mean total production of 8.57 million metric tons per year was achieved (Table 1). In 1991, this output is expected to increase to 9.8 million metric tons with the implementation of the Rice Action Program (RAP).

Of the more than three million hectares (ha) of potentially irrigable arable lands of the Philippines, 48 percent or 1.5 million hectares are already provided with irrigation facilities as of the end of December 1990 (Table 2). The national (government-managed) irrigation systems

Table 1. Rice production, area harvested and yield, the Philippines, 1970-90.

Year	Production (Million tons)	Area harvested (Million ha)	Yield (t/ha)
1970	5.32	3.11	1.71
1971	5.26	3.25	1.62
1972	5.11	3.39	1.51
1973	5.39	3.38	1.60
1974	5.55	3.52	1.58
1975	6.38	3.63	1.76
1976	6.54	3.65	1.79
1977	7.26	3.70	1.96
1978	7.22	3.55	2.03
1979	7.69	3.54	2.17
1980	7.65	3.47	2.20
1981	7.91	3.42	2.31
1982	8.33	3.35	2.49
1983	7.30	3.06	2.39
1984	7.83	3.16	2.48
1985	8.81	3.31	2.66
1986	9.25	3.47	2.67
1987	8.54	3.26	2.62
1988	8.97	3.39	2.64
1989	9.46	3.50	2.70
1990	9.32	3.32	2.81

Source of basic data: Bureau of Agricultural Statistics.

(NISs) cover 0.634 million hectares while the communal (farmer association-managed) irrigation systems (CISs) encompass 0.715 million hectares.

The other 52 percent of the total irrigable area is targeted for full irrigation development within the decade ending in the year 2,000. This is embodied in the Republic Act 6978, an act promoting rural development by providing an accelerated program within a ten-year period for the construction of irrigation projects.

Mean cropping intensity from 1979 to 1989 in the NISs was only about 134 percent per year, i.e., 74 percent during the wet season and 60 percent during the dry season (Table 3). The area programmed is less than the total service area even during the wet season. During the dry season, this is even less, primarily due to inadequate water supply particularly in the direct diversion type systems.

Table 2. Status of irrigation development as of end of December 1990, the Philippines.

Region	Total land area ha)	Potential irrigable area (ha)	Irrigation service area (ha)				Irrigation development (%)
			National systems	Communal systems	Private systems	Total	
1	2,156,800	309,764	45,386	133,604	5,520	184,510	59.56
2	3,620,400	539,709	153,107	85,986	36,593	275,686	51.08
3	1,827,800	482,215	172,064	85,690	22,946	280,700	58.21
4	4,751,400	263,593	55,455	72,332	27,948	155,735	59.08
5	1,763,300	239,646	16,209	51,392	16,943	84,544	35.28
6	2,022,300	197,251	53,500	34,191	21,677	109,368	55.45
7	1,495,100	50,739	0	19,382	2,481	21,863	43.09
8	2,143,300	84,381	15,633	38,841	2,176	56,650	67.14
9	1,868,500	76,498	13,348	21,587	2,804	37,739	49.33
10	2,855,900	230,148	22,732	46,158	2,045	70,935	30.82
11	3,158,000	290,276	48,876	63,589	6,872	119,337	41.11
12	2,340,600	362,077	37,610	62,062	4,123	103,795	28.67
Total	30,003,400	3,126,297	633,920	714,814	152,128	1,500,862	48.00

Source: CORPLAN, National Irrigation Administration.

Table 3. Service areas, irrigated areas and irrigated cropping intensity in national irrigation systems, the Philippines, 1979-89.

Year	Service area (ha)	Irrigated area					Irrigated cropping intensity (%)
		Wet season (ha)	Dry season (ha)	Total	% of service area		
					Wet season	Dry season	
1979	475,174	372,232	285,845	658,077	78.34	60.16	138.49
1980	472,182	374,349	293,472	667,821	79.28	62.15	141.43
1981	491,729	372,038	300,416	672,454	75.66	61.09	136.75
1982	514,334	390,342	320,463	710,805	75.89	62.31	138.20
1983	549,930	362,340	293,329	655,669	65.89	53.34	119.23
1984	548,345	416,824	290,851	707,675	76.01	53.04	129.06
1985	568,203	430,888	349,424	780,312	75.83	61.50	137.33
1986	595,902	438,237	381,914	820,151	73.54	64.09	137.63
1987	596,953	433,151	370,351	803,502	72.56	62.04	134.60
1988	614,164	445,287	342,786	788,073	72.50	55.81	128.32
1989	621,144	461,613	389,562	851,175	74.32	62.72	137.03
Average	549,824	408,845	328,947	737,792	74.53	59.84	134.37

CROP DIVERSIFICATION IN RICE-BASED SYSTEMS

Crop diversification may provide a means by which farm income can be increased, given resource constraints such as those of land and water. It has the effect of reducing the risk in crop production caused by fluctuations in market-related variables. Diversification is also a step towards market-oriented production, which means that the farmer will not only be producing for his family's consumption but for the market as well. There is thus an increased effort in making the farmer realize that the level of income that will be derived from his small farmholding is of utmost consideration in making decisions on the type of farming systems he will adopt.

Crop diversification in rice-based systems is not really new in the Philippines. Technologies have been developed in line with the production of nonrice crops as alternatives to rice, particularly for the rain-fed cropping systems. With the anticipated self-sufficiency in rice coupled with the uncertain dry season water supply, the production of nonrice crops offers some opportunities for increased agricultural productivity of the irrigated ricelands.

Rice-Based Areas for Crop Diversification

The Bureau of Soils and Water Management (BSWM) has indicated that some 1.785 million ha in rice-based areas are suitable for crop diversification (Table 4). These areas are planted to upland and lowland rice, either rain-fed or irrigated.

In existing Philippine irrigation systems, there are areas suitable for upland crop production. These areas are marginal for rice production due to their lighter soil texture. These areas are commonly found in the fringes of irrigation systems and, in some cases, even dominate the major portions of the service area. In the national irrigation systems (NISs), there are approximately 207,000 ha of irrigated lands suitable for nonrice crop production (Table 5). These areas are found in regions where the rainfall could not sustain rice production during the dry season.

The traditionally water-deprived, uncultivated sections of irrigation service areas during the dry season which account for about 40 percent (253,568 ha) of the total net service area of the NISs are the most attractive targets for crop diversification. Considering soil, topography and drainage characteristics, about 30 percent (76,070 ha) of these water-deprived areas have been identified as suited to nonrice field crop cultivation.

Diversification in Irrigated Rice-Based Systems

Except for an irrigation system in the southern Philippines, there is no deliberate planning or programming of nonrice crop cultivation in most irrigation systems. However. in some irrigation systems, many enterprising farmers have traditionally been growing upland crops following irrigated lowland rice. Onion, pepper, eggplant, tomato, turnip, corn and garlic are grown in Ilocos Norte and Nueva Ecija. Cotton, tobacco, and mungbean are dominant in Pangasinan, while cotton and corn are grown in south Cotabato. Monitoring of the area cultivated to nonrice crops in irrigation service areas is not yet a regular function or activity of the NIA nor of any other agency. Nevertheless, a recent inquiry from the NIA's field offices revealed that 2.02 percent (12,808 ha) of the 633,920-hectare area isolate of the NISs was cultivated to nonrice crops during the 1989-

90 dry season (Table 6). In the 1990-91 dry season, this was only 1.45 percent. No similar data are available from the CISs, but the same percentage may likely exist.

Table 4. Rice-based cropping system development in the Philippines, 1990.

Region	Area for crop intensification (ha)	Area for crop diversification (ha)	Total (ha)
1	13,460	257,665	271,125
2	180,150	243,400	423,550
3	116,500	422,000	538,500
4	100	314,272	314,372
5	7,475	159,450	166,925
6	172,000	81,900	253,900
7	23,976	37,482	61,458
8	169,760	3,007	172,767
9	50,807	56,079	106,886
10	45,425	38,615	84,040
11	107,192	59,476	166,668
12	150,794	75,796	226,590
CAR	88,575	36,100	124,675
Total	1,126,214	1,785,242	2,911,456

Source: Bureau of Soils and Water Management, 1990.

Table 5. Dual and diversified croplands in the Philippine national irrigation systems (NISs), 1988.

Region	Service areas of NISs (ha)	Dual and diversified croplands (ha)*	Percent of service area
1	46,082	32,965	71.5
2	140,962	30,110	21.4
3	175,285	60,770	34.9
4	54,238	27,296	50.3
5	16,466	4,264	25.9
6	53,461	7,678	14.4
7	none	-	-
8	16,860	none	-
9	12,449	none	-
10	20,013	6,820	34.1
11	34,711	24,291	69.9
12	27,426	13,768	50.2
Total	597,953	207,962	34.8

* Dual and diversified croplands are areas suitable for both rice and diversified crops.

Source: NIA, 1988.

Table.6 Area planted to nonrice crops in national irrigation systems (NISs), the Philippines, 1989-90 and 1990-91 dry seasons.

Region (ha)	Service area (ha)	1989-90 dry season			1990-91 dry season		
		Served (ha)	Not served (ha)	Total (ha)	Served (ha)	Not served (ha)	Total (ha)
1	45,386				no report		
2	55,705				no report		
3	68,779	2,001	1,860	3,861	2,000	1,863	3,863
4	55,455	-	-	-	204	-	204
5	16,209				none		
6	53,500				none		
7	0				none		
8	15,633				none		
9	13,348				none		
10	22,732	58	-	58	178	-	178
11	48,876	3,387	-	3,387	3,387	-	3,387
12	37,610	662	3,729	4,391	441	3,949	4,390
MARIIS*	97,402	4	352	356	5	335	340
UPRIIS**	103,285	755	-	755	722	-	722
Total	633,920	6,867	5,941	12,808	4,937	4,284	9,221
% of service area				2.02			1.45

* Within Region 2.

** Within Region 3.

PROMOTING CROP DIVERSIFICATION IN RICE-BASED IRRIGATION SYSTEMS

While observations show the promising agronomic and economic performance of upland crops grown in the dry season with or after wetland rice, there is still a need to promote this system of production to a much wider area and a greater number of farmer adoptors. In this regard, the government has implemented a number of activities to address this concern.

Research and Development (R&D) Support

The Filipino farmers have been used to planting rice in the service areas of irrigation systems. Considering the contrasting requirements of rice and nonrice crops, technologies and information on the production of upland crops before or after rice become necessary to convince farmers and promote diversification. The Medium-Term Philippine Development Plan (MTPDP) (1987-92)

stipulates crop diversification as a strategy for increasing farm productivity, and expanded R&D activities are thereby encouraged. These R&D outputs should be available to support the promotion of crop diversification.

In the mid-1980s, the research program of the Department of Agriculture was focused on technology verification trials which were conducted in farmers' fields. In most cases the trials involved a test of cropping pattern options in lowland rice areas. The cropping system invariably included the growing of a nonrice (annual upland) crop in the traditionally rice-rice cropping pattern. Clearly, diversification within the rice farming system was a major objective. The research did result in concrete changes being adopted by the farmers. The rice-rice-mungbean pattern is now popular in some provinces in northern Luzon.

A 1988 comprehensive review of past accomplishments on R&D showed that there is still a lack of information on crop diversification in relation to irrigation. The International Irrigation Management Institute (IIMI) with support from the Asian Development Bank (ADB), started in 1985 a more comprehensive study on crop diversification in irrigated areas. In collaboration with research institutions in the country, the project identified the constraints and opportunities for crop diversification both at the system and farm levels. Two years later, the International Rice Research Institute (IRRI) joined forces with IIMI and national research agencies and institutions in conducting studies providing options to rice farmers. The studies focused on irrigation management, taking into consideration the technical, socioeconomic, institutional and managerial aspects of crop diversification.

The ADB-funded project on irrigation management for crop diversification showed that limited water supply and suitable soils were the main physical factors that enabled farmers to effectively irrigate rice and nonrice crops during the dry season. The active involvement of the irrigators' associations (IAs) in water allocation and distribution resulted in the optimal or effective use of the limited water supply. Further investigations into other factors like the rice priority policy and other socioeconomic incentives that will make irrigated crop diversification attractive and profitable to farmers were suggested.

The results of the IIMI-IRRI collaborative project also supported the earlier findings of the ADB project. The documentation and analysis of the procedures employed by both irrigation agencies and farmers in systems with mixed cropping have shown a clearer idea of these procedures. Opportunities and options for improving these procedures were also better perceived.

Considering the seemingly contrasting requirement of rice and nonrice crops, some studies have dealt with investigating specific factors that may influence changes in rice irrigation systems to accommodate nonrice crops. In characterizing these factors, recommendations and strategies have been identified to make their implementation more effective. These include: 1) system characterization and mapping; 2) use of better methodologies and techniques; 3) improved structural control; and 4) more active involvement of irrigators' associations and more farmer participation.

The involvement of farmers and farmer organizations as early as the planning stage may reduce problems during implementation. In systems with active irrigators' associations, the determination of the program area is facilitated through the participation of the IAs. Involvement of farmers during the planning stage does not necessarily mean teaching them to plan for themselves but explaining to them the necessity of the plan and reasons for the actions taken. This ensures farmers' commitment to abide by the plan. This also gives a feeling of importance on the part of the farmers.

Technology Transfer Programs

The Department of Science and Technology (DOST) has given the highest priority to technology transfer and commercialization to support economic development. It has strengthened collaboration with other government agencies, particularly the DA, to address this concern. This is also the present emphasis of the Philippines Council for Agriculture, Forestry and Natural Resources Research Development (PCARRD). After 18 years of R&D effort by the National Agriculture and Resources Research and Development Network (NARRDN), it is but logical to make use of most of the developed technologies that can be useful to and adopted or commercialized by the farmers, the private sector and other end-users. Appropriate technologies from R&D outputs must be transformed into outcomes in countryside development.

Pilot demonstrations/promotion projects. For the last several years, growing upland crops after rice has been piloted in a larger scale by PCARRD in collaboration with the DA and other research institutions and universities. Mungbean, soybean, lowland potato and wheat have shown promising yields and returns. Average yields of more than 1 t/ha have been achieved for mungbean, soybean and wheat, while for lowland potato, an average yield of 12 t/ha has been obtained, which is comparable with the yield in the highlands (15 t/ha).

In May 1987, the NIA and the Japan International Cooperation Agency (JICA) launched the Diversified Crops Irrigation Engineering Project (DCIEP). The Project aims to: 1) study the most appropriate method of providing irrigation to diversified crops; 2) establish design criteria for irrigation and drainage facilities for nonrice crops on irrigated rice fields; 3) study the importance and potential of diversified crops to develop more efficient utilization of available water and land resources, and establish comprehensive irrigated, diversified-crop farming systems; and 4) conduct technical training for NIA personnel and disseminate information for the introduction of diversified cropping systems. The expected output of the project is a manual of technical criteria and procedures for the guidance of engineers and related personnel in planning, designing, operating and maintaining irrigation and drainage facilities for crop diversification in existing NIA systems. It will also show the prospects and potentials of crop diversification in these systems.

The Diversified Crops Irrigation Engineering Center (DCIEC) is a complementary undertaking of the DCIEP. It is envisioned to provide the soil and water laboratories and a training venue for the DCIEP. Crop diversification in the NIA could be institutionalized through the DCIEP. The project is a strong manifestation of the desire of the NIA to promote adoption of nonrice crops in existing irrigation systems to attain a higher efficiency in water and land utilization. It is also a means of hastening the awareness of top- and mid-level field managers on the importance of crop diversification.

