Management Arrangements for Diversifying Rice Irrigation Systems in Sri Lanka

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INTRODUCTION

SRI LANKA IS a 65,600-square-kilometer island with a population of just over 16 million. Seventy-five percent of the people are engaged directly in agriculture or related activity. Tea, rubber, and coconut are the main foreign exchange earners. Until the full impact of Sri Lanka's recent development effort was felt, considerable sums of money were spent to import rice and other subsidiary food crops.

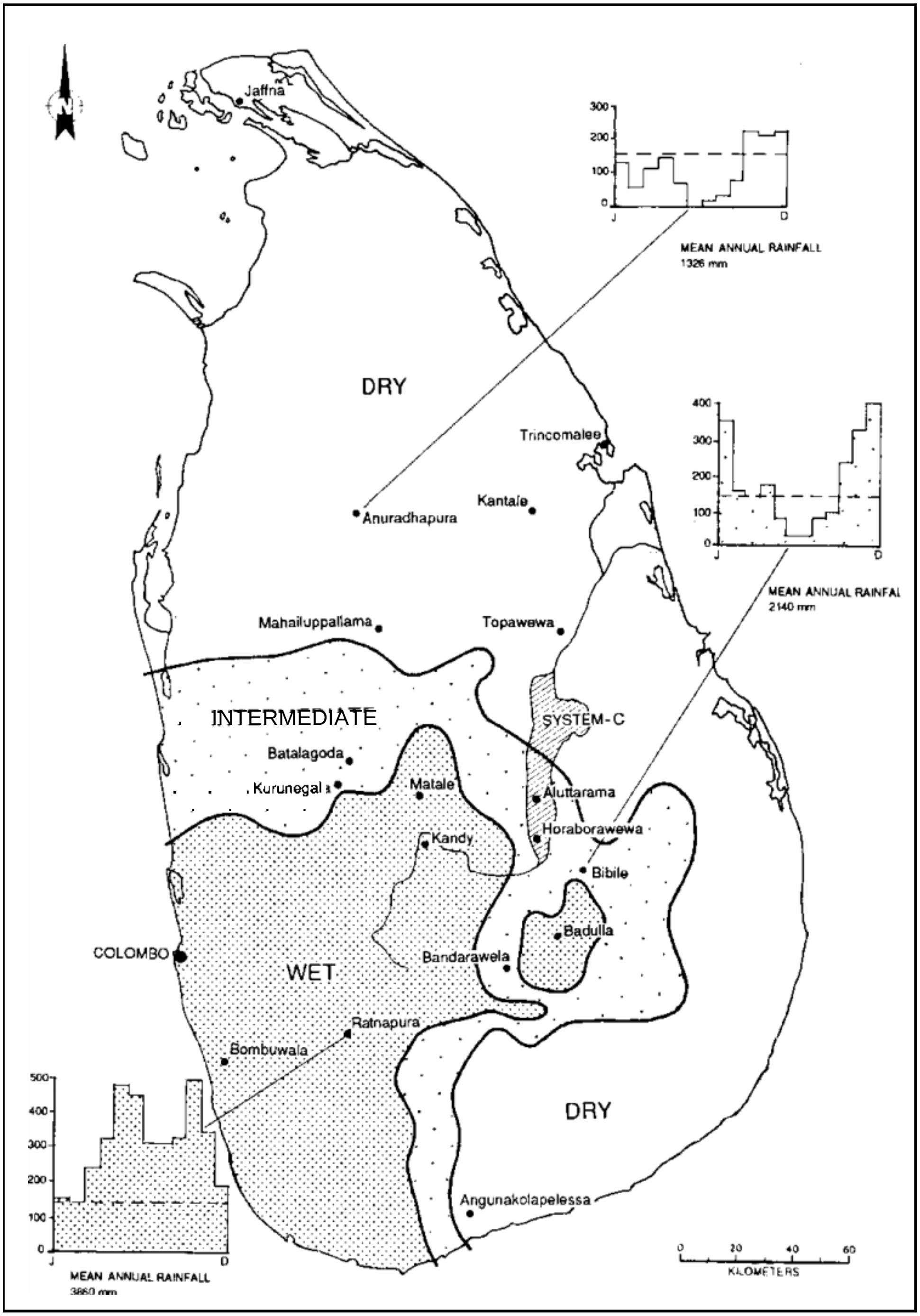
Sri Lanka is divided into three main agroclimatic zones, based on the annual rainfall and its distribution (Figure 1): the dry zone with an annual rainfall of less than 1,905 mm, the intermediate zone with 1,905 mm to 2,540 mm, and the wet zone with over 2,540 mm.

