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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