The DCIEC facilities could also provide continuing support for the activities of the Research Network on Irrigation Management for Crop Diversification in Rice-Based Systems (IMCD). The center would be open to the different countries in the region and could play an important role in the exchange of technology and research findings. It could serve as a venue for workshops, seminars and training programs of the Network while at the same time contributing its own breakthroughs and field-verified technologies.

Also relevant to crop diversification in rice-based systems is the pilot project on small-farm reservoirs (SFRs). This project was started in one region in 1989 and expanded to two other regions in 1990 and 1991. The SFR technology is basically an earth dam, indigenously developed by

farmers in Central Luzon to harvest and store rainfall and runoff. This structure is built using a bulldozer at the rate of 8-12 hours per unit. SFRs are being used in the rain-fed rice growing areas to provide supplemental irrigation of a rain-fed lowland wet season rice, partial irrigation of a dry season crop, and fish production.

IIMI started to pilot-test the results of its work in the Philippines since 1985. Irrigation management innovations had been discussed with the National Irrigation Agency (NIA) and farmers who agreed to trying them out in the field. Tests during one season showed promising results but activities had to be cut short because of the termination of support.

Information materials/publications. Promoting crop diversification could also be hastened by providing extension technicians and other users with the necessary information through published materials. As mentioned earlier, the DCIEP hopes to come up with a manual on the technical criteria and procedures on planning, designing, operating and maintaining irrigation and drainage facilities for crop diversification in existing NIA's systems. This will be used as a guide by engineers and other related personnel.

For extension technicians, PCARRD has lined up for publication the Philippines Recommendations for Irrigation Management for Diversifying Wetland Rice Areas. This has been initiated to: 1) translate the existing technical information on irrigation management for crop diversification into specific techniques/approaches, 2) provide management options/alternatives to irrigation system managers and water users for efficient allocation of resources, and 3) present recommendations and strategies to guide the formulation of policies for increased and sustainable productivity.

The publication will consolidate information on technologies developed through years of research. It will serve as a reference for irrigation system managers and farmers. Indigenous technologies developed by the farmers themselves will also be included when appropriate. It is hoped that it will serve as a catalyst that will hasten the spread and adoption of crop diversification in irrigated areas.

Development communication strategies. PCARRD implements technology packaging and dissemination programs through the Applied Communications Division. The division develops appropriate development communication strategies toward research utilization and technology diffusion.

In the regions, the Regional Applied Communication Outreach/Office (RACO) takes the lead in operationalizing technology packaging and dissemination activities. To date, there are 15 RACOs which are working components of the national and regional research consortia and centers which PCARRD coordinates.

To operationalize the research-extension interface function of RACO, PCARRD has established a linkage with the DA through the Agricultural Training Institute (ATI) and the Bureau of Agricultural Research (BAR) for an interagency collaborative effort in technology matching, packaging and dissemination activities. The signing of a memorandum of agreement in 1986 among these agencies set forth the National Integrated Applied Communication Program (NIACP).

The NIACP is a relatively recent and positive approach to the research-extension, farmer tie-up which is implemented at the national, regional and farm levels. At the national level, the program backstops technology transfer and maintenance activities of the PCARRD R&D network by retrieving and processing technical information for technology transfer. It develops this

technical information into communication materials directly usable by extension workers, farmers and producers. The DA multiplies and distributes these materials to the regions, and the program evaluates their impact.

The NIACP also established permanent linkages with agricultural communication/information offices within the R&D network in order to activate research information from all regions of the country into the mainstream of technology transfer activities. It provides training skills for the communication development of the staff of the research centers to enable them to implement a viable multi-media information dissemination activity, in support of the agriculture and natural resources development workers to make them more effective in the field.

Policy Support

Considering the broad base of the agricultural sector for economic growth potentials and its impact on development, policymakers are looking for ways and means to pursue an economic growth process anchored on agricultural sector development. Policies have therefore shifted emphasis from merely increasing agricultural production to raising farm productivity. This will provide a broader policy framework which considers not only productivity but all other factors that affect farmers' income such as prices, other income-generating activities, inputs, credit, etc.

Pricing policy. The pricing policy may be the single most important factor that influences rice farmers to diversify out of rice farming. The Philippine government currently maintains a price support for rice, based on cost of production, to protect the income of the farmers from adverse market conditions. However, the limited resources enable the government to procure only a small portion of the produce at the set price. Price fluctuations are, therefore, still inevitable in many areas. This instability in price causes farmers to consider other options. The incentive price mechanism provided by the government to boost production of other crops is also a major factor influencing the decision of farmers to diversify.

Tax and tariff policy. Major agricultural exports have previously had nominal taxes ranging from 4-10 percent, which in a way curtailed the volume of exports. The new policy removes these export taxes which may encourage the production of crops with export potential. Furthermore, it will make our products more competitive in the world market, i.e., to the extent that export taxes are passed on to the buyers in the form of higher market prices.

The reduction in the tariff rates for imported agricultural inputs is foreseen to motivate a shift toward the adoption of modern technologies. With a minimal tariff rate ranging from 0-5 percent *ad valorem*, the costs of agricultural inputs are expected to decrease, resulting in an increase in the use of better fertilizers, chemicals, and seeds, which, in turn, results in increased productivity.

Import liberalization measures in agriculture were done on a selective basis, depending on the domestic ability to produce and the overall impact on the sector. With the new trade policy, it is expected that agricultural productivity will increase since cost constraints have been reduced if not totally scrapped. This means that the country can now be directed toward the production of crops with a natural comparative advantage. For instance, although the country has a comparative advantage in corn production, it is not produced sufficiently in the sector and therefore, has been imported. With the move toward greater competition in the domestic market, there is an increasing

incentive to produce commodities that use domestic resources more efficiently. Corn is one of them.

Land tenure policy. Security of land tenure is essential if landholdings are to be developed and capital is to be invested. The government's land reform program is designed to give farmers the security of tenure in order to encourage them to intensify their crop production. Since any income gain resulting from intensified production activity will accrue only to them, the farmers now have an incentive to adopt income-increasing technologies. Thus, crop diversification, particularly in rice and corn areas, is expected to proceed favorably following the implementation of the Comprehensive Agrarian Reform Program (CARP).

Subsidy and credit policy. The gradual elimination of all subsidies is a national policy. The removal of subsidies in favored commodities is an attempt to allow greater competition in the market by removing policy and institutionally-initiated distortions that penalize the other (nonfavored) commodities.

Irrigation is one input that is subsidized by the government. Subsidy comes in the form of equity contributions to the NIA, budgetary appropriations for construction and maintenance of facilities, and interest charges on capital costs in the construction of irrigation facilities.

The NIA is now contemplating on improving its services through the restoration of irrigation facilities which anticipates that an increase in the efficiency of irrigation service fee collection will follow. This is the major focus of the Irrigation Operations Support Project (IOSP) which the NIA is now implementing nationwide.

Credit programs are based on the concept of the Integrated Rural Financing (IRF) Project of the Department of Agriculture (DA). This is a credit facility for the farm household, based on a whole farm budget for a multicrop/livestock enterprise. IRF is also offered at rates below the market rates.

Irrigation service fee rates. The NIA has been collecting lower irrigation service fees for nonrice crops. It charges 60 percent of the rates established for rice when farmers plant nonrice crops. In a way, this encourages the production of nonrice crops.

APPROPRIATE STRATEGIES TO PROMOTE CROP DIVERSIFICATION

While it may be argued that diversification may not need any push from the government because the farmers will automatically diversify if the conditions are conducive, promoting the implementation of crop diversification could still be hastened and facilitated with government support and intervention. However, the aggressive programs that already exist to promote diversification still need some kind of coordination to effect stronger complementation among these activities and the different sectors pursuing them. The establishment of a multi-sectoral linkage system is necessary to effect complementation, supplementation and effective coordination. Thus through a Memorandum of Agreement (MOA) among concerned agencies, the National Committee on Crop Diversification (NCCD) has been created.

The NCCD hopes to implement a functional working relationship among the various agencies to push crop diversification. Signatories to the agreement are the Department of Agriculture (DA), the Department of Agrarian Reform (DAR), the Department of Science and Technology (DOST), the National Economic and Development Authority (NEDA), and the National Irrigation Administration (NIA). The committee provides a working mechanism for better linkages among the research, extension, policy and infrastructure services.

This has been made clear in the MOA. As stipulated, the Committee shall: 1) coordinate the formulation, development and implementation of a comprehensive program on crop diversification in the country to include research, development, training and extension; 2) facilitate the provision of necessary technical, financial and other support services for the implementation of the program; 3) formulate and recommend policies promoting crop diversification and zonification; and 4) serve as the link between the national program and other related programs within the country as well as outside the country.

The Committee is now in the process of formulating a national crop diversification program laying emphasis on rice-, corn-, coconut- and sugarcane-based areas. Working groups have been created to tackle the individual programs.

During the national consultation on crop diversification held on 30 August 1991 at PCARRD, a general framework on crop diversification was presented and agreed upon. For diversification in rice-based systems, it was agreed that the areas currently devoted to rice should not be reduced by the added cultivation of other crops. Areas that have a limitated supply of irrigation water either due to inadequate supply or difficulty in holding water for rice production may be considered for diversified cropping.

The consultation also agreed on a plan of how to carry on crop diversification in rice-based systems. Table 7 shows the general areas of concern and institutional participation to carry out the plan, while Table 8 gives the identified areas for R&D. The NCCD will repackage the plan, considering the comments and suggestions during the workshop. The NCCD will also look for funds to operationalize the plan.

Table 7. Areas of concern and institutional participation (rice- and corn-based crop diversification).

Areas of concern	Agencies involved
1. Database compilation and updating	
a. Land resource use for rice, corn and crops used in crop diversification	DA-BSWM, NIA, BAS, DA-Regions
b. Completed and ongoing R&D projects related to crop diversification	PCARRD, DA-BAR, UPLB-FSSRI, CLSU, PHILRICE, NAPHIRE, USM
c. National/regional programs on water resources development and management related to crop diversification	NIA, CLSU, BSWM, UPLB, PHILRICE
d. Socioeconomic and market data	PCARRD, NEDA, DTI, DA-Agri-business, DA-BAS
2. Information campaign, training, extension services	DA-ATI, SCUs, PCARRD Consortia Media
3. Seed production, storage, and distribution	DA-BPI, UPLB, CLSU & other SCUs, Private companies NAPHIRE, PHILRICE, NFA
4. Irrigation systems and other infrastructure development and improvement	NIA, BSWM, NFA, FTI, BPWH, Private firms
5. Credit and support services	LBP, Rural Banks, DBP, NLSF, Cooperatives, TLRC
6. Postharvest and marketing	NAPHIRE, DA-Agribusiness, NFA
7. Research and development	DOST-PCARRD, DA-BAR, SCUs, NIA, DA-Regions, PHILRICE, NAPHIRE
8. Overall coordination	DA-BAR, DOST-PCARRD Interagency

Table 8. Research and development concerns and agency involvement (rice- and corn-based crop diversification).

	R&D concerns	Agencies involved
1.	Developing package of technologies for specific/recommended cropping patterns	PCARRD & NARRDN, DA-BAR, DA Regions
2.	Expanded studies on corn-based cropping systems	DA-Regions, UPLB-FSSRI, USM
3.	Field-testing of newly generated rice- and corn-based cropping systems	DA-Regions, UPLB-FSSRI
4.	Water augmentation system development and management (shallow groundwater pumps)	NIA, CLSU, BSWM, UPLB
5.	Small water-impounding projects (SWIP), small farm reservoirs (SFR), communal systems development and management	CLSU, NIA, BSWM
6.	Developing water management and irrigation delivery plan for diversified cropping system	NIA-DCIEP
7.	Piloting diversified crop production projects with water management schemes	NIA-DCIEP
8.	Drainage systems improvement for crop-diversified areas	NIA, CLSU, UPLB, IRRI
9.	Biofertilizer studies	UPLB, BSWM, DA-Regions
10.	Development of small machinery and equipment firms	DA-BPI, AMDP, AMTEC Private
11.	Post-production studies for crops other than rice and corn	NAPHIRE, UPLB, CLSU
12.	Socioeconomic studies on crop diversification	UPLB, CLSU, other SCUs
13.	Policy/market studies	UPLB, DA-Agribusiness, CLSU, BAS

CONCLUSIONS AND RECOMMENDATIONS

Role of National Institutions and Agencies

Although crop diversification is also within the national thrust of Philippine agricultural development, its promotion in rice-based areas has not been done aggressively. This is due to the government's policy of increasing rice production to attain self-sufficiency. However, there is a large hectarage of rain-fed rice that can contribute substantially to increase the production of nonrice commodities. These are the main areas initially identified for crop diversification.

Another aspect that has still room for improvement is the agency coordination as far as crop diversification is concerned. Although there are agencies responsible for coordination of R&D activities and training and extension, a holistic approach to address the whole continuum from research generation to extension and utilization, and the necessary support policies and services to implement the program is still lacking. This apparent lack of coordination could hopefully be addressed by the creation of the NCCD.

Role of Other Countries and International Institutions

Interdependence among countries can help much in the promotion of crop diversification. Aggressive trade among countries in nonrice crops will further help promote crop diversification. Development of intercountry marketing linkages at least within the region can be a very important project of the network.

The International Agricultural Research Centers (IARCs) are very good sources of expertise and consultancy services which the national agencies could tap. Since the IARCs usually deal with specific commodities, they could contribute to technology generation and promotion of alternative crops that could be considered in crop diversification. They should also be able to assist in packaging and drawing up of proposals for funding by donors such as the World Bank (WB), Asian Development Bank (ADB), and others.

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Promoting Implementation of Crop Diversification in Rice-Based Irrigation Systems in Sri Lanka

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INTRODUCTION

SRI LANKA IS a tropical island in the Indian Ocean situated between the latitudes 6°N and 10°N, with a gross land area of about 65,000 km^2. The main source of income is the agriculture sector, with water and land as the prime physical resources. Over 75 percent of the country's population of 16.5 million, live in the rural areas, with agriculture or agriculture-related activities as their main occupation.

Sri Lanka receives most of its rainfall during the northeast and the southwest monsoons, resulting in two distinct seasons for cultivation, *maha* or the main season from October to February, and *yala* or the dry season from April to June. More precipitation is experienced over the whole island during the northeast monsoon, which usually supplies adequate moisture for the cultivation of crops. The southwest monsoon brings rains mostly to the southwest parts of the island, resulting in soil moisture inadequacy in the other parts during the rest of the year. Based on this phenomenon, the island is roughly divided agroclimatically into dry, wet and intermediate zones.

Rice is the staple diet of the people and is the main crop grown under irrigation. Although Sri Lanka has come very near self-sufficiency in rice, there is still a need to increase rice production to feed the growing population. In turn, increased production demands optimum utilization of the limited land and water resources. To meet this need, the operation of the existing irrigation

schemes at a high level of agricultural production becomes an important objective of the government. Therefore great emphasis is now placed on the following activities:

1. Rehabilitation and improvement of the performance of existing irrigation schemes.
2. Improvement of the management of the irrigation schemes by:
   a) ensuring farmer participation in the operation and maintenance of the schemes; and
   b) integrating the services and facilities provided by the various government agencies concerned with the development of irrigated agriculture.

IRRIGATION AND IRRIGATION MANAGEMENT

The total land area under irrigation at present is approximately 520,000 ha, of which 300,000 ha, are managed by the Irrigation Department (ID), 45,000 ha by the Mahaweli Authority of Sri Lanka (MASL), and 175,000 ha by the Department of Agrarian Services (DAS).