Sri Lanka's irrigation systems fall into two categories, which are basically differentiated by their command areas: major irrigation systems with a command area of 80 ha or more, and minor irrigation systems with command areas below 80 ha.

Most of the irrigation schemes, including the Mahaweli areas, are concentrated within the dry zone owing to the abundance of land, sparse population and the shortage of water. Solar radiation is the most favorable factor for crop production in the dry season, whereas other climatic factors have a mixed effect.

The precipitation having a bimodal pattern influences crop production mostly in the dry zone. The major rainy season (rainfall around 950 mm), maha, occurs between mid-October and mid-January, and the minor rainy season (rainfall around 360 mm), yala, occurs between late March and mid-May. Although the total rainfall in yala is sufficient for short rain-fed crops, the main problem lies in the spatial and temporal distribution of the rains. Long, dry

Figure 1. Climate zones of Sri Lanka



spells are common within the season and the high wind velocities towards the latter part of the season make crop husbandry virtually impossible. Therefore, any type of cultivation during the yala season in the dry zone needs irrigation whether within rice lands or on highlands.

Diversification during the maha season is somewhat difficult owing to the conditions that prevail in the area during this period. The cloudy skies, high rainfall and very wet soils create unfavorable conditions for other field crops unless they are established before the high rainfall period and after adequate drainage facilities are provided. Since rice can survive such conditions, it thrives during the maha season.

The yala season is relatively more favorable for Other Field Crops (OFCs) or nonrice crops, which can withstand soil moisture stress for short periods better than rice. The consumption of water by OFCs is much less than ricr during their growing period. Evapotranspiration increases to about 6.0 mm per day in yala compared to 3.5 mm per day in maha. Thus crop water requirements also increase during yala. Under such conditions rice needs more frequent irrigation, and in a water scarce situation, yields of rice become very low and uneconomical. If irrigation water is not guaranteed, the farmers, due to the high risk involved, use only a low level of inputs as a measure of economy, thereby not expecting high yields and high profits.

Under yala conditions therefore, the cultivatioii of OFCs becomes more profitable. Furthermore, it allows a greatrr area of land to be cultivated with the same amount of water than when rice is cultivated. However, thr major soil group in the dry zone, Reddish Brown Earths (RBEs) or Rhodustalfs and their associates, play a key role in growing OFCs. Sudden high intensity rains, which arc very common during the yala season, lead to slaking, surface sealing, erosion and temporary waterlogged conditions. On the other hand, a few days without water will make the soil very hard and unworkable. Both these extremes adversely affect OFC cultivation. On-farin drainage as well as system drainage facilities are important when growing crops other than ricr on irrigated ricr lands.

Continuous desiccating winds during the latter part of the yala season, increases the crop evapotransporation to a peak between 6 and 7 mm per day. This makes it necessary for the crops to have derpcr root systems for better absorption of water. Thus, even though the plant may have suitable characteristics for cropdiversification in rice fields, physical impediments also play a major inhibitive role.

Conditions during the yala season are very favorable for biomass production if provided with adequate amounts of nutrients and water. Yet, the major constraints to be considered arc thr extensive and proliferating weed growth which smothers the crop if uncontrolled, and the associated pests and diseases. The soils of the dry zone carry a high population of disease organisms and soil-borne pests. Yet, equally prevalent are the symbiotic organisms which increase thr yield, such as in leguminous crops.

The traditional cultivation pattern in the old villages in the dry zone, prior to the development of settlement schemes, was to store water from the monsoonal rains in the villagr tanks and use it for rice cultivation. There was also a unique cultivation arrangement known as *bethma* practices in these old villages. In a bethma system, the volume of water available in a village tank dictates the land area that could be cultivated. This land area is then dividrd among those in the villagr, based on the amount of land that each one has. The old (purana) villages were entirely dependent on the rains for their cultivation.

