Crop Diversification Strategies for Minor Irrigation Schemes

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B. Marambe, U.R. Sangakkara and K. Azharul Haq, editors

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Foreword

OVER THE **LAST** few decades Sri Lanka has made determined efforts for crop diversification to raise farm production and improve the quality of life of the farmers. Significant progress has also been made and a large area has been brought under different crops, especially, chili and big onion, two very important cash crops. Most of these developments have occurred in medium and major schemes resulting in significant increases in the cropping intensity as well as in the participation of fanners.

Minor schemes which command around 42 percent of the total irrigated area of the country, however, did not benefit much from the crop diversification program and their cropping intensity continued to fluctuate between 80 percent and 90 percent for nearly half a century. At the same time, because of increasingly reduced return from rice farming, many farmers in these schemes are looking for off-farm employment to make a living. To understand the technical and socioeconomic dynamics and develop strategies for crop diversification in minor schemes, the Irrigation Research Management Unit (IRMU) of the Imgation department (ID) in collaboration with the Sri Lanka National Program (SLNP) of the International Imgation Management Institute (IIMI) organized a consultation workshop on Strategies for Crop diversification in Minor Imgation Schemes.

This volume is the report of the proceedings of the above workshop held at the Imgation Department, Colombo, Sri Lanka on 20 February, 1996. The workshop provided an opportunity to the participants from different organizations to exchange experiences and identify new approaches to crop diversification. We hope that the deliberations of the workshop will prove helpful to policymakers, researchers, practitioners, and fanners.

The organizers are grateful to the resource speakers, session chairmen and participants for their contributions. Special thanks are due to Mr. L.T. Wijeysuria, Director General, Imgation Department, Dr. Sarath Amarasiri, Director General, Department of Agriculture and Mr. K.S.R. de Silva, Project Director, NIRP who in spite of their busy schedule, participated in the workshop.

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Acknowledgements

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Editors

Executive Summary

MINOR IRRIGATION SCHEMES play a significant role in the food production sector of Sri Lanka and provide employment to the rural sector. However, rice yields and cropping intensities are low in minor irrigation schemes when compared to major schemes. Scarcity and unreliability of water supply have been identified as the major cause for the low rate of success in these schemes. Inadequacy of water is considered the major factor for limiting cultivation in the maha (dry season) whereas in yala (dry season) land in these schemes are seldom cultivated.

In the recent past, partial abandonment of rice fields due to water shortages was common in the minor irrigation schemes. Thus, the concept of crop diversification was adopted to devise a more efficient cropping pattern and water management system. This was to gain the maximum economic benefit from the available water. Crop diversification strategies have failed in most cases in practical implementation due to the ignorance of factors influencing the respective farming systems. Thus, the present workshop was conducted to identify constraints in the implementation of a sustainable crop diversification program in minor irrigation schemes and provide the Central Government of Sri Lanka with some policy recommendations for developing viable fanning systems in these schemes.

Land tenure and fragmentation were identified as major constraints in implementing crop diversification strategies. Involvement of Fanner Organizations and Agrarian Service Centers would help overcome the limitation in land tenure. Land consolidation would possibly be a temporary solution to the problems involved in land fragmentation, although implementation would be difficult.

Low expansion of irrigation investment is a major factor stagnating extents of cultivation. Achievement of the technological ceiling set by plant breeders has resulted in stagnation in crop yields, mainly rice, in the recent past. Plowing into shallow depths, incorporation of organic manure, and avoiding the use of adulterated fertilizer would help overcome this limitation to a certain extent. A major breakthrough in the production systems could be achieved by exploiting non-traditional highlands, addition of organic manure, and the development of value-added products aiming at export markets.

In terms of production, seasonal adjustment in land preparation would be necessary to implement rice-based cropping systems. Detailed planning and implementation of irrigation schedules and matching them with crop requirements, physical planning of area, production analysis for correct input use, and input-output service planning for diversified cropping are necessary for the successful implementation of crop diversification strategies. However, irrigation management may not seriously inhibit the expansion of diversified cropping in rice fields if greater flexibility exists in the provision of suitable lands.