The DAS manages minor irrigation schemes with command areas of less than 80 ha. These are small village irrigation schemes renovated or newly constructed by the government and handed over to the farmers for operation and maintenance. It is estimated that there are about 25,000 minor irrigation schemes irrigating about 175,000 ha.

The main feature of the irrigation systems under the Mahaweli Project is the diversion of water from the Mahaweli basin by means of transbasin canals to supplement old irrigation schemes. Twelve old irrigation schemes have benefitted from this diversion.

The planned irrigable area under the current program is approximately 200,000 ha. Approximately 120,000 ha of this area have already been provided with irrigation facilities, with 75,000 ha maintained by the ID and 45,000 ha directly managed by the Mahaweli Authority.

The history of the ID dates back to the year 1900, since when, it has been engaged in the development of irrigation in Sri Lanka. It has constructed a large number of irrigation schemes (reservoirs and run-of-the-river diversions) all over the island.

According to the nature of water sources and supply in the dry zone, five broad categories of irrigable lands are identified.

Category 1: This consists of major irrigation schemes with transbasin diversions from the wet zone. In this area, almost every year during maha and most years during yala, there is an adequate supply of water. Hence, the greatest opportunity for crop diversification exists within this area.

Category 2: This consists of major irrigation schemes with their own catchment areas lying within the dry zone. Only during years of normal rainfall is the full irrigation supply assured for maha, and at least 25-50 percent of the supply for yala. One of the more difficult management problems lies in planning, due to the highly variable availability of irrigation water.

Category 3: These are minor irrigation schemes with moderately stable water supplies. Crop diversification is done during the yala season.

Category 4: These are minor irrigation schemes with unstable water supplies. There is a potential for crop diversification which is yet untapped. Although experiments are successful in cultivating nonrice crops (NRCs) at least in parts of the command area no effective intervention has taken place.

Category 5: This consists of schemes with lift irrigation from open shallow wells or channels. NRCs with high productivity rates are usually grown as the cost of water pumping has to be covered.

The main problem of irrigation management is the lack of awareness of involved officials as well as farmers. Strengthening extension activities will be a good way of addressing this concern.

During the past few years, increasing attention has been given by the authorities to the role of farmers in the management of irrigation schemes. From the position of a passive recipient of resources, they now become active participants. Both the authorities and the farmers have realized the need for this participation.

Farmers' organizations are essential to ensure farmer participation in the activities of a scheme. These organizations will provide an opportunity for dialogue and interaction between the farmers and the officers working with them. This makes a cropping program much easier to implement.

Experiences gained so far have shown the need for farmers' organizations to share in management decisions and responsibilities. Farmers' organizations should be considered not merely as a desirable element but as an essential component of irrigation management. They have to play a major role in crop diversification in irrigation systems.

IRRIGATED RICE-BASED CROP DIVERSIFICATION

Prior to the 1960s, irrigated agriculture in Sri Lanka was synonymous with increasing the area under rice with the sole aim of achieving self-sufficiency in rice production. In the early 1960s, recognizing that water was the limiting factor for food production, the Department of Agriculture started field experimentation and extension work in growing NRCs on irrigable lands during the dry yala season. Initially, crop diversification was accepted with mixed responses at a time when irrigation management was not considered at the policy-planning level. In the late 1970s with the Accelerated Mahaweli Development Project (AMDP), new directions had to be looked at with regard to irrigated agriculture where crop diversification clearly showed comparatively better economic benefits for the individual farmer. The design criteria of the AMDP had been improved, based on the experiences of previous irrigation schemes. Subsequently, the actual operations were adapted for irrigation management for crop diversification through research and extension.

Table 1 shows the potential area for crop diversification in irrigated areas. The potential areas are based on the water availability in tanks and the drainage class of the soils.

Table 1. Potential area for crop diversification (CD) in irrigated areas of Sri Lanka.

Province	Irrigated area (ha)			Potential area for CD (ha)			
				Major		Minor	
	Major	Minor	Total	Maha	Yala	Maha	Yala
Western	2,974	6,992	9,966	145	733	340	1,680
Southern	24,570	11,980	46,550	8,745	11,370	2,990	4,490
Uva	10,824	14,678	25,502	3,245	7,575	4,405	10,275
Sabaragamuwa	1,937	12,095	14,032	580	1,355	3,055	7,320
Central	11,069	21,770	32,839	1,880	5,390	3,340	9,630
Northwestern	21,380	45,826	67,206	6,410	14,300	13,750	31,070
Northcentral	57,964	45,401	1,03,095	18,640	37,720	1,57,775	20,430
Northern and Eastern	1,20,387	29,193	1,49,580	41,190	65,130	10,080	13,200
Total	2,50,335	1,87,935	4,38,770	80,835	1,43,575	53,735	98,095

Source: Data based on DOA 1989-90 Agriculture Implementation Program.

Table 2 shows the cultivated area of nonrice crops by district, during the 1990-91 maha season and the 1990 yala season.

Table 2. Cultivated area (ha) of other field crops under irrigation by district.

District	Maha 1990-91	Yala 1990
Puttalam	2,283	1,627
Kurunegala	177	9,240
Ratnapura	82	308
Kandy	0	95
Matale	117	1,330
Badulla	148	1,701
Monaragala	25	225
Jaffna	4,349	3,384
Killinochi	1,185	970
Vavuniya	6,245	1,132
Mullaitivu	3,796	na
Mannar	1,598	na
Anuradhapura	356	5,104
Polonaruwa	767	3,449
Trincomale	884	na
Batticaloa	2,269	na
Ampara	19	1,118
Hambantota	4,424	1,291
Kalawewa	141	10,270
Walawe	360	219
System B	na	683
Total	29,225	42,146

Note: na = data not available.

PROGRAMS/ACTIVITIES RELATED TO PROMOTING CROP DIVERSIFICATION

Research and Development

Agricultural research in Sri Lanka is presently handled by the Department of Agriculture, Department of Minor Export Crops, Forest Department, Tea Research Institute, Rubber Research Institute, Coconut Research Institute, Sugar Research Institute, Veterinary Research Institute and the Post-Graduate Institute of Agriculture. With these many agencies conducting research and development activities there is no overall body like the Indian Council of Agricultural Research (ICAR), Malaysia Agricultural Research and Development Institute (MARDI) or the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD)

to direct research at the national level. As a result, priorities cannot be determined and interacting areas of research are often neglected. Without such a body, there is very little communication between the government and the individual research organizations. In 1987, however, the Council for Agricultural Research Policy (CARP) was established by an Act of Parliament. It advises the government on all matters pertaining to the planning, coordination and execution of agricultural research handled by the ten organizations stated above.

Most of the research and development works on growing NRCs in rice fields is carried out by the Department of Agriculture. Research problems could be related to agronomy, water requirements at the field level, effective control of soil moisture regimes, on-farm irrigation and drainage systems, selection of crops and varieties, breeding and introduction of new crops, and economic evaluation. These are presented to the researchers at a seasonal forum called the Provincial Technical Working Group (PTWG). Research on the socioeconomic aspects, management problems and system control is handled by various national agencies with support and assistance from the International Irrigation Management Institute (IIMI), which has a special Sri Lanka Field Operations Office.

Pilot-Testing and Demonstration.

Adaptive research into the transfer of new technology or the improvement of an existing technology is jointly carried out by the research and extension divisions of the Department of Agriculture. Adaptive research is conducted in farmers' fields by the extension division.

The Mahaweli Agriculture and Rural Development (MARD) Project aims at carrying out special demonstrations in farmers' fields in System B of the Mahaweli scheme to assist diversified cropping. New technologies, crops and varieties, better seed and planting materials, and improved water management techniques are some of the components of this project. It also aims to raise the income levels of the farmers through increased production and the cultivation of high-value crops.

Training

The training of officers in the DOA is carried out through organized and systematic bi-weekly training programs. These programs are based on cultivation in the field and the work to be done during the two weeks following cultivation.

In addition, officers are trained ahead of the season on subjects requested by the field staff so that they will be competent in advising the farmers. There are special training programs on specific subjects conducted at the In-Service Training Institutes. The Mahaweli Economic Agency also conducts regular and systematic training programs for its staff, mostly in conjunction with the DOA.

Farmer training is conducted in the field by the DOA extension staff on a group-approach basis relating to the day-to-day problems encountered by the farmers. It may be need-based or on a general topic. Village level extension officers are expected to regularly visit their assigned areas.

PROBLEMS IN PROMOTING CROP DIVERSIFICATION PROGRAMS

The constraints involved in crop diversification have been identified in the various physical, agronomic, economic, social and management areas. Moisture inadequacies as well as excesses, soil drainage problems, structural inadequacies to cope with the various irrigation demands, lack of awareness in the farmers of the additional work necessary to make the field suitable for NRCs, limited crop and varietal availability, marketing and storage problems, social values which have a negative effect on NRC promotion and farmer organizational problems are a few of the factors which would affect a crop diversification program.

Information on Crop Diversification Technologies

The transfer of technology on the cultivation of the new NRCs from the researchers to the farmers, and the feedback on its impact are major and important components in the implementation of a crop diversification program. Very frequently, a major setback in the successful cultivation of NRCs in rice-based systems is the lack of precise information needed by the farmers on the use of new technologies. Sometimes, even the government officers are not aware of the need for the precise control of soil moisture for higher yields in NRCs, which could be due to inadequate agronomic data on nonrice crops. This makes it difficult to promote these crops to the farmers.

There are even problems which research has not been able to address. At times, the officers have not been able to provide the farmers with the answers they need.

Socioeconomic Incentives

As is well known, higher prices for the farmers' produce provide the best incentive for them. Commercial farming, however, requires access to more capital. Farmers' organizations or even individual farmers should have access to markets and quality planting materials.

In the nucleus farm/outgrower scheme, one who has a nucleus farm supplements the supply to his factory or direct market with an organized supply from a group of outgrowers generally located close to his operation. In contract farming, a purchaser enters into an agreement with the farmers who will supply him with a particular product. The most risky system is where farmers cultivate to cater to a market that they know exists but are not sure of the details of the price and quality required. It is in this instance that the middleman steps in and fills the void in the marketing system, and in some instances, exploits the farmers.

APPROPRIATE STRATEGIES TO PROMOTE CROP DIVERSIFICATION

Research-Extension Linkage

In the implementation of a crop diversification program, a frequent and regular reciprocal dialogue between research and extension is essential. The cultivation environment of NRCs is different from that of rice and it is inevitable that many field problems will occur in relation to agronomy and socioeconomics. A continuous flow of information from research to extension and to the farmers, and a reverse flow of field issues and problems is a standard approach that is necessary for the implementation of a crop diversification program.

Research and extension linkages are fairly well maintained through the organized structure of the Department of Agriculture which plays an active role in crop production. Information that is needed by other institutions or organizations involved in crop diversification is supplied by the DOA whenever required or requested. Regional Research Centers (RRCs) have been established in all identified major agro-ecological regions in the country to cater to the research services required in these regions.

Extension services were planned and implemented by experienced Assistant Directors of the DOA at the district level, and through a well-organized network of extension officers at the middle and grass-root levels. They are all in a direct line of command for technical and administrative functions. The main purpose is to use the extension program as a tool to boost national agricultural production. A different technical and administrative structure has been adopted by the Mahaweli Economic Agency (MEA), but it also maintains a similar information system. Even in the MEA, most of the research and extension programs are supplemented by the DOA.

With the reorganization of the administrative functions in the provinces and the devolution of central responsibilities to the provincial governments, a modification of the extension procedures has been done. Different provincial governments adopt different systems of extension administration. Shortcomings in the delivery of extension packages and in the provision of other services are reported. The link of farmers with extension at the grass-root level was the *Krushikarma Vyapti Seva Nilandhari* (KSVN). This "link' was replaced by the *Grama Seva Niladhari* (GSN) who has fewer farmers to deal with. The disadvantage with the new arrangement is that the GSN is burdened with the other administrative functions of the farmers. This goes against the extension principle that has been practiced in which the complete attention of the extension workers is given to the farming activities of the farmer.

At present the research-extension linkage is relatively weak due to the unreliability of information coming from the field and the inability of those concerned to evaluate the magnitude of the field problems.

Appropriate Incentives

The incentives available for farmers to implement a crop diversification program are either direct or indirect in nature. The direct incentives are: a) the delivery of inputs in the required quantities at convenient locations and at affordable prices, b) a complete agricultural extension system that

assists farmers to diversify into NRCs successfully and profitably, c) a regular and organized market information system so that farmers can take decisions on what crops to cultivate, and d) distribution of prizes, in cash or in kind, to generate competition among farmers growing NRCS. Although these will encourage the farmers to diversify, to some extent they will act only as initial incentives.

Therefore, if diversified cropping is to be a permanent feature then it is desirable to look at other types of incentives such as favorable prices, better markets, improved processing technologies, better transport systems,etc.

CONCLUSIONS AND RECOMMENDATIONS

Role of National Institutions and Agencies

A number of organizations are involved at present in the implementation of crop diversification programs in Sri Lanka. These are mainly, the DOA, the MEA, and the Irrigation Management Division of the Irrigation Department. Now, the Provincial Councils are also involved through their Ministries of Agriculture. Unfortunately, each of these organizations works independently of the others. A concerted and coordinated program is necessary if the country's diversification program is to be expanded and sustained. All these institutions should agree that an increased contribution to national production and farmer incomes are the objectives in diversifying into NRCs. These two common objectives should make coordination easy.

Grassroot-level organizations have to be strengthened through irrigation management organizations to be able to take greater responsibility in planning and implementing diversification programs. They should also supply accurate information to the management and pass it on to their fellow farmers. This becomes even more important in the absence of suitable extension workers at the farm level.

Role of other Countries and International Agencies

The exchange of information on experiences in crop diversification in different countries is important. The interaction among personnel who actually implement such programs through newsletters, for example, is beneficial. However, it should be understood that all experiences may not be transferrable to any country due to climatic, socioeconomic and other differences.

Through financing crop diversification programs, international agencies can be directly involved in such programs. They may be able to convince the planners at the national level on the importance and benefits of crop diversification. International agencies could convince the planners at the national level on the need for grassroot-level extension, help in funding research activities, and assistance in training of extension staff and policymakers, and in identifying and obtaining better seeds and planting materials.

Finally, the degree of success of a crop diversification program lies in its acceptance by the farmers. International agencies can play an effective role in negotiating with governments to offer

attractive prices and better markets for NRCs. The exchange of information on market needs of different countries is an area where they can play a crucial role so that farmers who grow NRCs concentrate on better quality produce and processed products to earn a better income. This global market intelligence system will enhance the value of the produce even on a regional basis, and thus, enhance the global demand from the region.

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Promoting Implementation of Crop Diversification in Rice-Based Irrigation Systems in Thailand

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INTRODUCTION

AGRICULTURE DOMINATES THE economy of the Kingdom of Thailand, contributing more than 33 percent of the total national export in 1990. About 70 percent of the total working population is engaged in agriculture and agriculture-related activities.

Rice constitutes the main agricultural crop, cultivated in about 9.5 million ha or approximately 62 percent of the total cultivated area. In the 1970s, the government promoted agricultural development to increase rice production to feed the growing population and increase export. At the end of the fiscal year 1990, about 3.5 million ha were irrigated, and about 2.5 million ha were planted to wet season rice (Tables 1 and 2). The yield averages 3.13 t/ha.

Rice has been the largest foreign exchange earner with a record export value of US$1,110 million, or 5 percent of the total export in 1990. However, the sharp drop in the world prices of rice in the early 1980s has made rice production less profitable. Moreover, the population growth has slowed down and the per capita rice consumption has started to decline. It thus becomes difficult to justify irrigation and agricultural projects for rice production.

Table 1. Irrigation projects and irrigated areas in Thailand.