However, the assurance of water availability for a successful season is higher in the major irrigation schemes compared to the minor irrigation schemes. Every year, the land area left fallow is higher and the harvested area is lower in minor irrigation schemes, the problem being aggravated in the dry yala season. Table 1 gives details of the cultivable and harvested areas under major and minor irrigation schemes.

Table 1. ***Area under rice in major and minor irrigation systems (in '000 ha).***

Season	Major irrigation systems		Minor irrigation systems	
	Cultivable area	Net harvested area	Cultivable area	Net harvested area
Maha				
84/85	264.1	225.9	156.5	125.2
85186	267.9	225.3	151.4	118.8
86/87	278.3	236.4	158.9	129.2
87/88	292.3	248.3	163.2	134.0
88/89	281.1	238.2	153.7	123.1
89/90	295.2	250.3	150.7	119.8
Yala				
85	152.5	132.1	62.8	49.2
86	167.8	145.8	64.9	51.6
87	194.2	168.9	70.7	56.4
88	204.1	178.1	71.2	57.9
89	184.9	160.9	67.7	54.2
YO	191.4	166.1	66.6	53.6

In the late 1960s, the Extension Division of the Department of Agriculture (DA), recognizing the need for crop diversification in rice fields in yala. to enable the farmers avoid the risk of rice crop losses and obtain higher incomes, embarked on the initial testing of OFCs in major irrigation schemes. After these pioneering efforts, the rice-based fanning systems in major irrigation schemes took on a new dimension under the Accelerated Mahawcli Development Project (AMDP) when System H of AMDP successfully carried out a program for the cultivation of OFCs in rice fields during yala. The Annex is a note on the progress of crop diversification in the Mahaweli projects.

At present, farmers in System H grow a full rice crop during the maha season followed by OFC cultivation in well-drained soils and rice in poorly drained soils during the dry yala season. This rice-based cropping system is being gradually introduced to other areas where water scarcities occur, to enable the farmers get better incomes. Table 2 gives the details of rice and OFC cultivation since 1984 in Mahaweli System H and in the major/minor irrigation schemes outside Mahaweli. The security situation in the country in 1988 and 1989 had an adverse effect on OFC cultivation in certain areas.

The details of areas under crop diversification in some of the major irrigation schemes during yala 1990 are given in Table 3 together with the extent under rice in these schemes.

Table 2. Comparison of extents (ha) of rice and OFCs in Mahaweli System H and in other major and minor irrigation systems during yala.

Year	Mahaweli System H		Major/minor irrigation systems	
	Rice area	OFC area	Rice area	OFC area
1984	16805	5640	255000	6855
1985	10220	8570	207545	10085
1986	8570	12815	229290	14520
1987	3990	12680	175980	17120
1988	1460	8860	223240	13400
1989	1455	2290	183500	157601

'Information from some districts not available.

Source : Extension Division. Department of Agriculture.

Table 3. Pr ss of crop diversification in some major irrigation systems durin ,ala, 1990.

Irrigation scheme	Area (ha) under	
	Rice	OFC
Kantale	5838	226
Giritale	2935	719
Minneriya	8943	412
Kaudulla	4312	190
Rajangana	5000	1525
Huruluwena	2900	691
Mahavilachchiya	975	140
Nachchaduwa	2987	127
Inginimitiya	1200	1195
Dewahuwa	498	142
Minipe	4808	1041
Muthukandiya	720	85

Progress of Crop Diversification

Crop diversification in rice fields in Sri Lanka has developed to its present position due to a number of reasons such as:

1. The gradual banning of imports of subsidiary food crops starting in the early 1970s.
2. Higher economic benefits for farmers through higher net returns and cost benefit ratios with better product prices on some OFCs, compared to rice.
3. Frequent water scarcities in the low rainfall season yala, in most of the major irrigation schemes.
4. Better extension services and improved communication between farmers and agency officials.
5. Institutional support for crop diversification mainly through greater interest generated for irrigated crop diversification among policymakers.