The concept of regional specialization of crops aiming at developing a better cropping pattern could be a viable technique to increase cropping intensity. It would also enhance economic returns to the farmers. Any large-scale expansion of diversified cropping in rice fields or command areas under minor irrigation schemes should be focused for special captive markets. More attention has to be paid to increase agri-business opportunities that help develop value-added products, market research and promotion, quality control and export. This would ensure the success and sustainability of crop diversification programs.

Government intervention needs to focus on motivating and assisting farmers to organize and manage their own system of production and support services. Matching importation of crops with local production with the help of a favorable trade policy is vital in motivating farmers. It would also secure markets for agricultural produce. The development of a national production plan based on long-tern demand and supply is recommended to avoid drastic price fluctuations in the market. The development of a crop insurance scheme for other field crops to assure farmers of their income with government involvement is essential.

Improving water retention capacity of existing minor tanks, investigating the conjunctive use of water and availability of other resources (e.g., solar radiation) are major hydrological aspects that need greater attention in implementating crop diversification strategies. Other hydrological aspects that determine the success and sustainability of a crop diversification program are the use of agro-wells as supplement for tank water, the adoption of water conservation technologies (i.e., conservation farming, mulching), and the increase of water use efficiency through proper application technologies.

Planning of cultivation in yala and maha through farmer participation (decision making on crop selection and cropping pattem) is a major social aspect that should be considered in developing crop diversification programs in minor irrigation schemes. Investigations on the techniques and processes involved in harvesting, utilization and conservation of aghricultural products, options available for a year-round cropping pattem to the farmers, and potential for cultivating perennial crops under water-deficit conditions are key technological aspects that warrant exploration.

The success of any crop diversification program primarily depends on the profitability, availability of marketing facilities and the collective approach of farmers. Therefore, the concept of crop diversification must undergo an evolutionary process which allows a reasonable time duration to be economically, socially, physically and ecologically sustainable. Participatory role of farmers is vital in achieving the expected objectives of planning which would lead to an effective crop diversification program.

Editors

Welcome Address

B.M.S. Samarasekara[1]

I WOULD LIKE to extend my thanks and gratitude for your presence at this workshop, which has been organized through the cooperation of the International Irrigation Management Institute (IIMI). Crop diversification under minor irrigation schemes has become one of the main themes of the Irrigation Research Management Unit (IRMU) of the Irrigation Department. I am happy to inform that this is the first workshop on this aspect organized by the IRMU. Therefore, this would be an ideal opportunity for the participants from various institutes in Sri Lanka to discuss, exchange and disseminate information on the possible strategies for crop diversification under minor irrigation schemes.

I hope you will be engaged in fruitful discussions and exchange your experiences during the workshop sessions. On behalf of the organizing committee, I would like to extend my gratitude for your active participation in making this a successful workshop.

[1]Mr. B.M.S. Samarasekera, Deputy Director, Irrigation Research Management Unit, Irrigation Department, Colombo.

Introduction to the Workshop

K.S.R. de Silva'

THE NATIONAL IRRIGATION Rehabilitation Project (NIRP) was begun in 1992 to rehabilitate 1,000 minor irrigation schemes and *60* medium irrigation schemes. The project's major objective is *to* stabilize and increase agricultural production and incomes of h e r s . Promotion of crop diversification has been identified as one of the major activities to raise farmers' income. Cropping intensity and production in minor irrigation schemes have been reported to be low and stagnated. In addition to these factors, a low-profit margin from rice has also resulted in the generation of low income to farmers from irrigation agriculture.

Although many studies have been conducted in this aspect in major irrigation schemes, there is a scarcity of information on crop diversification under minor irrigation schemes. It is important to note that the results of the extensive research carried out by the Department of Agriculture, Sri Lanka has not reached the grass-root level. The major obstacles for the dissemination of information may be the inefficient extension system and the lack of national policy on crop diversification.

