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.

References

Bangladesh Bureau of Statistics (BBS). 1986. The Bangladesh Census of Agriculture and Livestock, 1983-84, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.

BBS. 1990. Statistical Yearbook of Bangaldesh, 1990. Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.

Biswas, M.R. 1991. Balancing irrigation water for diversified crops. Paper presented at the workshop on "Irrigation Management for Crop Diversification," Bangladesh Agricultural University, Mymensingh. 5-6 March 1991.

Canadian International Development Agency (CIDA). 1990. Bangladesh Crop Diversification Program, Inception Report, Vol. I and II.

Mandal, M.A.S. 1988. Irrigation management for diversified cropping in rice-based systems of Bangladesh. Research Network on Irrigation Management for Diversified Cropping in Rice-based Systems, Colombo, Sri Lanka. IIMI.

Mandal, M.A.S.; M.A. Ghani and M. Huq. 1990. Management arrangements for accommodating nonrice crops in rice-based irrigation systems in Bangladesh. Paper presented at the First IMCD Research Network Annual Review and Workshop held in Manila, the Philippines. 10-14 December 1990.

Mandal, M.A.S. and M.T.H. Miah. 1991. Profitability of irrigation and non-irrigated crops in Bangladesh. Paper presented at the workshop on "Irrigation Management for Crop Diversification," Bangladesh Agricultural University, Mymensingh. 5-6 March 1991.

Mennonite Central Committee (MCC). 1990. Mennonite Central Committee Agriculture Program. Report No. 17. July 1990. Bangladesh.

Memorandum of Agreement (MOA). 1991. Action Plan on Oilseeds and Pulses: Fourth Five-Year Plan (1990-91 to 1994-95). Ministry of Agriculture, Government of the People's Republic of Bangladesh.

Planning Commission. 1990. The Fourth Five-Year Plan, 1990-95. Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.