Agencies Involved in Crop Diversification

The following sectors are involved in crop diversification in Sri Lanka:

Irrigation. Basically, the control of regulatory and conveyance structures as well as their maintenance in the major irrigation schemes outside Mahaweli is handled by the Irrigation Department (ID) while the Mahaweli areas come under the Mahaweli Economic Agency (MEA). The activities of the ID arr expanded through the Irrigation Management Division (IMD) which is responsible for looking after the interests of farmers mainly through farmers' organizations. Within thr minor irrigation schemes, maintenance of the reservoir and other structures and the control of water are basically the responsibility of the Department of Agrarian Services (DAS).

Agriculture. The MEA has its own agricultural staff for extension and farmer training and an efficient agricultural input system for the Mahaweli areas. The basic agricultural policy adopted by the Mahaweli is the national agricultural policy.

The DA carries out the extension work in the rest of the country through an intensive network of trained extension workers. It is also responsible for all agricultural research. Agrochemicals, fertilizer, machinery and implements are sold through the retail outlets of the Department of Agrarian Services (DAS) located in the Agrarian Service Centers set up in strategic places throughout the country.

Credit nnd insurance. Several public and privatr banking institutions extend credit facilities to farmers. viz., Bank of Ceylon, People's Bank, Rural Banks, Hatton National Bank, Commercial Bank. Crop insurance is effected through the Agricultural Insurance Board (AIB), a state organization. Due to their bureaucratic approach and lack of finances, the AIB crop insurance schemes have become failures.

Marketing and pricing. A number of state sector institutions such as the Cooperative Wholesale Establishment (CWE), Department of Marketing Development (DMD), Paddy Marketing Board (PMB) and Multi-Purpose Cooperative Societies (MPCS) are instrumental in the marketing and pricing of produce. In addition, the private sector plays a key role in marketing and pricing, a role which the state sector has failed to play. Floor prices are fixed by the government for some farm products, to encourage farmers to get a better income and to encourage the cultivation of these crops.

Mahaweli (a special case). Within the Mahaweli areas, irrigation, agriculture and other support services are all provided by the MEA. This enables a better coordination of all activities in relation to the services and inputs necessary for agricultural production. Although marketing and pricing are not handled by the MEA, it provides infrastructural support services such as storage space, transport to better markets, and arranging of forward contracts with interested buyers, etc., for the benefit of the farmers.

IRRIGATION PLANNING AND OPERATION FOR RICE-BASED SYSTEMS

Practices in Rice Irrigation Systems

Planning for the cropping season within Mahaweli areas. Planning for rice irrigation in the Mahaweli projects is started 60 days before the season using the rainfall and inflow probability values based on data of the past 30 years. Closer to the season, necessary adjustments are made to allocations to each area and within the area, from the main system. This is possible due to the reliable information and communication system that is in place, as well as the continuous monitoring and evaluation at each level of management within the Mahaweli on irrigation, agriculture and lands. The weekly progress is monitored specifically for agriculture and irrigation to enable necessary adjustments to be made at the system level. Usually, the maha season does not pose many problems of irrigation for rice cultivation since the demand for water is met by rainfall and supplementary rotational irrigation towards the end of the season.

In the Mahaweli areas, the opportunities for and the constraints to cultivation are discussed in a series of preseasonal meetings of smaller fanner groups, organized by the MEA staff, where consensus is rrached through effective communication and dialogue.

The Water Panel (WP), which consists of all senior officers of the departments and sections involved in irrigated agriculture in the Mahaweli downstream areas and those which benefit from Mahaweli water, meet once in the preseason and confirm the Seasonal Operational Plan (SOP) which has been formulated at all levels, starting with the fanners in the field. The WP has jurisdiction over all areas that receive Mahaweli water at some stage. The logistical backup and database for the WP is provided by the Water Management Secretariat (WMS), which operates at a higher intersystem level and plans and monitors very closely all activities in the cultivation areas covered by the WP.