Thus, understanding the present status and developing strategies for crop diversification in minor irrigation schemes are of national importance. While identifying its national importance, the Irrigation Research Management Unit (IRMU) has decided to hold a consultation workshop on strategies for crop diversification in minor irrigation schemes.

I wish you success in this important event.

[2]Mr. K.S.R. de Silva, Project Director, National Irrigation Rehabilitation Project (NIRP), Irrigation Department, Colombo.

Address by the Chief Guest

L. T. Wijesuriya[3]

IT HAS LONG being recognized among rice-producing countries that rice, as an agricultural commodity, may no longer give sufficient benefits to farmers. Competition among different uses of water is becoming keener, thus forcing us to utilize water more efficiently. Therefore, crop diversification has become an important topic.

The present workshop, organized by the IRMU of the Imgation Department is also important in a situation where Sri Lanka, for several months, has been affected by a severe drought. This situation should encourage people to promote and intensify efforts toward crop diversification.

I understand that this is the first workshop addressing the crop diversification strategies under minor irrigation schemes at a national level. In the current situation development of a national policy plan on crop diversification would be an asset to the national agricultural development programs.

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

I wish you all success and expect an appropriate set of recommendations to be incorporated into the national policy on crop diversification.

[3]Mr. L.T. Wijesuriya, Senior Deputy Director (Rehabilitation), Irrigation Department, Colombo.

TECHNICAL SESSION

Chairperson

S. Amarasiri
Director General,
Department of Agriculture
Peradeniya, Sri Lanka

Agro-Ecological, Socioeconomic and Institutional Factors Affecting Diversified Cropping in Rice Lands of Sri Lanka

C. M. Wijayaratna[4]

ABSTRACT

DIVERSIFIED CROPPING IN rice lands has primarily been centered on Other Field Crops **(OFCs)** such as chili, onions (red onion and big onion), green gram, cowpea, black gram, soybean, groundnut and vegetables. To a lesser extent banana, sweet-potatoes, gingelly and gherkin have gained importance in specific areas. The rain-fed uplands in the dry and intermediate zones have provided the bulk of **OFC** requirements in the past. Almost all the maha (wet season) **OFC** cultivation in the dry zone is rain-fed. Of late, upland areas under lift imgation and well-drained rice land under gravity irrigation during the dry season have contributed to an increasing supply of **OFCs.**

Recent trends in the production of selected major OFCs are indicated below:

* Although chili records the highest extents grown in 1976/77, the production over the years, in general, has shown an increasing trend up to 1986. It has remained stagnant since then. During the past decade (1982-92), however, a clear shift from rain-fed to irrigated chili in rice fields is evident with irrigated chili reaching peak production in 1986. This, in turn, has resulted in increased crop yields and in higher total production. At present, however, the yields are being threatened by pests and diseases.

* In the case of big onions, the extents grown increased appreciably from 1981 to 1988. The increase thereafter was a very rapid--almost four-fold from 1989 to 1991.

* Green gram has shown a consistent increase whereas cowpea has shown a decreasing trend recently.

* No definite trend can be discerned in soybean; the marketing/price factors have influenced sudden increases and shortfalls.

* Maize production has remained somewhat stagnant.

* Yam production which increased through the 1970s, reached a peak in 1978 (due to policy interventions) but of late it has decreased to a lower plateau because it is cultivated under rain-fed conditions. Potato production has shown an increasing trend. Of late, sweet potato has been gaining popularity.

[4]Leader, Sri Lanka National Program and Watershed Management Research, IIMI, Colombo

The general reasons for the recent trends in OFC cultivation, especially the fluctuations in supply, can be attributed to a number of factors: climate, markets and prices, and availability of imported substitutes. Other factors such as pests and diseases, and crop management contribute to a lesser extent.