Region	Large-scale projects		Medium-scale projects		Total	
	Number	Irrigated area (ha)	Number	Irrigated area (ha)	Number	Irrigated area (ha)
North	12	265,296	222	353,767	234	619,063
Northeast	11	280,785	314	257,161	325	537,946
Central	44	1,793,582	152	216,288	196	2,009,870
South	6	123,596	88	213,250	94	336,846
Total	73	2,463,258	776	1,040,465	849	3,503,725

Notes: Large-scale project - More than 12,800 ha of irrigated area and more than 100 milion m^3 of reservoir capacity.

Medium-scale project - Less than 12,800 ha of irrigated area and less than 100 million m^3 of reservoir capacity.

Table 2. Irrigated areas (ha) for wet season rice in Thailand, (1985-90).

Region	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
North	333,193	390,591	359,513	364,529	382,686	376,705
Northeast	326,572	348,269	358,974	355,140	362,034	375,510
Central	1,476,844	1,447,349	1,467,921	1,467,451	1,445,280	1,487,515
South	176,830	178,560	203,608	230,010	229,762	248,313
Total	2,313,438	2,364,769	2,387,017	2,417,130	2,419,761	2,488,044

The Royal Irrigation Department (RID) is responsible for irrigation, drainage, and flood control projects in Thailand. It has classified water management of irrigated areas into three stages:

Stage I. Upon completion of the irrigation project, water user groups are organized ditch by ditch and trained in appropriate water uses. The leaders of each water user group are trained in water management by the RID or other concerned government agencies.

Stage II. After the farmers learn how to use water properly, production technologies in accordance with physiography, soil, climate, market, etc., of each region are introduced to increase yield both in quantity and quality. At this stage, the activities of the water user groups organized in Stage I may be modified.

Stage III. Projects which have passed Stage II may still encounter water shortage problems. In order to address these problems, groundwater development may have to be implemented.

Presently, the water management of existing irrigation projects is mostly under Stage I. A few are in Stage II but no project has yet reached Stage III.

CROP DIVERSIFICATION IN RICE-BASED SYSTEMS

In the wet season, crop diversification in Thailand is limited because farmers prefer to grow rice to guarantee their food supply. Furthermore, water is excessive for upland crops in most irrigated areas and is fully allocated to the irrigated areas without regard of the dry season planting. Thus, the area for the following dry season crop has to depend on the water situation at the end of the wet season, especially in irrigation systems which get water from reservoirs.

The potential for crop diversification is generally confined to areas with access to water during the dry season. Table 3 shows distribution of irrigated areas for dry season cropping from 1985 to 1989. It shows a breakdown of irrigated areas for dry season rice, upland crops, vegetables, sugarcane, fruit trees, perennial crops and fish ponds. Table 4 shows the percentage of irrigated area used for diversified cropping, 1985 to 1989.

Tables 5 to 9 present the distribution of areas for regional crop cultivation from 1985 to 1989 in Thailand. It is to be noted here that administratively, the RID manages the irrigation system by dividing the country into 12 regions as shown in Figure 1. Table 10 shows the planted and irrigated areas of selected irrigation projects in 1989-90. It can be observed that good potential areas for diversified crops are in the north and in some portions of the central plain.

Table 3. Distribution of irrigated areas (ha) for dry season cropping, 1985-89.

Year	Rice	Upland crops	Vegetable	Sugarcane	Fruit trees	Perennial crops	Fish ponds	Total
1985	569,100	107,360	27,400	49,459	56,990	23,130	29,096	862,535
1986	556,282	113,233	33,444	61,292	103,139	54,904	35,536	957,830
1987	509,157	116,800	29,931	67,119	96,883	59,297	37,023	916,210
1988	562,958	112,128	29,846	99,963	103,587	51,448	42,157	1,002,087
1989	699,724	113,025	26,506	108,802	99,056	42,899	44,804	1,134,816
Average	579,444	112,509	29,426	77,327	91,931	46,335	37,723	974,696

Table 4. Percentage of irrigated areas used for diversified cropping.

Year	Irrigated area ('000 ha)	Diversified cropping area ('000 ha)	Percentage of diversified cropping area
1985	3,179	293	9.23
1986	3,240	402	12.39
1987	3,360	407	12.11
1988	3,396	439	12.93
1989	3,460	435	12.57

Table 5. Distribution of areas (ha) for dry season cropping in 12 regions according to RID administration, 1985.

RID Region	Rice	Upland crops	Vegetables	Sugarcane	Fruit trees	Perennial crops	Fish ponds	Total
1	2,150	21,330	2,420	-	-	-	-	25,900
2	4,320	11,750	2,030	-	160	-	-	18,260
3	26,670	11,530	660	120	-	-	6	38,986
4	4,780	5,870	550	8	-	-	-	11,208
5	2,700	3,900	590	2	-	-	30	7,222
6	4,060	7,990	1,950	-	-	-	-	14,000
7	311,260	4,910	6,650	10,310	15,470	1,560	3,390	353,550
8	109,290	17,010	950	20	16,380	3,090	12,180	158,920
9	51,440	1,120	600	-	30	20	10,630	63,840
10	36,060	20,370	10,290	38,990	18,080	13,670	2,850	140,310
11	1,420	420	530	7	6,840	4,790	10	14,017
12	14,950	1,160	180	2	30	-	-	16,322
Total	569,100	107,360	27,400	49,459	56,990	23,130	29,096	862,535

Table 6. Distribution of areas (ha) for dry season cropping in 12 regions according to RID administration, 1986.

RID Region	Rice	Upland crops	Vegetables	Sugarcane	Fruit trees	Perennial crops	Fish ponds	Total
1	2,187	26,766	1,958	-	8,008	23	70	39,012
2	2,722	15,920	2,286	413	15,127	17,906	765	55,138
3	22,230	12,457	624	128	1,980	259	123	37,801
4	11,141	3,061	1,491	47	339	-	221	16,300
5	4,329	8,297	927	-	160	17	412	14,144
6	2,551	5,530	805	-	-	-	32	8,918
7	293,731	8,361	8,114	8,888	16,185	1,850	4,451	341,580
8	102,861	10,413	712	3	20,345	3,796	13,233	151,363
9	55,575	2,168	378	64	2,333	2,430	10,708	73,657
10	45,443	19,780	15,617	51,742	29,654	20,985	5,471	188,691
11	1,034	308	492	4	8,948	5,953	44	16,683
12	12,478	271	42	2	59	1,684	6	14,542
Total	556,282	113,233	33,444	61,292	103,139	54,904	35,536	957,830

Table 7. Distribution of areas (ha) for dry season cropping in 12 regions according to RID administration, 1987.

RID Region	Rice	Upland crops	Vegetables	Sugarcane	Fruit trees	Perennial crops	Fish ponds	Total
1	2,877	25,343	2,269	-	8,008	23	68	38,589
2	1,528	13,652	1,874	499	15,271	17,906	567	51,299
3	25,328	15,476	209	4,357	1,980	259	141	47,752
4	4,365	4,094	994	64	245	2	197	9,961
5	4,811	99,400	707	93	221	33	631	15,897
6	3,512	6,786	2,093	-	-	-	25	12,417
7	272,785	5,820	8,032	9,04	15,206	1,521	7,262	321,230
8	83,379	9,720	1,012	83	16,573	4,063	14,056	128,886
9	50,051	2,768	762	166	3,842	2,674	10,792	72,056
10	44,196	21,875	11,195	52,243	26,306	21,158	3,245	180,218
11	3,089	322	674	4	9,076	7,332	38	20,534
12	13,234	543	111	4	154	4,325	1	18,372
Total	509,157	116,800	29,931	67,119	96,883	59,297	37,023	916,210

Table 8. Distribution of areas (ha) for dry season cropping in 12 regions according to RID administration, 1988.

RID Region	Rice	Upland crops	Vegetables	Sugarcane	Fruit trees	Perennial crops	Fish ponds	Total
1	2,398	28,617	2,151	-	8,008	23	-	41,197
2	3,647	17,488	3,747	499	15,297	14,181	119	54,978
3	31,344	10,432	673	6,985	1,751	109	44	51,338
4	16,746	6,824	2,158	51	156	204	453	26,592
5	8,432	12,328	1,930	147	11	17	949	23,814
6	7,099	3,425	240	-	-	-	27	10,790
7	256,573	3,947	6,644	11,174	18,434	624	7,360	304,410
8	97,326	4,299	652	88	19,580	1,812	16,653	140,410
9	51,568	1,948	398	199	3,927	3,480	12,684	74,204
10	69,758	22,063	10,366	80,813	27,083	22,684	3,845	236,611
11	3,302	372	700	1	9,270	6,773	18	20,436
12	14,763	387	189	6	72	1,540	4	16,961
Total	562,958	112,128	29,846	99,963	103,587	51,448	42,157	1,002,087

Table 9. Distribution of areas (ha) for dry season cropping in 12 regions according to RID administration, 1989.

RID Region	Rice	Upland crops	Vegetables	Sugarcane	Fruit trees	Perennial crops	Fish ponds	Total
1	2,664	28,609	1,736	-	8,008	23	-	41,040
2	2,339	19,347	2,594	499	11,669	2,521	89	39,059
3	75,258	13,079	139	9,487	1,907	160	156	100,184
4	24,287	5,172	1,828	52	16	30	443	31,828
5	12,966	13,864	1,281	-	-	-	147	17,044
6	7,608	8,071	1,218	-	-	-	147	17,044
7	314,793	3,155	7,954	12,825	12,919	635	10,767	363,064
8	96,492	4,919	391	5	22,055	1,884	14,761	140,507
9	48,985	1,733	313	18	3,916	3,163	12,970	71,098
10	98,032	14,259	8,283	85,798	29,208	22,583	4,496	26,258
11	1,985	347	653	1	8,744	6,395	3	18,128
12	14,315	470	118	1	605	5,505	43	21,056
Total	699,724	113,025	26,508	108,686	99,047	42,899	44,022	886,310

Table 10. Planted and irrigated areas in selected irrigation projects, 1989-90.

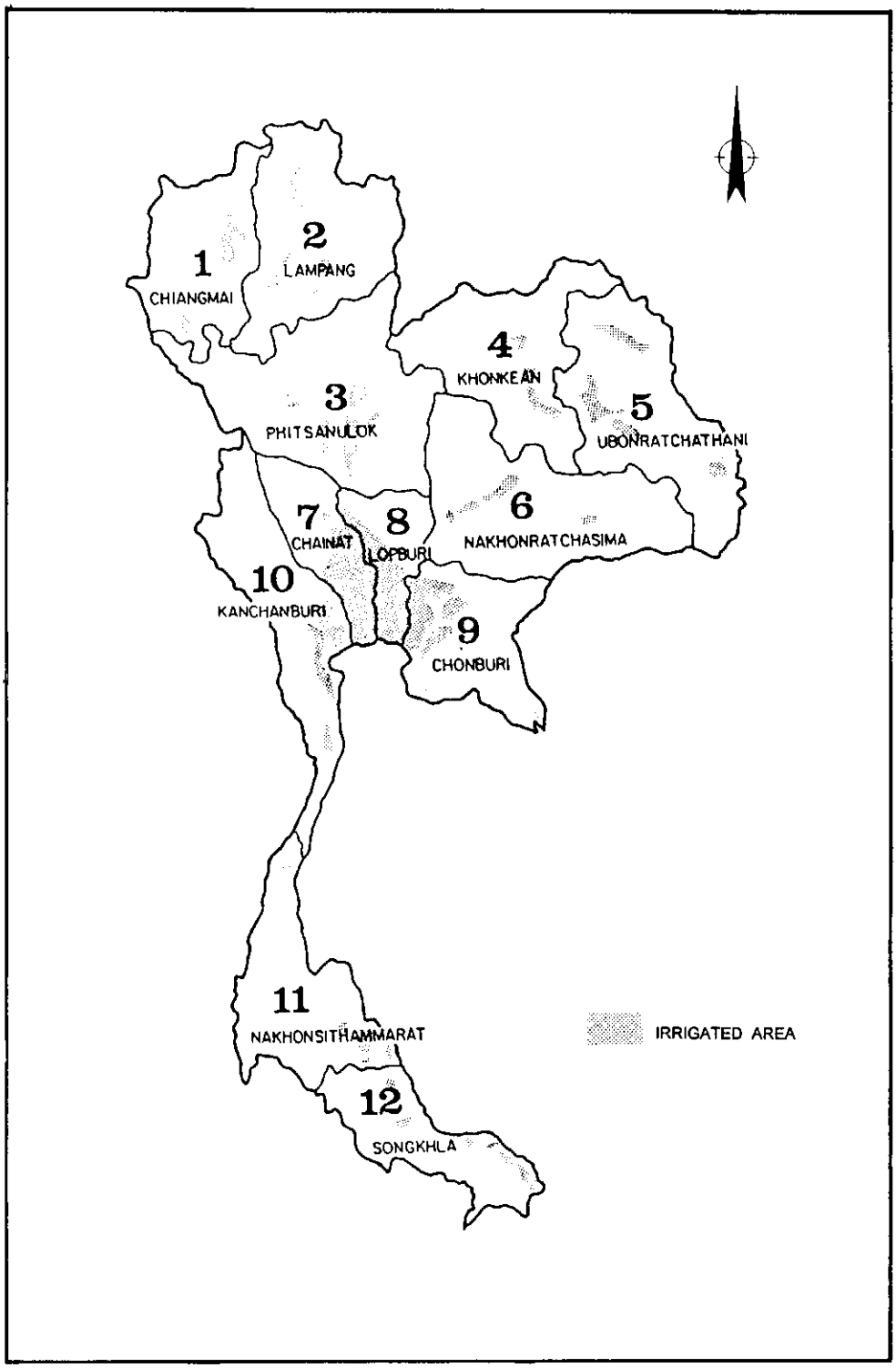
Project	Project area (ha)	Area of wet season rice (ha)	Area planted to dry-season crops (ha)							
			Rice	Upland crops	Vege-tables	Sugar-cane	Fruit trees	Perennial crops	Fish ponds	Total
Northern Region	125,412	105,080	16,957	26,531	3,340	449	2,290	15	110	50,322
Mae Taeng	23,000	17,600	285	10,192	305	-	2,572	-	21	13,375
Mae Faek	11,200	7,088	211	3,516	274	-	-	-	-	4,001
Mae Ping Kao	7,200	7,360	1,005	1,175	985	-	-	-	-	3,165
Mae Kuang	9,600	9,363	3	1,474	469	-	-	-	-	1,946
Kew Lom	24,480	17,386	729	7,455	1,270	499	348	15	89	10,405
Phitsanulok	50,032	46,283	14,724	2,719	37	-	-	-	-	17,480
Northeastern Region	204,412	187,506	56,861	15,836	2,051	-	12	-	621	75,381
Nong Wai/Nam Phong	48,400	40,676	29,912	2,825	302	-	3	-	202	33,244
Lam Nam Oon	32,480	28,098	846	2,464	52	-	9	-	166	3,537
Lam Pao	50,400	49,060	14,678	3,737	590	-	-	-	-	19,005
Lam Dom Noi	24,000	26,052	4,220	1,374	144	-	-	-	199	2,644
Lam Praploeng	11,123	13,306	6,260	449	72	-	-	-	54	5,792
Lam Takong	22,000	16,253	679	3,274	425	-	-	-	-	4,378
Central Region	389,106	161,382	74,515	9,724	11,321	50,060	39,245	4,392	9,119	198,376
Mae Klong	389,106	161,382	74,515	9,274	11,321	50,060	39,245	4,392	9,119	198,376
Total	719,000	453,969	148,333	52,091	16,712	50,509	42,177	4,407	9,850	324,079

Source: Royal Irrigation Department, 1990.