Planning for the cropping season outside Mahaweli areas. Outside the Mahaweli areas, the situation is entirely different, where individual reservoirs or run-of-the-river systems (diversion schemes) have to manage their own systems and resources. They may have to depend entirely on the rainfall in their own catchment and its runoff. Planning officials have to wait until the reservoir is filled to a certain level so that at least selected areas could be irrigated. Farmers would like to cultivate with the minimum risk and therefore, even though the officials propose to start cultivation early with the first rains, they will not initiate any activity under water scarce situations. The allocations of water are made only after ascertaining the availability of water in the reservoir.

Under the Irrigation Ordinance, each irrigation scheme should hold a ***kanna*** (seasonal cultivation) meeting, immediately before the start of the season, to decide on the dates to begin and terminate the water issues for cultivations, which crop/crops are to be cultivated and other calendar deadlines for various activities related to cultivation. Farmers are informed of the available resources (mainly water), opportunities, options and expected problems at these meetings, and they are allowed to take decisions on the above aspects. Once the farmers agree on the dates and other matters, the decisions taken are confirmed.

The basic organizational structure for planning a cropping season in the major irrigation schemes is the Project Committee, which comes under the program for Integrated Management of Major Irrigation Schemes (INMAS). A Project Manager coordinates the functions of the line departments if that irrigation scheme comes under the management of the Irrigation Management Division (IMD) of the Irrigation Department. Otherwise the Government Agent (GA) of the district is entrusted with these functions.

At the district level, program planning, implementation and monitoring are supported by the District Agricultural Committee (DAC), chaired by the GA and consisting of the district heads of all the line departments. They meet once a month. The progress of cultivation, supply of inputs, marketing of produce and other field problems are discussed at these meetings.

Policy guidelines, decisions, and directions for the program are sent by the Central Coordinating Committee at national level comprised of the secrelaries of the Ministry of Land, Irrigation and Mahaweli Development and the Ministry of Agricultural Development and Research as well as the Heads of the Departments of Agriculture, Irrigation, Land Commission, and Agrarian Services and the slate banks.

The main functions of the Project Committee are to formulate and implement a cultivation program taking into account availability of water for the maha and yala seasons, to ensure the proper distribution of water, arrange timely provision of inputs and marketing facilities, arrange operations and maintenance programs for the irrigation system and organize farmer participation.

Assessing and matching water supply and demand. The Mahaweli areas have the necessary infrastructure for assessing and matching water supply and demand. In areas outside Mahaweli, facilities and staff are seldom available for the measurement and control of water, monitoring of activities, etc., to carry out these programs. The absence of sufficient hydrological data and its unreliability when available, are common to most major irrigation scbemes.

In the case of rice irrigation, management arrangements are not as effective yet to supply the optimum on-farm water requirement with respect to space and time although the total quantity may have been supplied. On-farm supply may be either continuous or rotational or both. It is very seldom based on the agronomic requirements of the plants. This apparently is due to the incapability or shortcomings of the delivery system and/or the reluctance of the management to take on extra responsibilities.

Allocation of water and land areo. Allocation of the land during yala is usually for rice cultivation in poorly drained soils which occupy the bottom of the valley or the catena. Although there is no legal requirement to do so, rice farmers are compelled to adhere to this drainage class due to the restricted issue of rotational water during yala. In Mahaweli, every effort is made to get as many farmers as possible to grow OFCs in well-drained soils in order to be able to cultivate as large an area as possible. The bethma system, referred to earlier, has also been tried out successfully in System H. Under this system, water is issued for cultivation only under selected distributary channels which are close to the source of water. Even in these distributary channels, the poorly drained soils at the tail end are not taken up for cultivation.

Modified practices to accommodate nonrice crops. In changing to OFCs from rice during the yala season, the Mahaweli system can generally cope with the planning needs since they have a good base of past hydrological data and performances. In the areas outside Mahaweli, such support information is not fully available for accurate planning. allocation of water and operation of their irrigation systems. Due to this shortcoming, the farmers have little faith in the system, or in the management, As a result, the allocation of land and water by the management has to wait until the season has almost begun, by which time the farmers have very limited options.

Some irrigation systems do not have the necessary infrastructure and adequate canal delivery capacity to supply intermittent flows for irrigating OFCs, although in some of the major irrigation schemes, the delivery system has been subsequently modified to cater to such requirements.