INTRODIJCTION

Rice cultivation continues to play a vital role in the Sri Lankan economy. Investments in irrigation and associated technologies such as high-yielding seed varieties and fertilizer, together with management inputs had contributed to significant increases in rice production and productivity in the past. The land area cultivated with rice and the national average rice yield had reached their peak levels by the mid-**1980s.** The turning point appears to have been in 1985. Since then, key determinants of total production such as yield and extent of cultivation have not shown a clear rate of growth, especially in irrigated areas. The cropping intensity, which had been stagnating over a long period, has also not shown any significant improvement. Moreover, the increase in the market price of rice during the recent past has failed to compensate for the increase in the cost of production. On the other hand, local demand for this basic staple food will continue to rise, at least for a few decades to come. Despite the **low** population growth rate annual increase in population will remain high for some time due **to** the high level of the base population. Therefore, it is crucial to explore the possibility of improving the efficiency of rice production. In the context of uncertain (world) prices for rice, declining growth rates of production and eroding profit margins, it would be prudent to explore the potential for future increments in productivity of scarce factors of production, increasing cropping intensity and checking rises in the cost of production.

Research into appropriate crop management techniques should also investigate the comparative long-term productivity of the continuous cropping of rice (with high levels of agro-chemical inputs) against alternative rice-based cropping patterns in areas where agro-ecological factors are conducive. In such cases, providing "break crops" into a rice cropping system would help regenerate soil fertility, reduce weeds and pest incidence, and provide more diversified options to sustain total household incomes. Grain legume crops such as green gram, leguminous green manures or vegetable crops may be particularly suitable rotation crops with rice. Improving crop yields (both rice and non-rice) in such systems may be achieved through improved efficiency in input **use.** Improving irrigation management efficiency would be the key factor. In addition, integrated plant nutrient management, integrated pest management, etc., should also be considered.

Hence, **future** policy in this major staple food sector should be twofold: maintain a high degree of self-sufficiency in rice and encourage diversification in areas possessing comparative advantages for other field crops. It is suggested that this "dual objective" can be achieved through a proper integration of appropriate technology, organization/institutions, policy and resources.

The supply of water for crop production can be augmented through **a** judicious combination of surface water and groundwater and by optimizing the use of rain water through proper timing of planting operations. More profitable cropping patterns based on agro-ecological suitability can **be** established through organized group action by small farmers.

In this context this paper examines (a) the recent trends, (b) agro-ecological factors including irrigation-related factors and (c) economic, social and institutional factors affecting the diversified cropping in rice lands of Sri Lanka.

RECENT TRENDS

Diversified cropping in rice-rice lands has primarily been centered on Other Field Crops (OFCs) such as chili, red onions (shallots), big onions, green gram, cowpea, black gram, soybean, groundnut and vegetables. Bananas, sweet potatoes, maize, gingerly (sesame) and gherkins which have been cultivated on these lands to a lesser extent are gaining importance in specific areas. More recently, attempts have been made to introduce newer crops primarily for export. These include melons, baby corn, okra and hybrid maize. Some interest is being shown in new oil seed crops such as sunflower. However, in examining the changes in cropping patterns during the past decade, the focus is on chili, onion, green gram, cowpea, black gram, soybean, maize, groundnut, gingerly and vegetables.

Unlike rice, for which seasonal crop cutting/estimation surveys are conducted, the production and average yield figures for OFCs are only estimates based on general observations by agricultural extension staff. Although chili and onion yield estimates are the closest to accuracy, the best available criteria for evaluating progress in cultivation of OFCs are the extents cultivated. Past trends in cultivation of OFCs in rice lands under irrigated and rain-fed conditions are summarized in figure 1. The period covered is 1982-1993.

District-wise information on areas cultivated with OFCs has been obtained by scrutinizing individual seasonal reports of the districts provided by the Extension and Communication Centre of the Department of Agriculture (DOA), Peradeniya. It is evident from the ten-year annual trend (1982-91) of *total* land area (rain-fed and irrigated combined) under major OFCs that regional specialization in OFCs has been taking place. It is assumed that this represents the recent trend in production as well. Examining these trends, the district priorities can be listed as shown in table 1.