Among the diversified crops grown, upland crops are predominant and contribute about 40 percent to the total cropped area. Soybean, mungbean, groundnut, taro and vegetables are the popular cash crops grown in the central plain after rice. Tobacco, garlic, onion and soybean are cultivated in the north, while groundnut, sesame, mungbean and watermelon are generally grown in the northeast. In some areas, rice fields have been converted permanently into fish ponds or orchards.

Soybean production is only 0.6 million mt per year, which is not enough for domestic requirements and therefore, soybean has to be imported. Thus, soybean is given top priority in rice-based systems. Mungbean has a high demand in foreign markets, along with vegetables and fruits. Fishery products, particularly shrimp and prawn, have an increasing demand in the world market.

Figure 1. The 12 regional Irrigation Offices and irrigated areas in Thailand.



PROGRAMS RELATED TO PROMOTING CROP DIVERSIFICATION

Shifting Rice Lands to Other Farming Activities

Rice is the singlemost important crop in Thailand, and the major source of income for farmers and provides export earnings averaging more than 35,000 million bahts a year. However, there is now stronger competition among rice exporting countries in the world market and the water supply in irrigated areas is becoming limited. Thus, the Agriculture Ministry is conducting a project which is looking into ways of using rice lands for other farming activities.

The project aims at (i) assisting farmers in irrigated areas to utilize water more effectively, and (ii) providing these farmers with farming alternatives so that they will not depend on rice alone.

In the short term plan, other crops which require less water and which have a high market demand like mungbean, maize, vegetables and some upland crops could be planted instead of a second crop of rice. In the long run, these lands could be converted to orchards, pastures for dairy cows, or used for other more permanent enterprises.

Part of the project is the provision of government support to the participating farmers along with the following incentives:

1. Seedlings and other inputs. The government provides, without cost, seedlings of upland crops and vegetables. Seedlings of fruit trees and dairy cows are given on loan, at low interest rates.
2. Technology transfer. The government organizes training courses on farm management, crop cultivation methods, and dairy cow raising.
3. Marketing. In order to ensure a stable market and stable prices, the Agriculture Ministry has invited the private sector to join the projects through contract farming.

Extension Programs for Soybean Production

Soybean plays an important role in many industries in Thailand, especially in animal production. The government has tried to promote soybean production to meet the domestic consumption demand but to no avail. In 1988-89, soybean production was estimated at 0.283 million mt while the domestic demand was 0.453 million mt. Meanwhile, animal production has expanded rapidly.

At present, soybean is largely cultivated in the northern part of Thailand. Production is estimated at 70 percent in the rainy season, and 30 percent in the dry season.

Soybean production can be increased by increasing the yield per hectare and/or by increasing the growing area. In irrigated areas, soybean can replace rice. Water requirement for soybean is 3-4 times lower than that for rice and farmers can earn more from soybean when water is limited.

Research has looked at improving the existing technology and the rice-soybean and rice-tobacco cropping patterns, for which local varieties are being used at present. In six years (1982-1988), the study found that the farmers accept the rice-soybean-soybean cropping system. When compared with the yield value of 18,012 baht/ha, from the rice-soybean-mungbean pattern, rice-soybean-soybean gives a return of 23,368 baht/ha, a difference of 5,365 baht/ha or 29.7 percent.

Factors which affect the adoption of the cropping system are as follows:

1. Farmer's experience. The farmers have acquired the skill and knowhow in soybean production.
2. Soybean yield. The new varieties of soybean (SJ. 4,5 and Nakornsawan varieties) give higher yields than the local varieties.
3. Price. The price and the availability of soybean convince farmers to grow it and expand the soybean production area.
4. Benefit. The benefit and yield/unit area of soybean are higher than those for existing crops.
5. Harvesting process. Soybean is harvested easily, rapidly, and in one gathering.

It was found that at the end of the 1987-88 growing season, 76.6 percent of the farmers wanted to continue soybean production the following year. Only the farmers in the Western and Central regions were not receptive to soybean because of low yields, stable prices and markets for rice, and inadequate knowledge of soybean production. Other results have shown the following:

1. If soybean is planted later than January, the flowers will not be fertilized.
2. The recommended method of dropping seeds into rice stubbles is not accepted by farmers.
3. Farmers use a higher seeding rate because they broadcast the seeds, which makes it difficult to control weeds, resulting in poor yields.
4. Farmers did not realize that caterpillars and other pests from deformed seeds, and rats can be a serious threat when soybean is grown in rice areas.

The future extension program for soybean production should include seed production, adequate water during the growing season, equipment that farmers can acquire, Rhizobium culture for new growing areas, and consumption of soybean at the farm level.

PROBLEMS IN PROMOTING CROP DIVERSIFICATION PROGRAMS IN IRRIGATED AREAS

1. The irrigation and drainage infrastructures of the command areas are not well-suited to meet the irrigation and drainage requirements.
2. The rice farmers usually expand their cultivated areas during the dry season without due regard to the availability of water. Consequently, water shortages and low crop yields result.
3. Because of the farmers' lack of collateral (land title) required by banks, institutional credit becomes a problem. This makes it difficult for the farmers to buy the modern inputs needed to increase yield and, consequently, the country's competitiveness in the export market.
4. There is a high risk involved in investing in crop diversification as experienced by several agro-businesses during the last decade.
5. Substitute crops to replace rice during the dry season are still not well-known. Since the farmers are used to growing rice in the dry season for a long time, the price and availability of markets have convinced them to maintain this practice.

6. There are conflicts among water users who grow different crops. Different maturing rice varieties and field crops have different demands for water in terms of quantity and timing.
7. Nonagricultural employment which provides more income than on-farm activities during the dry season causes labor shortages in the rural areas. This, in turn, has the following effects:
   i. Farmers not expanding their cultivated land in the dry season.
   ii. Delay in planting and harvesting that affects the quality of some crops.
   iii. Social problems in rural and urban areas.
8. Some areas are not suitable for growing field crops. For instance, the irrigated area in the northeastern region which is partly clay and partly silty is left idle in the dry season.
9. In some irrigated areas, the farmers do not plan their irrigation because they lack the know-how on appropriate water applications.
10. In some areas especially in the central plain, the farmers grow rice continuously in the wet and dry seasons. This causes some pest problems. In 1980, brown plant hoppers spread out and damaged the rice production in the dry season. Incidentally, some farmers apply chemicals incorrectly.
11. In terms of the market, the farmers do not trust the market availability of other crops, the price of existing crops still attracts the farmers more than other considerations, the promotion of contract farming according to government policy benefits only the minority, and some joint projects with private sectors have not achieved their objectives.

APPROPRIATE STRATEGIES TO PROMOTE CROP DIVERSIFICATION

Research and Extension

The linkage between research and extension in Thailand has been through committees and sub-committees with different levels of coordination.

Under the Research and Extension Coordination Committee, policies are formulated in line with the National Economic and Social Development Plan and according to the policy of each department. After the policy is set, a workplan is formed and proposed to the Agricultural Research and Extension Coordination Committee. The workplan is then forwarded to the Agricultural Research and Extension Coordination Sub-Committees at the regional offices for implementation.

There are seven programs/projects being implemented under this linkage scheme:

Research. The Department of Agriculture is responsible for carrying out the task according to the workplan while the DOAE provides the necessary information from the field. Feedback from farmers is also considered in drawing up research plans and policies.

Seed multiplication. In practice, the DOA breeds and certifies the new varieties, and produces breeder seeds and foundation seeds. From the foundation seeds, the DOAE produces registered seeds and extension seeds which are then distributed extensively to the farmers.

On-farm trials. This is to test or adjust the technology from research stations under field conditions. This is conducted by the DOA in cooperation with the DOAE.

Multi-location trials. The results of on-farm trials are tested in various locations. The socioeconomic conditions of the farmers are considered as the major factor that contributes to the adoption of technology. The DOAE, in cooperation with DOA, conducts this task.

Demonstration trials. The results of multi-location trials are extended to the majority of farmers by means of demonstration plots or field days. The DOAE is responsible for this task and the DOA assists in providing detailed information.

Information distribution. Research results at all levels are distributed to technologists, extension agents and farmers in general by means of academic documents, publications and audio-visual aids. This is done by the two departments.

Technology transfer. Technology as innovation is transferred from the research section to the extension section to enhance the ability of extension technologists. This is done through conferences, seminars, workshops, trainings, study tours or by consulting the agricultural service centers in every research institute.

Appropriate Incentives

To convince rice farmers to plant other crops, the government would have to provide the following incentives:

1. Stable prices and markets for the new products. A minimum price guarantee that would provide a total income of not less than that received from rice should be established.
2. Provision of inputs. Besides the price guarantee, the government should help provide the farmers with the required inputs such as seedlings, fertilizers and pesticides to encourage them to participate in the project.
3. Provision of low interest loans. Turning rice lands to other farm types like orchard farms and dairy cow raising pastures would require high investments. Most farmers lack cash, therefore, the government must provide them with low-interest loans to persuade them to undertake the projects.
4. Appropriate technology. Because the farmers may not be acquainted with the new farming activities, training courses and other means should be available to guide farmers and demonstrate the new practices.
5. Working together as a cooperative. To encourage farmers to help each other, to have easy transfer of technology, and to have bargaining power in the markets, the participating farmers must be formed into groups.

CONCLUSIONS AND RECOMMENDATIONS

Roles of National Institutes and Agencies

Government and private institutions and agencies play an important role in convincing rice farmers to shift from rice cultivation to other farming activities. The government sector should focus on the following:

1. Research. It is necessary for the government to do research on suitable crops for diversification.
2. Technology transfer. The results of research, new techniques developed, should be transferred to the participating farmers.
3. Good quality inputs. Seedlings, fertilizers, pesticides and other production inputs should be adequately provided.
4. Improved irrigation systems and water management. The irrigation systems must be improved for better water use for agricultural diversification. The RID has to provide training in advanced water management for the water user groups.

Financial institutions, traders, and the farmers themselves have their respective roles to play. Low-interest loans should be provided to the farmers by private financial institutions and partly compensated by the government to lower the interest rate. Exporters or processors can be involved in contract farming. The government can provide incentives such as import or export quotas, low-interest package credit, etc.

Role of Other Countries and International Agencies

International cooperation for implementing crop diversification can provide exchange of experiences and facilitate the transfer of technology. This is particularly important among Asian countries because of similar climates, customs and traditions.

Another important consideration is the necessary investment capital. Without support from governments or international agencies, crop diversification will not succeed.

In the past, the USAID granted support to the RID for the implementation of agricultural diversification in the Nam Oon Irrigation Project. At present, the ADB has provided a grant of about US$750,000 to the RID to study agricultural diversification in the lower west bank portion of the Chao Phraya Project with an area of 249,000 ha. The study has been undertaken by a team of consultants from Thailand, Australia and Japan. It was expected to be completed in December 1990.

Promoting Implementation of Crop Diversificationin Rice-Based Irrigation Systems in Vietnam

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INTRODUCTION

VIETNAM IS IN the tropical monsoon region. Its land area is 331,000 km^2, of which one third is arable. The annual temperature is 23°C and the annual rainfall ranges from 1,800 to 2,000 mm.

South Vietnam has a higher and a variable temperature. It has more sunshine which is available for agricultural production all year round. North Vietnam's climate is relatively severe. In the winter and spring, from November to April, it is affected by the Northeast cold wind with the temperature averaging below 20°C. Sometimes it goes down below 10°C.

Water resources in Vietnam are abundant but uneven in distribution. Rainfall in the rainy season accounts for 85 percent of the total. Typhoons usually occur from July to November, frequently bringing heavy rains which cause overflowing of rivers and waterlogging.

The country has a dense network of rivers and streams with 25 river systems. About 70-80 percent of the total river runoff is concentrated during the rainy season, causing serious floods. On the contrary, the river runoff is meager in the dry season and the water level is low, resulting in difficulties in irrigation and drought in many areas.

GENERAL AGRICULTURAL DEVELOPMENT

Vietnam is an agricultural country with 80 percent of the population engaged in agricultural production. Rice is the staple food but other crops such as corn, sweet potato, potato, beans, cassava, vegetables and fruits are also widely grown.

The arable land area is 11 million ha, with 7 million ha under cultivation. Three million ha are planted to rice while 4 million ha are in the highlands.

Agricultural production cooperatives (land area ranging from 100 to 300 ha) have been established in the rural areas. Recent reforms in agriculture have considered not only the achievement of self-sufficiency but also commercial production on the basis of market-oriented mechanisms. The right to use lands for agriculture is given to farmers and the peasant household is now becoming an autonomous economic unit in the agricultural economy of the country.

The agricultural land area of the country is not large but the climate allows the growing of more than one crop a year. Thus, emphasis is given to both expansion and vertical development, i.e., expanding new irrigated areas and increasing cropping intensity.

The development of agriculture is considered a priority task in the development of the country's economy. The priority is to meet the demand for food by the growing population.

As a result of policy reforms, agricultural development has progressed especially in the last five years. Annual cropped area increased from 4.8 million ha in 1985 to 5.7 million ha in 1990. Total production of rice increased from 18 million tons to 21.4 million tons. Cropping intensity has more than doubled.

Agriculture, however, is still too dependent on nature. Drought, waterlogging, typhoons, floods and unusual changes of weather remain threats to agricultural production. For example, the spring crop this year suffered heavy losses due to high temperature during the seedling stage and low temperature at the flowering stage.

WATER RESOURCES DEVELOPMENT FOR AGRICULTURE

Over the past years, the development of water resources has been emphasized. One hundred irrigation systems have been constructed. These include 650 large and medium reservoirs, more than 3,500 small reservoirs, 2,500 electric pumping stations with 10,000 pumps and a total power demand of 340 Mw, and over 1,000 sluice gates, with the potential to irrigate an area of 2.2 million ha. The area irrigated by gravity is 840,000 ha, while 800,000 ha are irrigated by pumping, and the rest by minor projects constructed by the farmers themselves. In addition, more than 700,000 ha of coastal land affected by sea water intrusion are now receiving fresh water supplies while 900,000 ha are being drained.

The goals of irrigation development for agriculture are to increase the irrigated area, and the intensity of farming and yields through multiple cropping and crop diversification. To meet these goals, attention has been given to strengthening the operation and maintenance (O&M) of existing systems, assuring a reliable water supply for intensive farming and increasing the production of mainly nonrice food crops in winter.

Annually, the revenue from the 160,000 tons of rice paid as irrigation service fee (130 billion and 12 billion Vietnam Dongs from the Central and Provincial Governments, respectively), have been invested on O&M systems. As a result, the annual irrigated area increased from 4.8 million ha in 1985 to 5.7 million ha in 1990. The nonrice crop area doubled and its production accounted for 12 percent of the total production of the country. Additional nonrice food crops in winter, called winter crops, have been grown, especially in the Red River Delta which is entirely under irrigation. Winter crops occupy 35 percent of the total area on average, the percentage even reaching 40-50 percent in some provinces. Currently, cropping intensity ranges from 2.3 to 2.4.

CROP DIVERSIFICATION IN RICE-BASED IRRIGATION SYSTEMS

Vietnam is a densely populated country with limited arable lands, and many regions remain uncultivated. The development of these areas would require large investments, especially in irrigation development.

Rice is a popular food crop, having great potential for increased production. Thus, rice cultivation represents a major activity in the production system of the country. Irrigated lands can produce 2, or even 3 crops per year.

Since 1980 and especially in the last 5 years, multicropping and crop diversification have played an important role in agricultural development. Table 1 shows the rates of increase in the area cultivated to rice and nonrice crops during the period, 1986-90.