A major setback in accommodating OFCs in almost all the major irrigation schemes is that adequate drainage facilities to convey excess water from a heavy downpour have not been provided. Even if the on-farm drainage facilities are provided, OFCs may suffer substantially due to lack of surface drainage facilities. However, the undulating landscape provides for natural drainage in the dry zone where most irrigation schemes are situated.

Adequate on-farm drainage facilities are also necessary for OFC cultivation. On-farm land preparation has to be carried out within a shorter period for OFCs compared to rice, as relative dryness of soil is necessary. Consequently, the water requirement for land preparation is less for OFCs where only soaking to an optimum water content is necessary before working the soil. Unlike flat bed cultivation of rice, the method of seed bed preparation recommended and adopted for OFCs is the raised bed system. Farmers may adopt the recommended method or deviations from it such as flush basin flooding and broad bed and furrow systems, depending on their ability to bear the costs, and socioeconomic expectations.

The difficulty in demarcating the land precisely between the different drainage classes poses problems for officers as well as farmers. In addition, no precision leveling is done before farmers are given land. Seepage is very bigh along unlined canals resulting in an elevated groundwater table. The narrow moisture range of workability of reddish brown earths. which is the dominant soil group in the dry zone, is a constraint to promoting OFCs.

Only a few OFCs are tolerant to high soil moisture levels. No short duration varieties of OFCs with high productivity have been identified. Although some farmers have mastered the cultivation of OFCs in rice fields, the majority have yet to improve their field agronomic practices.

The requirement of cash and labor inputs is higher for OFCs compared to rice and the majority of farmers are not financially capable of investing or undergoing the risk of such investment. Institutional credit is not available to most farmers who have been rendered uncreditworthy due to weak monitoring by the banking agencies. Noninstitutional credit is available at any time, but at very high interest.

Farmer participation in management is an important aspect when scarce water has to be shared rationally under rotational issues of irrigation. Some major setbacks for such collective action are land tenurial problems such as leasing, subletting and other related land transfers, where the temporary occupant is not interested in participating in making improvements to or maintaining the system.

Low and unstable market prices as well as a lack of organized marketing Structures and storage facilities are hindrances to the development of OFC cultivation. The unpredicted and unplanned importation of locally produced crops leads to low market prices. It is also important that farmers are made aware that uniformity and high quality of their produce are important aspects of marketability.

As empirically observed, it should be noted that social norms and rituals also have a bearing on most of the decisions taken by the farmers. Auspicious dates and times, festivals and religious observance days, become a constraint to effective implementation of a cultivation program.

STRATEGIES TO ADDRESS CONSTRAINTS AND OPPORTUNITIES

Improvement of Irrigation Facilities

A more accurate database for all the major irrigation schemes based on rainfall probabilities, mean rainfall and inflow values should be developed so that effective planning could be done. This will help the management to take into account the different scenarios of water availability and plan accordingly for water and land allocation. As a result, there will be better integration of management and farmers.

Canal capacities have to be improved to deliver water up lo the tail end in equal quantities. This would entail better regulation and control measures and better maintained structures.

Improvements in Procedures and Practices

System *characterization and mapping*. Identification and mapping of different drainage classes of the soil in the command area under the field channel, with fair accuracy, may help the fanners as well as the management to decide, ahead of the season, what crops to be grown, what cultural practices to adopt, etc. Improvement of the monitoring capacities is important for the effective control of water at every stage of delivery to the on-farm turnout.

Simulation modeling. The rainfall-intlow-capacity modeling based on past available data will be of significant benefit for predicting water availability and cultivable areas.

Simulation modeling to find out thevarious input requirements, including water for OFCs based on the varieties and age classes of the different crops together with the ratio of OFC to rice on turnout and distributary-channel bases would help the management to make effective decisions. In addition, they will help project the effective cultivation of marketable produce and provide other information which will help farmers obtain better incomes.

Participation of farmers. One way of improving system management is to improve communications between themanagement and farmers as well as allowing fanners to share the responsibilities of management at least at secondary and tertiary levels. This will make fanners aware of the conditions which lead to management decisions and help create a better understanding.