Table 1. District priorities in OFCs

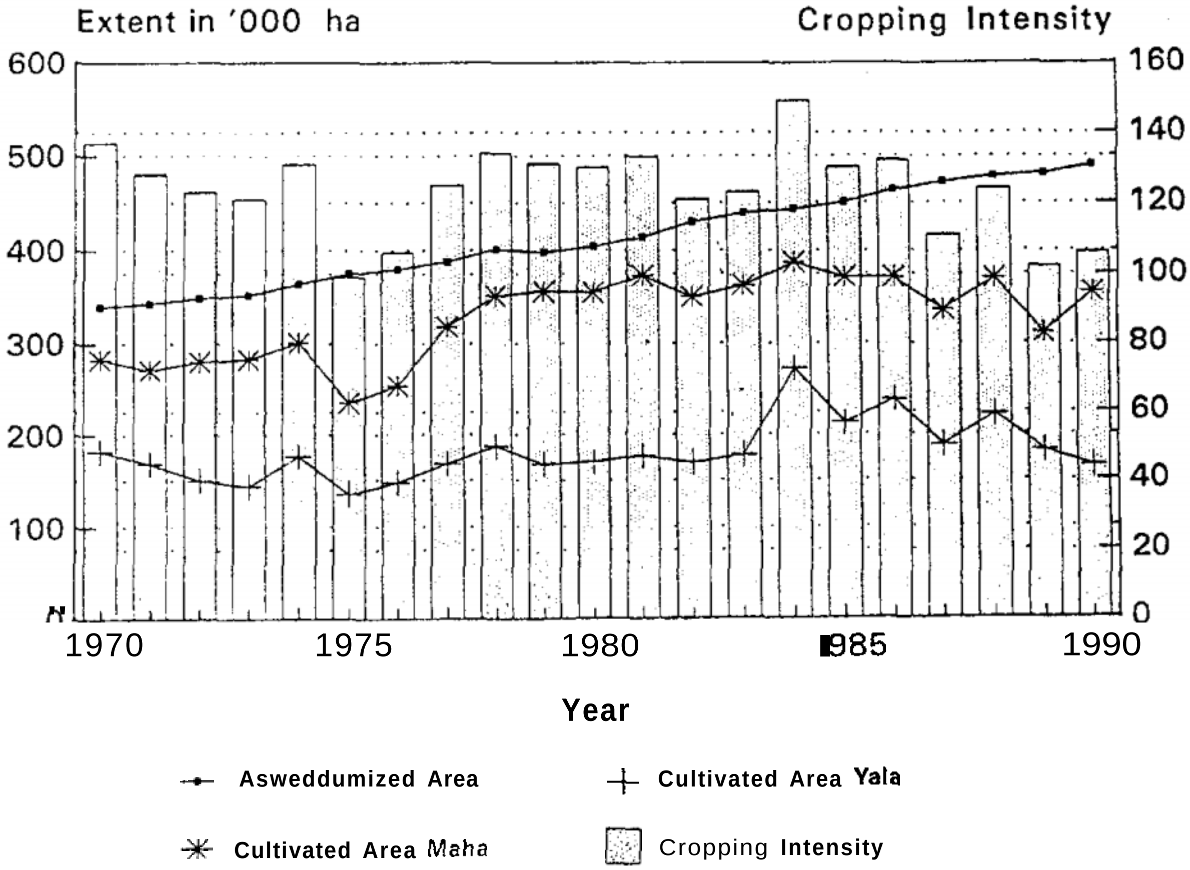
Crop	Districts Recording Successful Diversification				
Chili	Kalawewa	A'pura	Jaffna	Matale	Kurunegala
Red onion	Jaffna	Puttalam	Ratnapura	Batticaloa	Moneragala
Big onion	Kalawewa	Matale	Jaffna	Polonnaruwa	System 'B"
Green gram	Kurunegala	Moneragala	Hambantota	Puttalam	Ratnapura
Cowpea	Kurunegala	Puttalam	A'pura	Moneragala	Hambantota
Black gram	Vavuniya	A'pura	Mullaitivu	Kurunegala	Puttalam
Soybean	A'pura	Matale	Kalawewa		
Groundnut	Moneragala	Puttalam	Mullaitivu	Ampara	Kurunegala
Gingerly	A'pura	Kurunegala	Puttalam	Moneragala	Vavuniya
Maize	A'pura	Ampara	Badulla	Moneragala	Matale
Potato	N'Eliya	Badulla	Jaffna		
Kurakkan	A'pura	Matale	Moneragala		