Table 1. Increase in the area cultivated to rice and nonrice crops in Vietnam, 1986-90.

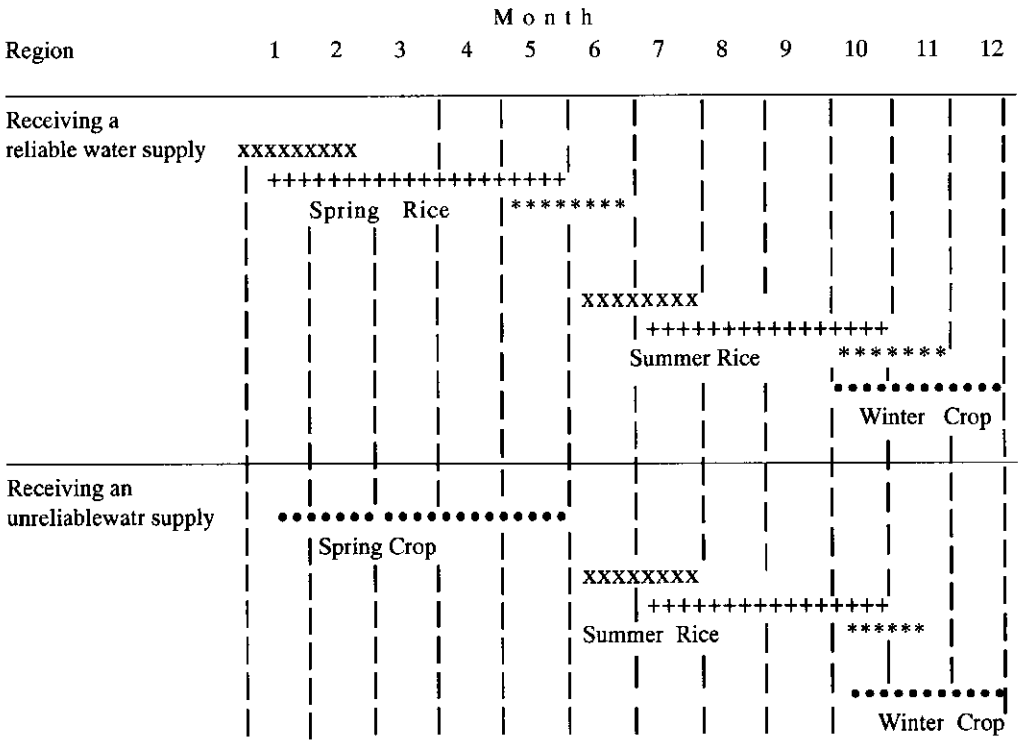
Crop	Percent increase per year	
	Total area	Rice-based irrigation system
Rice	1.25	3.90
Nonrice crops	5.40	12.90

The prevailing cropping pattern in rice-based irrigation systems is rice-rice-nonrice crop (Figure 1). On highlands with an unreliable water supply, the cropping pattern is winter dry crop-spring dry crop-summer rice crop. Major dry crops are corn, sweet potato, potato, ordinary vegetables and high-value vegetables for export such as garlic, chili and water melon.

Since 1980, dry crops, especially nonrice food crops, have played an important role in solving the food problem of the country, and in the development of the economy as a whole.

The food program described in the Five-Year Plan (1986-90) stressed the implementation of intensive farming, multi-cropping and crop diversification in agriculture to achieve food self-sufficiency, and produce agricultural products for export in a short time. Policies and activities of various agencies for promoting crop diversification were in terms of the following: irrigation management, research and extension, and related government policies.

Figure 1. Cropping pattern in a rice-based irrigation system.



Legend :

xxx	Land preparation.
+++	Rice-growing period.
***	Harvesting.
•••	Winter dry crops.

Irrigation Management

Irrigation systems in the country are designed to provide water for rice cultivation. According to field irrigation criteria land preparation, the maximum water consumption is 0.80-1.0 lps/ha while the gross irrigation coefficient is 1.00-1.40 lps/ha.

The irrigation coefficient for rice during the growing state is 0.30-0.40 lps/ha, and 0.30-0.35 lps/ha for nonrice crops (Table 2).

Table 2. Field irrigation coefficient and water requirement of rice and nonrice crops.

Crop	Field irrigation coefficient (lps/ha)	Water requirement (m^3/ha)
Rice		
Land preparation	0.80 - 1.00	1,000 - 2,000
Growth period	0.30 - 0.40	3,500 - 4,000
Nonrice (dry) crops	0.30 - 0.35	2,000 - 2,200

Note: Irrigation technical procedure promulgated by the Ministries of Water Resources and Agriculture.

The cropping season is planned on the basis of climate and the irrigation system's capability to supply water. The water supply (WS) is evaluated based on the amount of water that can be diverted from the water source (Qs), and the gross water demand (Qd). It is essentially the ratio of Qs to Qd.

Usually, during the land preparation period, Qs > Qd, i.e., WS > 1.00. In this case, water is sufficient for crop cultivation. Figure 2 indicates the general relationship between the water supply and the water demand in rice-based irrigation systems.

When the WS can be maintained above 0.80 but below 1.00 and the whole service area in the irrigation system is still planted to rice, rotation irrigation and water saving through proper water management have to be implemented. In cases where WS is expected to be lower than 0.80, some rice lands are planted to nonrice crops. Usually, crop diversification occurs at the highland or tail-end areas of the system. When this situation occurs, the system managers inform the district and agricultural production cooperative leaders and make their suggestions to them. Leaders in areas that will be difficult to irrigate need to be notified to make the cooperative cropping plan possible.

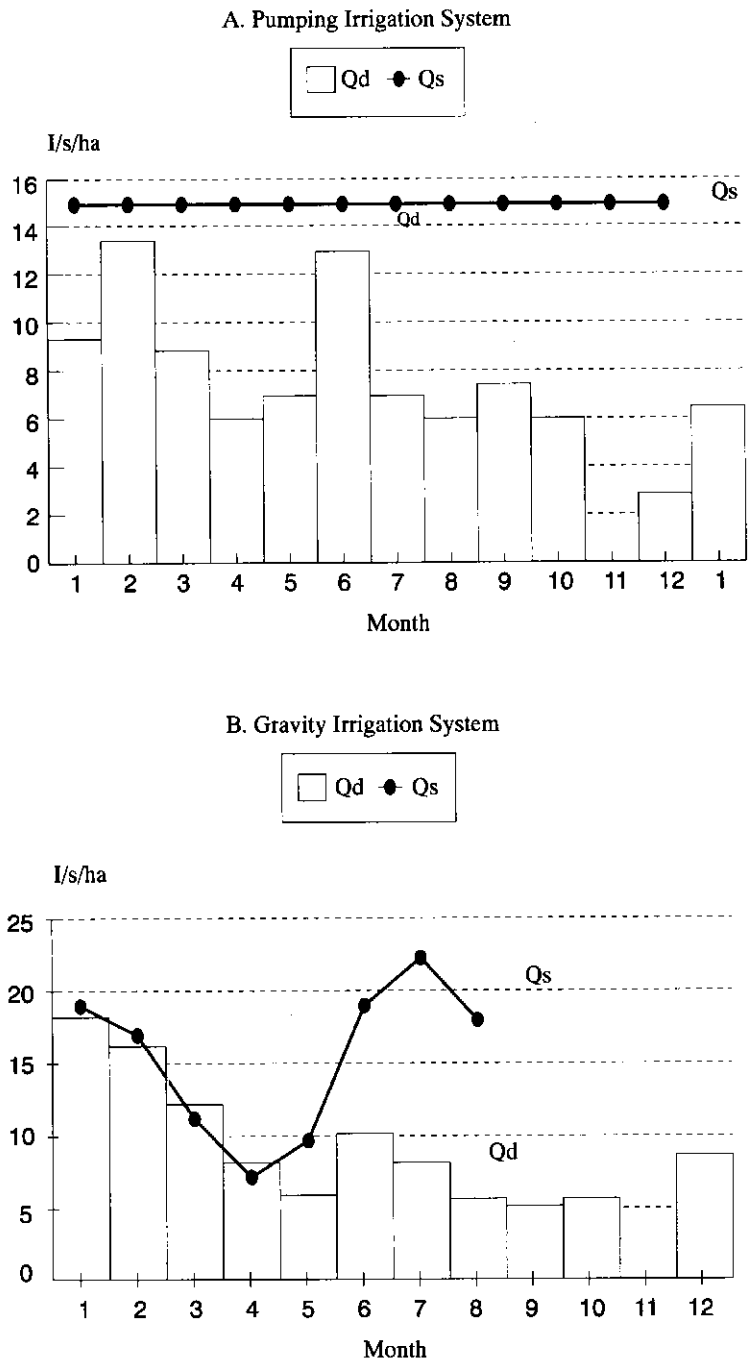
Cooperative leaders and farmers must make cropping decisions. For example, when WS is less than 0.80, an important issue arises as to whether or not system managers have enough knowledge of soil conditions and reliable data to make decisions on the water supply capability of their systems. In most cases, farmers usually grow rice rather than other crops even if irrigation water deliveries cannot be assured. There are two explanations for this: First, they are more familiar with their traditional cultivation habits, and they have inadequate information on technologies for other crops, which could lead to crop failures. Second, there is a lack of incentives to grow crops other than rice.

Besides the two rice crops, food crops and vegetables are widely planted as winter crops in irrigation systems. Winter crops are planted right after the harvests of very early maturing rice and early maturing rice. To make this possible, the system management must consider the following:

1. Assuring a reliable water supply for transplanting summer rice and for crop cultivation according to the cropping pattern of the year.

   A delay of a crop will result in the loss of the next crop, reducing the crop area and yield, or even in the loss of the first harvest when the weather is bad. Adherence to the cropping season plan, therefore, is a very important factor in determining the success or failure of production.

Figure 2. General relationship between water supply and water demand in a sample rice-based irrigation system.



Notes: Qs = Amount of water that can be diverted from the water source.
Qd = Gross water demand.

2. Assuring good operating conditions of the irrigation system.

   Irrigation systems are in operation to provide water for 3 crops in a year. The repair of physical structures and machines, and desilting are scheduled to be carried out within a one-month period, so they must be done within the shortest time possible.

   River water contains a large amount of silt cm- - 1.0-3.0 kg/m^3. During floods, silt is deposited in the intakes of headworks. The amount of silt reaches more than 1 million m^3, including that in the main conveyance and in the field canal network. Desilting is mainly carried out by machines and manual labor when the amount of silt deposited in the intake of a headwork is 500-2,000 m^3.

   Both electric and diesel pumps are used widely for irrigation in Vietnam. As their usage is continuous, the repair of structures and machines must also be carried out regularly and on time.

3. Draining rain water for winter crop cultivation.

   Timely draining of rain water for winter crop cultivation should also be considered. Norms of field drainage for dry crop cultivation were promulgated in 1978 by the Ministries of Water Resources and Agriculture.

Research and Extension

Research institutes such as the Institute for Research in Water Resources, the Institute of Science in Agriculture, the Institute of Food Crops, Corn Research Institute, and central and provincial extension agencies of the Department of Irrigation, the Department of Cultivation and others have been involved in crop diversification. Research being carried out is on major crop varieties and cultivation technology for increasing crop yield with emphasis on:

1. The cropping season and its relation to cropping patterns in order to avoid the influence of unfavorable natural factors such as flood, drought, waterlogging, cold wind and rainfall.
2. Diversification of rice varieties. Rice varieties with different growth durations have been studied and selected. Early-maturing and very-early-maturing rice varieties are needed to make winter crop cultivation possible or to prevent loss of summer rice crop.
3. Technical procedures for the irrigation of rice crop and dry crops. The technologies used in cultivating corn, soybean and potato are examples of other fields of research.

Research stations and experimental fields of various institutes and extension agencies constitute an effective network for research and extension. These research stations are generally located in cooperative fields, and are conducted by agriculture and irrigation technicians and engineers. These serve as avenues for training cooperative leaders in agricultural production, farmers, and agriculture and irrigation workers at the farm level.

Pamphlets and easily understandable guides and manuals on irrigation and crop cultivation techniques have played an important role in improving farmers' knowledge and competence in agriculture.

Government Policies for Promoting Crop Diversification

Some incentives offered for the cultivation of winter crops are:

1. Sufficient supply of fertilizer and seeds.
2. Lower input costs.
3. Adequate electric power for pumping.
4. Free water service. In some provinces, water service is given free to encourage farmers to cultivate winter crops. Irrigation costs are subsidized from the provincial budget although this continues to be a subject of debate.
5. Availability of markets and reasonable market prices for winter crops.
6. Increased investment capital for irrigation management. Priority should be given to the enhancement of desilting and repairing of irrigation facilities.

Constraints to the Implementation of Crop Diversification

The fragmentation of diversified cropped area results in increasing costs of irrigation and difficulties in system management. Taking into account the overall costs of input, it is clear that costs are still high despite some inputs being provided at a low price.

The market for farm products is unstable and the processing industry for agricultural products is still not available. Some locations produced more garlic, chili, water melon, etc., but these were unmarketable, making farmers lose interest in nonrice crop production.

CONCLUSIONS AND RECOMMENDATIONS

Crop diversification in rice-based irrigation systems involves problems with regard to research, technology and cost. Its development depends not only on physical conditions but also on farmers' cultivation habits and government policies. There is a need to study its overall benefits on the basis of various cropping patterns as well as policies supporting the implementation of crop diversification.

There is also a gap between research and extension. In Vietnam, cropping seasons, cropping patterns and infrastructures for restricting adverse natural influences on crops are still objects of research and extension activities. In this regard, the cooperation between international agencies and national institutions, especially between IIMI, FAO and Vietnam under the TCDC spirit, is of great significance. The cooperation can be based on the following:

1. Establishing methodologies for crop diversification in irrigation systems on the basis of market-oriented mechanisms.
2. Evaluating overall benefits of crop diversification as a basis to determine optimal cropping patterns.
3. Assessing optimal irrigation system performance under crop diversification conditions.
4. Upgrading physical conditions of the irrigation system to improve system performance.

Summary/Highlights of Discussions: Country Reports

THE COUNTRY REPORTS consisted of papers from the nine participating countries. They discussed their relevant experiences on irrigation and irrigation management, irrigated rice-based farming and crop diversification. They also presented programs/strategies and problems related to promoting crop diversification, and linkages with national, regional and international agencies and institutions. The following highlights the discussions which followed after each presentation.

BANGLADESH

In terms of the strategies to improve the research-extension linkage, it was mentioned that several years back, the extension services did not know what was being done in the research sector. Under the Agricultural Extension and Research Project, however, adaptive researches are now conducted in farmers' fields and the specific practices are recommended only if accepted by the farmers. The research-extension linkage is now stronger because of the creation of district and regional technical committees composed of researchers and extensionists who meet regularly.

The government sector provides support services while the private sector takes charge of fertilizer supplies. Some nongovernmental organizations are also involved in fertilizer marketing.

The profitability of crop diversification can be improved by using nonrice crops which can very well compete with rice. A stable price and an available market for nonrice crops are also essential.

There seems to be no indication that the area grown to nonrice crops is increasing or that diversification is decreasing. There are no clear policies which facilitate crop diversification nor are steps taken to monitor whether strategies to implement it are really working. The need for an improved monitoring process is recognized.

The information base is modified regularly according to the availability of the results of research and extension activities. The participation of farmers' associations is enhanced to make easier delivery of support services. To deal with small holdings, government-based farm cooperatives are created. For example, there are water user groups in gravity irrigation systems.