Where leasing and other land tenurial problems occur, the temporary occupant should be invited to farmer group meetings and the importance of sharing water resources in an equitable manner explained to him. Regularizing such practices may be of advantage when attempting to solve farmer-participation problems. However, research has to be carried out to ascertain the best approach to such regularization.

A successful start has been made, in an informal manner, in the Kimbulwana Oya Irrigation Scheme where farmers have effectively participated in the management of the system.

Water augmentation. Most irrigation systems cannot cope with long-duration OFCs during the yala season, due to water scarcity. Most short-duration crops available are not high productivity crops and do not have high market prices. On the contrary, high productivity crops such as chili (long duration) and onion (requires frequent irrigations) need extra water. Farmers who grow high productivity crops should obtain additional requirements of water from a shallow well, which should be dug in their field and which will get water from canal seepage and groundwater.

Cropscheduling. The main objective of crop scheduling should be to match the duration of the different crops to the period of water availability and to take advantage of limited water resources. In addition, crop scheduling to obtain stable market prices is of paramount importance when farmers are encouraged to go for commercial agriculture. Any management changes should be for the sustainability of the system. An additional income could be obtained from a crop of short duration, established immediately after the maha season (as has been successful in Mahaweli System H early this year), taking advantage of the residual moisture (Annex). Sandwich cropping, as it is called since it is between two cropping seasons, will help to stabilize the market and increase the cropping intensity as well.

On-farm irrigation practices. Although technology is available for on-farm irrigation and drainage for OFCs, most fanners deviate from the recommended practice of seed bed preparation due, to the need for higher investment. Land prepared for this purpose can be used only for a single season. It also requires a considerable amount of labor during a period of peak labor demand. Therefore, it is necessary to consider an OFC/OFC cropping system in well-drained soils instead of a rice/OFC system. at least for a few years, until the soils require a different cropping system. This will allow farmers to make a one-time investment in seed bed preparation for OFCs and save such expenditure each succeeding season.

Farmer training. The training of farmers is an essential component of any crop diversification program. Such training must be supported by experienced and effective trainers, good training material and other infrastructure requirements. The achievenrents in the Mahaweli project and a few other irrigation projects in crop diversification during the last few years is mainly due to the active involvement of the extension workers (field assistants/*krushi viyapthi niladharis*), who were well trained and dedicated to extension.

Cropping for future local and foreign markets. The expansibility of OFCs is limited due to the national requirement of rice as the staple diet and the limited domestic demand for OFCs. Overproduction may result in the collapse of the domestic market with irreversible repercussions unless export markets could be found early.

Other field crops grown locally do not have a large export market unless they are processed into the products the export markets demand. Farmers should be made aware of the quality and type of products that the export markets take in, and their profitability if a diversification program is to be successful and sustained.

Alternatively, new crops for international markets should be tested in the dry zone for suitability and higher incomes. The Mahaweli Authority has been successful to some extent in this respect, where private entrepreneurs are actively cultivating exportable crops like gherkins, asparagus, and strawberries. Sri Lanka’s continued presence in the export markrt for a long period depends on its ability to compete with other countries. On the other hand, there is another school of thought which says that eventually it will be best to introduce crops which could feed the local market at a price lower than that for rice or wheat. This can help to replace a considerable quantity of the staple diet with a lower cost food. Cassava, sweet potatoes, and other yams which come under this class of crop, are already being grown in smaller areas under irrigation in rice fields. Import substitution will save foreign exchange.

Instead of short-duration OFCs, another alternative cropping system would be to introduce semi-perennial crops that do not require as much water as rice and thus, can survive no-water-issue periods. Banana, which is grown successfully under irrigation in Uda Walawe. and some other fruit bearing trees come under this category. After a few years of semi-perennial crops, rice can be cultivated for a short duration. This system does not, however, earn much foreign exchange for the country as export crops would.

Extension services. Extension services should be able lo cater to the growing need for technical and financial information for fanners who will be turning more and more towards commercial farming.