Notes: A'pura=Anuradhapura; N'Eliya= Nuwara Eliya

Favorable cultivation conditions, ready markets and traditional farmer traits may have been the reasons for this form of specialization. This setting has influenced the more recent crop diversification programs in rice lands. It is likely that these district ratings will change over time.

Production levels of major OFCs are shown in table 2. Production estimates of these crops done by the DOA are based on average yields and extents cultivated. The data show that there has been a steady increase in production of chili, green gram, big onion and red onion since 1982. Production of soybean and groundnut has declined over these years. Increases in production of these crops are mainly due to increases in the areas cultivated rather than due to yield increments. However, in the case of big onion, increased yield has also contributed toward the increase in production.

Figure 1. Trends in cropping intensity and area cultivated to rice.



Note: Only major and minor categories included.
Source of primary data: Department of Census and Statistics

Table 2. Production of Other Field Crops, 1982-1991.

	Production of Major Subsidiary Crops in '000 MT									
Crop	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Chili	22.2	30.0	26.9	35.6	44.6	34.6	37.9	30.0	41.4	33.2
Green gram	18.4	16.2	17.5	15.5	17.8	23.6	23.4	19.2	30.7	36.5
Big onion	1.6	2.6	3.03	2.4	5.6	4.2	6.8	11.1	20.0	22.6
Red onion	96.2	139.	9.6	52.8	75.9	113.5	114.4	107.7	97.0	76.9
Soybean	10.1	11.6	8.0	2.8	7.3	10.1	9.9	2.9	7.1	4.0
Groundnut	14.7	19.5	6.5	8.3	9.8	9.9	11.9	8.8	11.1	11.5

AGRO-ECOLOGICAL FACTORS

The initial stages of a shift in irrigated agriculture from its traditional moorings of asweddumized rice culture took place around the early 1960s. This was prompted by the interaction of several considerations where water, rather than land, was the main limiting factor to a further expansion of the extent of irrigated rice lands in the dry zone. Options of crops other than high water-demanding rice had therefore to be properly planned and tested. Agronomic research on the cultivation of non-rice crops on gravity-irrigated land in the dry zone in the early sixties helped firmly establish the feasibility of growing crops other than rice, on the well-drained category of irrigated lands of irrigation schemes during the rain-less yala. Such alternative crops are referred to as Other Field Crops (OFCs). However, it was not until the mid-sixties, when the government took a definite policy decision to ban or reduce the imports of specific commodities such as chili and onion, that practical and realistic incentives became available to fanners to undertake the commercial productions of OFCs.

It should also be borne in mind that prior to the mid-sixties, all irrigation systems in Sri Lanka were primarily designed for wet season (maha) rice cultivation, and any reservoir storage that could be carried over to the subsequent dry (yala) seasons was used for irrigating a limited extent or portion of the command area for rice. It was only the post-I970 irrigation systems, notably the Mahaweli and similar systems, that were designed for alternating wet season rice with dry season non-rice cultivation.

While Mahaweli System H has been able to achieve its full potential of OFC cultivation on well-drained lands during the yala seasons over the period 1979-1987, parallel developments have also been taking place under irrigation systems, namely the large and small tank systems in the dry zone.

OFC cultivation on the better-drained rice lands or ***akkarawelas*** under small tank systems during the yala season received a further impetus by the agro-wells introduced close to and around the ***akkarawelus*** in the late ***1980s.*** A relatively reliable though limited supply of groundwater from April to August that could be drawn from open wells enabled fanners to cultivate a small extent of around 1.0 acre (0.405 ha) with a combination of high-value crops such as chili, onions and vegetables which commanded a good market.