INDIA

It was mentioned that it is not possible to have two crops of rice a year in India although there are pockets of areas where this can be done. In Nepal, there are river areas in the south where three

crops of rice a year can be grown, especially where the climate is sub-tropical. In India, however, especially in the northern states, temperatures sometimes become too low to have a rice crop. There are no rice varieties yet for the cold areas. In addition, light incidence is very low in the cold areas. Rice needs more than 6 hours of sunlight.

Water availability during the second season in most rivers is not sufficient for the rice crop. There may be pockets of areas where this is not the case, but they are not significant with respect to the total irrigable area. Varietal demand and price may also have an effect on the rice crop.In relation to rice self-sufficiency, India's rice requirement is around 20-25 million tons a year. It is very difficult to enter the rice world market. Rice production is highly subsidized - - at 50-60 percent.

There appears to be no recommended methodology yet to convince small farmers to shift from rice to nonrice crops. Training of farmers and providing them with information on the productivity of other crops may be helpful.

Again, as regards monitoring, policies should be developed to have a good system. Research may support the formulation of policies which are useful in evaluating the strategies implemented.

An important question is whether the government can impose cropping systems on the farmers. Changing a cropping pattern needs a lot of structural adjustment.

INDONESIA

Indonesia is now exporting rice. Irrigation service fee rates are based on the land type, topography and the farmers' ability to pay. Irrigation cost can be reduced mainly through proper management.

In terms of planning for crop diversification in irrigated areas, irrigation is already considered a part of crop diversification. All sectors concerned have to focus on this issue. Agricultural research is oriented towards crop diversification, the government makes relevant policies and provides the appropriate extension activities, and the farmers are given the necessary training.

It has been the government's policy to first become self-sufficient in rice, and then go for other crops. Indonesia became self-sufficient in rice in 1985.

The success of any policy partly depends on monitoring to assess whether the policy objectives are attained or not. For diversification, a much deeper meaning is given. Other than just looking at nonrice crops, the idea of commercializing crop production is also given emphasis. Crop diversification should be based on commodity, area and income.

MALAYSIA

With better employment and income opportunities in the cities and industries, farmers are leaving the farms. As a result, Malaysia is facing an acute shortage of farm labor. Mechanization is needed but farm type and cost have to be determined. There is also a need to overcome conservativeness/ traditionality. Steps should be taken to attract young people to the farms. Agribusiness is the key to crop diversification. This is being addressed by forming farmers' groups.

NEPAL

Irrigable area in Nepal is based on land use maps which also take into consideration water resources and climatic factors. The extent of irrigable area was determined by consultants approved by the government.

The average amount of rainfall is about 2,000 mm. The rainy season is between mid-July and mid-August. This is the rice growing period for the rainfed areas. The average national yield is about 2 t/ha.

THE PHILIPPINES

The Mount Pinatubo eruption has put out of production about 50,000 ha of irrigated area and 30,000 ha of rain-fed area. The effect on total production has been minimal, and due to a good harvest last year, there are no plans to import rice this year. A more immediate impact is the dislocation of the farm population. The eruption is still going on and planning for rehabilitation work is therefore, not easy. Water quality is another important issue under consideration. Sediment content is estimated to be up to 400,000 ppm. Groundwater is also affected and has been found to be acidic. It is hoped that the affected areas can still be put back into production.

The physical and chemical composition of the lava showed that the material is inert and may not have any immediate benefit in terms of soil fertility. However, the high humidity and temperature are conducive to active organic activities which can break down the chemicals in 3 to 5 years. In areas with an ash-cover of 6 inches or less, the farmers are advised to till and mix it with the underlying soil. In areas with an ash-cover over 6 inches, the ash cover has to be scraped down to 6 inches and then mixed with the soil. The pH of the ash is almost neutral (6.3-7.8). Of greater concern is sulfur, which is poisonous to the crop roots and affects productivity. However, the problem is temporary since sulfides could be released to the atmosphere.

The amount collected as irrigation fees is nominal and not enough to cover the actual O&M costs. The irrigation subsidy is in the form of soft loans for the improvement of communal systems.

Price support for rice is for the purpose of achieving self-sufficiency. Crop diversification is geared towards increasing crop intensity, especially in areas where water is not enough for rice during the dry season.

Since it is possible to have three crops a year, a definition of crop diversification could consider solving nutritional imbalances of the local diet. In the Philippines, crop diversification is more commercially oriented. Farmers should graduate from subsistence to commercial objectives to improve their economic status. For example, in the Ilocos provinces, when a tomato paste factory was set up, the farmers were encouraged to grow tomatoes and the response was good. This arrangement appears to be successful. The nutritional imbalances can be overcome by encouraging household garden plots. Small farm reservoirs are not economically feasible/viable in Bangladesh because the amount stored is often not enough to satisfy the requirements during the dry season. In the Philippines, however, this technology serves as a source of additional income because of additional crops during the dry season, which are not possible without the reservoirs. In addition, the reservoirs are being used for fish production.

In terms of solving water management problems for rice and nonrice crops, the Philippine experience has shown that there is no need to change the main irrigation system management to support crop diversification. Most of the adjustments are done on-farm by the farmers themselves.

SRI LANKA

The alternative crops for rice are chili, onions, vegetables, banana, sugarcane and pulses. These are chosen because of their high profitability. The usual sources of irrigation water are the minor tanks where there is no need to lift the water. These have small reservoirs and the flow is by gravity.

In the dry zone, run-of-the-river irrigation systems use water from rivers in the central hills of the wet zone diverted through long trans-basin canals. Also, drainage water is recycled in these areas.

The government has pushed the formation of farmers' organizations which have specific responsibilities. These organizations begin at the tail-end portion of the canal. The farmers are involved in the cleaning and general maintenance.

Crop diversification has resulted in increased farm income primarily because there is water even in the dry season.

THAILAND

A distinction is made between temporary and permanent diversification. In areas with permanent diversification, there is no rice. In the temporary diversification areas, the common crops are sesame, groundnut, onion, tobacco and mungbean. This is true especially in the central plain region.

Thailand has 3.5 million ha of irrigated area but not all are planted to rice. About 1 million ha are used for other crops. Rice is grown in the wet season and along with other crops (sesame, watermelon, garlic, tobacco, etc.) in the dry season. There is very intensive land use in the irrigated areas of the central region.

While the export value of agricultural products has doubled, it has declined in terms of the percentage of total exports. The reduction is due to the export of finished products which were exported as raw materials earlier.

Rice production is subsidized by providing water to the farmers free of charge. Fertilizer supply is subsidized for rice and also for other crops. Thai farmers are provided with many incentives. The network may benefit from this information and strategy.

VIETNAM

There are about 700,000 ha in the coastal areas where crops are produced. Fresh water comes from reservoirs and rivers. Sea water intrusion is prevented by the water from rivers.

The rate of growth of the area planted to nonrice crops is high, at about 12.5 percent per annum. Out of the 5.3 million ha of irrigated land, only 2.2 million ha are used in the wet season, and 1.8 million ha in the dry season. About 5 million ha are devoted to nonrice crops. All the areas that have been destroyed during the war are now cultivated.

Corn is transplanted after the winter rice crop and is grown using residual moisture. About 400,000 ha are planted to this crop with a yield of about 4 t/ha.

Crop diversification depends on the availability of water. The cooperative leaders decide when to grow rice. The farmers decide on the first and second crops.

To strengthen the O&M of systems, there are programs which are aimed at improving organizational and irrigation procedures. The investment of the government is based on the production of rice. About 5-8 percent of the total production is invested in irrigation. There is almost a 100 percent collection efficiency, and 30 percent of the amount collected is used for O&M costs. Even before planting, an agreement with the farmers as regards the irrigation fees is reached. Irrigation fees are paid in cash or in kind (rice).

GENERAL DISCUSSION

The practice of year-round irrigation has recently been started in Sri Lanka. However, this is being done only in nucleus farms organized by farmers. These were specially set up in areas alongside main and lined canals to enable farmers to respond to market demand at any time.

Malaysia is looking for modules and curricula for training. The experience in Sri Lanka in this area can be shared with Malaysia.

The importance of incentives and government interventions to promote crop diversification was emphasized. The provision of adequate credit, suitable infrastructures, and appropriate markets are some possibilities. The government can also play a significant role in searching for appropriate markets and providing the price signals for farmers to respond to. The role of cooperatives should be strengthened. In Indonesia, the government puts more emphasis on the export market.

Irrigation management as a measure of the success of crop diversification was mentioned, particularly when water delivery is used as a tool. If water is used efficiently, then the strategy may be considered a success. In Thailand, irrigation management is partly used to push crop diversification.

WORKSHOP GROUP REPORTS

Workshop Group Reports

THE GROUP WAS divided into two smaller groups after the presentation and discussion of the country reports. More detailed discussions focused on research and development, information dissemination and exchange, and funding and organization.

GROUP I: RESEARCH AND DEVELOPMENT

With respect to rice culture, the group identified three possible situations which may exist in the different network member countries. Like Bangladesh, most countries aim for rice self-sufficiency or near self-sufficiency. In the case of Thailand, production of rice is oriented towards export. Malaysia, on the other hand, sets a target of meeting 65 percent of the requirement from local production and filling up the gap through importation.

In discussing the commonalities and/or differences in experiences and strategies for promoting crop diversification in rice-based systems, the group first discussed the objectives of crop diversification. Along with these objectives, they identified research and development measures which have been successfully employed, constraints in the promotion that could be addressed by research and development, pressing research and development issues, and appropriate research-extention linkages.

Objectives of Crop Diversification

1. Enhance farmers' income level.
2. Achieve self-sufficiency in food.
3. Provide inputs to agro-based industries.
4. Optimize use of water for agriculture.
5. Generate employment in the countryside and rural areas (except in Malaysia).
6. Increase productivity under irrigated agriculture.
7. Attain a balanced diet and improved nutrition level (applies only to the Indian subcontinent).
8. Maximize land use.
9. Reduce pressure on O&M of irrigation schemes.
10. Enhance import substitution.
11. Promote export of nonrice crops.
12. Provide sustainability of agriculture.

Common Strategies to Promote Crop Diversification

As a strategy to promote diversification, the group emphasized the role of research and development, and policies. These include the following areas:

1. Extension services.
2. Training and study tours.
3. Piloting and field-testing.
4. Reorientation and improvement of irrigation system O&M.
5. Group or contract farming.
6. Subsidies (inputs, prices, credit).
7. Marketing and infrastructure.
8. Zoning and identification of suitable areas for crop diversification.
9. Trade (tariff, duties, levies).
10. Crop insurance.
11. Irrigation service fee rates.

Research and Development Outputs Found Useful

1. Market research for demand.
2. Planting schedule.
3. Optimum cropping pattern.
4. On-farm water management.
5. Main system management—pilot-testing.
6. Adoption of expert advice.
7. Use of high yielding varieties (HYVs) of crops.
8. Augmentation of water supply.

Constraints in the Promotion that can be Addressed by Research and Development

1. Lack of an adequate database.
2. Inadequate system drainage.
3. Lack of knowledge of technology relating to production and postharvest.
4. Lack of market information.
5. Lack of price support policies.
6. Lack of information on sociocultural aspects.

Pressing Research and Development Issues

1. Conjunctive use of surface and ground water.
2. Database.

3. System drainage.
4. Production technology.
5. Pilot-testing of management changes, and assessment of successful cases.
6. Market information.

Appropriate Research-Extension Linkage

At the institutional level, the full involvement of the irrigation agency in research and extension activities should be enhanced through some mechanism. It is believed that any improvement in the existing R&E linkage can benefit crop diversification.

GROUP II: INFORMATION EXCHANGE AND DISSEMINATION, AND FUNDING AND ORGANIZATION

The group also discussed the objectives of crop diversification before discussing the commonalities and differences in promoting crop diversification in the different countries.

Objectives of Crop Diversification

1. Optimal utilization of resources.
2. Increased farm incomes.
3. Improved nutrition in farmers' diets.
4. Improved soil fertility.

Common Experiences/Observations

1. Irrigation systems primarily designed for rice.
2. Serious problem in marketing nonrice crops.
3. No national programs on crop diversification except in Thailand, Malaysia and Bangladesh.
4. Lack of a monitoring and evaluation mechanism for crop diversification.
5. Labor shortage during peak periods.
6. Lack of mechanization.

Common Strategies in Promoting Crop Diversification

1. Adequate incentives like timely supply of agricultural inputs, fertilizers, seeds, etc.; easy access to credit; and subsidized inputs.

2. Market information.
3. Effective extension systems.
4. Suitable infrastructures, transport and storage facilities.
5. Efficient inter-season management.
6. Contract farming.
7. Stronger coordination among government agencies.
8. Crop insurance.

Strengths and Weaknesses

Representatives of the different countries presented specific examples of successful extension programs. Most of these were related to specific commodities like gherkin, sugarcane, rice and tobacco. Others presented experiences on the control of tungro disease, provision of seeds, and crop diversification. It appears that these programs became successful because of adequate credit, availability of inputs, availability of funds and government support.

The group identified the lack of specific government plans and an integrated crop diversification program as major weaknesses. In cases where programs exist, these are hampered by weak coordination among the agencies involved. The availability of funds for a crop diversification program in Malaysia and the creation of a coordinating body like the **NCCD** in the Philippines were considered positive steps towards crop diversification.

Research-Extension Linkages

Pilot projects provide a good testing ground for strengthening the linkage between research and extension. A national coordinating body may also be very helpful.

Role of the Network to Facilitate Promotion

1. Circulate news of successful policies and important information among different countries.
2. Prepare material documenting successful policies intended for use by policymakers.
3. Circulate research papers on integrated crop diversification through the newsletter.

New Network Ventures

1. Study tours for middle-level managers.
2. Cross-visits between neighboring countries.
3. Training, making use of existing facilities in the member countries.
4. Action program on market information system development.

Funding

1. Two-way funding program between IIMI and the network member countries.
2. Partial funding of on going programs which have irrigation and crop diversification components.

GENERAL DISCUSSION

The discussion of the two group reports highlighted a number of issues. As regards the action program which the network may immediately undertake, the problem on market information was mentioned. What is desired is a market information system which can be used by planners and farmers alike. Some simulation work can be done with existing data to predict prices. The system can also provide a mechanism to inform the farmers. This was identified as a common problem which all members can undertake.

IIMI is not a funding agency. So far, it has only provided funds to support publications like the newsletter and workshop proceedings, and to coordinate the annual workshops. IIMI, however, can lubricate the process of looking for and sourcing out funds.

The lack of a coordinating mechanism to orchestrate the activities of the different government agencies in the different countries was again pointed out as a major weakness. Some member countries are now considering creating a similar body like the NCCD in the Philippines.

Mr. Abernethy also mentioned a plan to conduct a study tour for middle-level managers in countries with environments different from those prevailing in the network member countries. The German government has signified support for such an activity for representatives from ASEAN countries, to conduct an observation tour in Egypt and Morocco.

WRAP-UP AND CLOSING SESSION

Wrap-Up And Closing Session

IN WRAPPING UP, Mr. Abernethy stated that it is not surprising to observe commonalities in irrigated crop diversification among the participating countries. It is also apparent that there are differences in strategies that the countries adopt to promote crop diversification in view of varying situations. In some countires, there is a labor shortage. In others like Bangladesh, the landholding is a very small. In Sri Lanka, there are resettlement projects.

The IMCD network has now reached a stage in which member countries can share experiences which can facilitate identification of the direction that irrigation management for crop diversification should take. Some questions can be answered by success stories from some countries. There is, however, a need to establish performance indicators or criteria to evaluate crop diversification. The policy objectives must be viewed vis a vis the results of related activities. In Thailand, the objectives of enhancing farmers' income and improving the utilization of water have been given attention. There will come a time when irrigation will have to compete with other uses of water.