DIRECTION OF CROP DIVERSIFICATION

Research and Development

Stretching the limited water available during the dry yala season over a larger extent has to be the key issue in crop diversification. At present, land utilization, using the available water resources, is not at an optimum. It is either underutilization of land or overuse of water where available. The records of water use in most irrigation schemes show high usage both at ex-sluice and on-farm. On the other hand, the annual cropping intensities for two consecutive seasons are as low as 150 percent.

Crop diversification in Sri Lanka is supported by a number of agencies for various reasons, but mainly to contribute to the GDP and for import substitution. There is a growing awareness among the planning agencies on the need for crop diversification. For further acceleration of crop diversification the following aspects are important.

Agronomic aspects. The technology available for irrigated OFCs in rice fields is fairly adequate at present. The trend during the last few years on net returns of some OFCs is of a diminishing pattern due to diseases, pests and the high unit cost of labor and other inputs.

Research should be directed towards developing comparatively high yielding varieties of crops to overcome the increased cost of production. In addition, these varieties should be of short duration to minimize any risk of water stress.

Pure seed material of the varieties suitable for the situation should be available to enhance the income of every farmer. Hybrid varieties, which will give a uniform crop and thereby a higher marketability, are of paramount importance in this respect.

Research on different cropping systems involving various OFCs which may complement each other on resources requirements will be advantageous to farmers. Finding a wide range of crop combinations suitable for irrigated rice lands will give the fanners bener options.

Research should be conducted on reducing costs of cultivation of OFCs, through optimum use of resources and minimum use of costly inputs and even mechanization wherever possible.

New crops and new avenues should be explored for the local as well as export markers. Development of value-added products of processed food made from traditional and non-traditional OFCs should also be explored.

Irrigation aspects. Simple methods should be developed to assess the field irrigation requirements for different cropping systems and crop combinations. Suitable water application methods should also be explored.

The water requirements for land preparation under different systems of seed bed preparation have to be reassessed.

Macro-drainage systems have lo be designed for all the irrigation systems, the majority of which do not have proper drainage systems.

Methods to distribute water equitably among fanners as well as within a fann (on-farm) have to be evolved. The present distribution pattern necessitates high irrigation which has attendant social problems.

Farmer participation in irrigation management has to be looked at closely. This is now the government policy in Sri Lanka. Where and how best farmers can participate in the management of their delivery system have to be analyzed. At present, farmer participation is effected through farmers' organizations at various levels, perceived as needed by farmers and donor agencies. It is opportune lo study whether another concept is needed under Sri Lankan conditions, at what levels and in what form.

Marketing aspects. Stable prices and marketing support services havr to be analyzed to ascertain the factors which will give the optimum rate of growth without a crash in the market. In the meantime. cropping during the off-season lo "catch" high prices should also be explored.

Credit and financial aspects. Credit facilities should be available to all farmers irrespective of their creditworthiness. How these farmers could be made creditworthy should he analyzed. Monitoring of disbursements and repayment of credit are key issues neglected by most of the credit giving agencies. This is something which policy planners should focus on. A crop insurance scheme for other field crops is necessary.

Dissemination and Exchange of Information

Dissemination and exchange of information should be more effective in respect of the various subjects related to crop diversification such as irrigation, irrigation management, agronomy, marketing and finance. This process should not only be vertical but horizontal as well and both aspects should be of a reciprocal nature.

Funding

There is a growing awareness, among the planning agencies, of the seed for crop diversification. The institutions already active in this respect will continue to carry on with their projected programs with a gradual and careful increase in activities. These institutions will continue lo accommodate and expand the support for research and development, extension, marketing, etc.

It is unlikely that at present the country can afford to disburse funds for various studies required for crop diversification, except for obtaining the services of professionals. Funds are required for research on various aspects including irrigation, agronomy, socioeconomics, marketing, extension and training of officers and fanners, where special studies and projects have to be undertaken and information has to be collected and documented. Research and extension are of importance towards the integrated fanning systems approach, where rice/OFC cultivations in irrigable lowlands and the farming activities on highlands will complement each other for stabilized incomes, in the context of the small farmer.

Finally, the importance of coordination at national level cannot be overemphasized if the above requirements are to be fulfilled.

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