The farmers themselves are an important component in the irrigated crop diversification system. Most of them still have doubts and resist changes. They should have a clear understanding of the benefits of diversification. Rice production is easier to do, requires less care/attention and low cash inputs. Moreover, rice has a stable market. The question of the comparative advantage of cultivating nonrice crops in irrigation systems designed for rice should therefore be addressed. The shortage of labor should likewise be considered.

The interrelationships among the different components in irrigated crop diversification should be well understood. Water is delivered by the irrigation agency; support services like credit and other production inputs are given by the agricultural agencies; while the farmers use these inputs and services to produce the crops. The question is to reorient the system so that all three components will work harmoniously. Reorientation could be effected through persuasion and negotiation among the sectors involved. Greater attention should now be given to this reorientation process.

Irrigated crop diversification may be moved through the provision of appropriate incentives and assistance provided by the government. An effective market information system has the potential of triggering this shift. Farmers will go out of rice monoculture if they are convinced that other crops have a market that can give them much higher incomes compared to rice. The change is more likely to happen with the provision, for instance, of necessary storage, postharvest and market facilities for nonrice crops, including more selective customers.

At the closing ceremony, Mr. Abernethy thanked all participants on behalf of IIMI. He also thanked the chairmen and rapporteurs, the organizing committee, and a consulting firm which gave donations for the activity.

Dr. Suprodjo said that the workshop consisted of lively discussions and exchanges of experiences among the participating countries. He described it as "mentally recharging." He also thanked IIMI and DGWRD for selecting the University of Gadjah Mada as the venue of the workshop.

Dr. Raja Rao spoke on behalf of the participants. He also thanked IIMI for its efforts in organizing the workshop.

Dr. Miranda likewise thanked the participants for presenting the papers and for their overall active participation. He also commended the workshop secretariat for a job well done.

APPENDICES

Appendix A

Field Visits and Observations

IN ADDITION TO the workshop deliberations, arrangements had been made for the participants to go on field visits to areas with activities relevant to irrigation management and crop diversification.

Surjan Farming System in Kulon Progo District

Kulon Progo District is divided into 12 sub-districts consisting of 80 villages. Most of the people depend on agriculture for their livelihood. The northern part of the area is a mountainous region stretching from east to west, while a wide lowland area (valley) comprises the southern part.

During the rainy season, some areas (Temon, Wates, Panjatan and Pengasih) are flooded but water shortage is experienced during the dry season. For this reason, farmers developed a system called the "Surjan Farming System."

The surjan system has the objective of harvesting rice in basin strips, and *palawija* (upland crops) and vegetables in elevated strips throughout the year. The system also addresses the problem of flooding during the rainy season, and water shortage during the dry season.

The crops grown at the surjan system are: 1) rice, 2) all kinds of beans and root crops, 3) vegetables, including onion and chili, and 4) a combination of 2 and 3.

Pijenan Irrigation System, Bantul

The system exemplifies the role of farmers' organizations in irrigation management. In this system, the farmers belong to a committee, the "Eleven Committee," named after 11 villages taking water from the Kamijoro Canal to irrigate their land of 2,226.85 ha. The committee was organized in 1953.

The committee was formed to overcome water shortage for irrigation which was caused by sand deposition at the culvert of the Kamijoro Canal. Farmers work together without compensation (*gotong royong*). They also contribute cash and material goods to address problems, particularly those related to infrastructure.

The cropping pattern followed in the system is upland crops (generally soybean) - first rice crop -second rice crop. These crops are planted in May, August, and January, respectively.

Small Irrigation Scheme in Ketonggo

In Yogyakarta, small irrigation schemes with areas of less than 150 ha are to be turned over to the farmers. However, for some reason, schemes with less than 100 ha are given priority at this time. Ketonggo Dam which is located at Bokoharjo village, Prambanan sub-district, is included in the turnover program for the year 1990-1991.

Previously, the dam was a village dam built by the people, using their own resources. In 1979-1980, the dam was rehabilitated by the government and turned over on 30 July 1990.

The Ketonggo irrigation scheme earlier covered an area of 50 ha - 27 ha in Yogyakarta and 23 ha in Central Java. However, because of the increase in tourism in the Prambanan Area, the irrigation scheme has been reduced to only 13 ha - 8 ha in Yogyakarta and 5 ha in Central Java.

The cropping pattern is rice-rice-palawija. Soyabean and groundnut are two types of palawija grown.

Tirtoyoso I Opak Irrigation System

The visit to this system provided a chance to hold discussions with a Water Users' Association (WUA). The association was established on 17 March 1982. Before 1979, the area did not have any irrigation. In 1972, construction of a dam was started, followed by construction of a canal network.

The association carried out its activities from 1982 to 1986. Irrigation fees equivalent to 75 kg of rice/ha were collected from each member during the harvest. The amount collected was used for maintenance and rehabilitation of the canal network, and to pay for services of the officers of the association.

From 1987 to 1989, the committee became inactive and no membership fees were collected. The committee was revived again in 1990.

Appendix B

Highlights of the Third IMCD Network Steering Committee Meeting

I. Attendance

1. Mr. Harunor Rashid, Bangladesh
2. Dr. R. Kulandaivelu, India
3. Ir. Soenarno, Indonesia
4. Dr. Prakriti S. Rana, Nepal
5. Mr. Chan Choong Cheong, Malaysia
6. Dr. Manuel M. Lantin,the Philippines
7. Mr. Jayantha Jayewardane, Sri Lanka
8. Ms. Anchalee Ooraikul, Thailand
9. Mr. Nguyen Manh Ta, Vietnam
10. Dr. Senen M. Miranda, IIMI
11. Mr. Charles Abernethy, IIMI
12. Dr. Donald Parker, IIMI
13. Dr. Amado R. Maglinao, the Philippines

II. Call to Order

The Steering Committee (SC) Chairman, Ir. Soenarno, called the meeting to order at 5:07 p.m.

III. Approval of the Agenda

The agenda was approved as presented.

IV. Review of the Highlights of the Second SC Meeting

The committee reviewed the highlights of the second SC meeting held in Cabanatuan City, the Philippines on 13 December 1990. The highlights were approved after correcting the names of Ms. Ooraikul and Mr. Wong.

V. Business Arising from the Highlights

As regards country proposals, it was again mentioned that IIMI would assist the countries in fund sourcing. However, not all countries had submitted proposals to IIMI which would have consolidated them for presentation to fund donors. With regard to the proposals already submitted, Mr. Chan mentioned that Malaysia had submitted an outline proposal for advisory assistance. Indonesia had also submitted an outline proposal. Dr. Maglinao mentioned that the Philippines had submitted a pilot-testing proposal on management innovations. Likewise, he mentioned a related proposal that IIMI-Philippines presented during the recent IIMI program review. He also informed the group that the NCCD in the Philippines would be finalizing a comprehensive program on crop diversification.

Thailand had not submitted any proposal yet but was to do so later. Nepal had already written to irrigation centers asking for proposals. Bangladesh was to relate its proposal to existing programs. Sri Lanka was interested in studies related to the administrative structure.

The issue of a research framework also arose. Each country may have specific interests although general ideas may be consolidated, for example, studies on markets and market information. Dr. Parker emphasized that the framework should be defined on the basis of the suggestions of the committee.

Mr. Abernethy again emphasized that the countries should send the proposals to IIMI. The proposals can be built on what the countries are already doing.

It was suggested that information from related activities like conferences should be made known to the Network. This can be facilitated through the IMCD Newsletter. The case of the Asian Farming Systems Research and Extension Network which would hold a workshop in Bangkok during September was mentioned. Thailand may check on this.

A question was raised as to how IIMI can work with other networks which may have related activities, like the IRRI Network. Dr. Miranda mentioned that he had been in touch with Dr. Carangal, IRRI's Farming Systems Network Coordinator, regarding the IRRI network.

The group was also informed about the proceedings of the last workshop in the Philippines. The first draft of the document was already completed.

VI. Election of Officers

As the Vice-Chairman, Dr. M.A.S. Mandal of Bangladesh automatically becomes the next Chairman of the Steering Committee. Then the Committee unanimously elected Dr. Prakriti S. Rana of Nepal as the next Vice-Chairman of the SC.

VII. Other Related Activities

A. ***Research and Development*** - Dr. Lantin reported on the outputs that the R&D group came up with which were presented during the plenary session. He cited the different measures that were identified to have been done successfully in the different countries. Additional areas include drainage, etc. Because of the long list, there should be some kind of prioritization. Each member was requested to look at the list and submit it to IIMI for consolidation.

B. ***Information Dissemination*** - It was announced that the release of the IMCD Newsletter has been delayed. The first draft of the proceedings of last year's workshop has been completed and will be published. The members were also reminded to submit news items for the next newsletter.

C. ***Funding and Organization*** - The members were requested to submit innovative ideas on how to generate funds. A resolution had been passed last year requesting IIMI to give priority to irrigation management for diversified cropping. The proposals submitted by the member countries could strengthen IIMI's bid for more money for IMCD.

VIII. New Network Ventures

According to Mr. Abernethy, IIMI has been able to generate funds from DSE to sponsor an observation tour for middle-level staff of selected member countries of the ASEAN: Indonesia, Thailand, Malaysia and the Philippines. The observation will be in countries where diversification has been practiced successfully, like Morocco and Pakistan. This is a one-month tour/training which may be conducted in October 1992. The participants will be required to document their findings and relate them to irrigation management for crop diversification.

At present, funding is available for one participant per country. In this regard, the countries can start thinking of possible candidates. IIMI would send the invitations before the end of this year.

IX. Plan for the Third Progress Review and Coordination Workshop

The next workshop will be held in Bangladesh, following the usual arrangement that the annual event is to be hosted by the country represented by the Chairman. It was suggested to hold it in early 1993, either in late January or early February.

The following were suggested as possible themes for the workshop:

1. Successful case studies on IMCD.
2 More food through irrigated diversified crops.
3. Role of postharvest technology and marketing for promoting diversified cropping.
4. Drainage requirement for crop diversification.
5. On-farm water distribution facilities.
6. Reliability of water supply for crop diversification.
7. Farmers' role in irrigated crop diversification.
8. Strengthening support services and structures for IMCD.

Eventually "Ensuring Reliable Water Supply for Crop Diversification" was the theme chosen for the next workshop.

The members were requested to submit a suitable format for the country reports, and also suggestions for special papers to be discussed in the workshop.

X. Other Matters

At this point, the chair was turned over to Mr. Rashid who acted on behalf of the next Chairman, Dr. Mandal. After thanking Ir. Soenarno, IIMI and the members of the committee, Mr. Rashid proceeded with the discussion of other matters.

1. Mr. Chan raised Malaysia's request for additional members in the country representation. However, other Committee members felt that the present allotment of three per country is sufficient. In future, additional members may be considered as funding becomes available but observers would always be welcome.
2. It was agreed that new country membership should be limited to developing countries.
3. Cross country visits between neighboring countries are encouraged.
4. Funding remains obscure. During the first two years of the Network's existence, funding was provided by the Japanese government. In the third year, the Network will have to compete with other IIMI activities for funds. There will be no money specifically earmarked for the Network. Now that it is part of the CGIAR, IIMI can incorporate in its five-year plan, activities related to irrigation management for crop diversification, including the Network. It was reiterated to bank again on the resolution earlier prepared and to request the DG to officially inform the IIMI Board about the interest of the Network member countries.
5. Dr. Miranda was requested to send to all the Workshop participants a complete list of the participants with their contact addresses, telephone, telex and fax numbers.

XI. Wrap-Up

Dr. Rashid in his wrap-up comments thanked the committee for electing Dr. Mandal as the next Chairman, and Bangladesh for hosting the next progress review and coordination workshop to be held either in late January or early February 1993.

XII. Adjournment

The meeting was adjourned at 11:12 p.m.

Appendix C

Workshop Program

9 September (Monday)

Venue:	Seminar Room Fakultas Pasca Sarjana Universitas Gadjah Mada
Registration:	0800 - 0845
Opening ceremonies:	0845 - 1000
Welcome Address:	Ir. Soenarno, M.Sc. Director of Irrigation I (OC)
Opening Remarks:	Soenarjo Kaman Vice Rector for Academic Affairs Gadjah Mada University
Message:	Dr. Roberto Lenton Director General of IIMI
Statement of Objectives and Expectations:	Dr. Senen M. Miranda
Introduction of Participants:	Ir. Soenarno, M.Sc.

1000 - 1030 COFFEE/TEA BREAK

Session I: Country Reports

Chairman: Dr. Donald Parker

Rapporteur: Mr. Ananda Jayasinghe

1030 - 1115	Bangladesh
1115 - 1200	India
1200 - 1330	LUNCH BREAK

Chairman: Dr. Jose A. Galvez

Rapporteur: Mr. Harunor Rashid

1330 - 1415	Indonesia
1415 - 1500	Malaysia
1500 - 1530	COFFEE/TEA BREAK

Chairman: Dr. Effendi Pasandaran

Rapporteur: Mr. Mohd Adnan Mohd Nor

1530 - 1615	Nepal
1615 - 1700	The Philippines
1700 - 1745	Sri Lanka
1900	DINNER PARTY
	(Hosted by IIMI)

10 September (Tuesday)

Session I: Country Reports (continuation)

Chairman: Dr. Manuel M. Lantin

Rapporteur: Mr. M. Shahrin B. Yob

0800 - 0845	Thailand
0845 - 0930	Vietnam

0930 - 1000	General discussion of all papers
1000 - 1030	COFFEE/TEA BREAK

Session II: Small Workshop Group Sessions

Group I : Research and Development

Group II: Information Dissemination and Funding

1030 - 1200	Small workshop group briefing
1200 - 1330	LUNCH
1330 - 1530	Small workshop group sessions
1530 - 1600	COFFEE/TEA BREAK
1600 - 1700	Resumption of small workshop group sessions
1700 - 2000	City tour
2000	DINNER

11 September (Wednesday)

Session III: Small Workshop Group Reports and Closing Ceremony

Chairman: Mr. Charles Abernethy

Rapporteur: Dr. Amado R. Maglinao

0800 - 1000 Presentation of group output and discussion

Group I: Research and Development

Group II: Information Dissemination and Funding

1000 - 1030	COFFEE/TEA BREAK
1030 - 1100	Workshop wrap-up
1100 - 1130	Closing ceremony
1130 - 1215	LUNCH
1215 - 1400	Cultural visit to Kraton

1400 - 16 30	Cultural visit to Borobudur
1930	DINNER PARTY
	(Hosted by Directorate of Irrigation I)

12 September (Thursday)

Field visit to irrigated crop diversified areas

0715 - 0800	Yogyakarta - Kulon Progo
0800 - 0900	Visit to Surdan System in Kulon Progo
0900 - 0930	Travel to Pijenan
930 - 1000	Visit irrigation system in the red belt in Pijenan
1030 - 1100	Travel to Karang Ploso
1100 - 1200	Discussion with "OPPA"
	(Water User Organization)
1200 - 1230	Travel to Yogyakarta
1230 - 1330	LUNCH
1330 - 1345	Travel to Ketonggo
1345 - 1455	Visit small-scale irrigation system, and discussion with OPPA
1455 - 1500	Travel to Prambanan Temple
1500 - 1600	Sightseeing at Prambanan Temple
1600 - 1630	Return to Yogyakarta
1630 - 1730	Third Steering Committee Meeting
1900	DINNER
	(Farewell party hosted by PRIS)

Appendix D

Workshop Participants

Bangladesh

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