An examination of the water regimes of the different irrigation systems where dry season crop diversification has taken place over the last three decades shows that it has been mainly confined to major and minor irrigation schemes that have a deficit or inadequate irrigation supply during the dry yala season. However, because of the high year-to-year variation in the water supply during this limited dry season, the total extent of dry season OFCs that could be cultivated will also show a high degree of variation between years. One of the major challenges facing diversified cropping on rice lands during the dry season is how to minimize this degree of variation and ensure a certain level of stability in OFC production over the years.

Another area of concern is the poor performance of diversified cropping in some of the major irrigation schemes that are well endowed with an assured supply of water for irrigation during the dry yala season. Examples include the major irrigation schemes in the Polonnaruwa District. Because of the reliable water supply in these systems during the dry yala season, they provide an ideal opportunity for the promotion of intensive, market-oriented non-rice crop products that should have a stable or assured market over the years.

Dimantha **(1987)** has estimated that altogether around 80,000 ha of well-drained land exist under the command of **major** irrigation schemes alone which he considers are well adapted for diversified cropping during a dry yala season. This provides a convenient future benchmark value for potential expansion **of** dry season diversified cropping in the major irrigation schemes.

In general, rice lands served by some form of irrigation have the potential for growing a single crop of rice during the wet season followed by restricted cultivation of either rice **or** non-rice crops during the yala season. The greatest potential for diversified cropping on rice lands exists in the well-drained soils occurring in these irrigated lands. It is therefore proposed to examine the relative potential for dry season diversified cropping on these different categories of irrigated rice lands in the dry and intermediate zones of the country. The following broad categories are recognized at present:

Category 1. Major irrigation schemes with either trans-basin water diversion, or with adequate irrigation supply from within its source for both maha and yala seasons.

Category 2. Major irrigation schemes where the catchment or the source of supply is situated entirely within the dry zone. Such schemes therefore have an adequate supply of water for the maha season and a limited supply that can be used for only some of the rice lands during the yala season.

Category **3.** Medium and minor irrigation schemes that have a moderately stable water supply that ensures at least a **75** percent cropping intensity in the maha season. Very little water is left for irrigation **during** yala.

Category 4. Minor irrigation schemes with an unstable water supply that permits between **50** and 70 percent cropping intensity in the maha season only.

Potential for Crop Diversification in the Four Broad Categories and Recent Performance

Category 1. Major Schemes with Adequate Supply for both Wet and Dry Seasons

Because of the high stability of the irrigation water supply during the dry season, the best opportunity for intensive dry season diversified cropping exists within irrigation schemes of this category. Table 3 shows some typical irrigation systems representative of this category, together with the extent of well-drained lands within each system, and the highest extent of land cultivated with OFCs during the past ten years.

Table 3 shows that Mahaweli System H had achieved almost its full potential on the well-drained soils during yala 1986. This exemplifies the degree of performance attainable when all essential support services, supplies and marketing have been provided by the Mahaweli Economic Agency (MEA). Approximately 75 percent of the land suitable for OFCs in the Uda Walawe RB area had been cultivated with these crops during yala 1993. The greater part of such cultivated land was accounted for by banana and to a less extent by chili and onions. The extent of OFC cultivation in the major irrigation schemes of the Polonnaruwa District has been comparatively modest. This is not surprising because these irrigation systems have had a longer tradition of maha rice followed by yala rice since their inception in the early forties. The additional supply provided from the Mahaweli diversion for the yala season has only helped stabilize yala rice production in preference to introducing OFC cultivation. Also, the proportion of well-drained soils within each system is significantly lower than in the Mahaweli and Uda Walawe project areas.

Table 3. Extent of well-drained soils and cultivation of OFCs in irrigation schemes (Category 1).

District	Name of system	Extent of well-drained lands (ha)	Highest extent (ha) with OFCs grown and season (ha)
1. Mahaweli	System H	14,500	12,090 (yala 1986)
2. Uda Walawe	Uda Walawe RB	4,200	3,060 (yala 1993)
3. Polonnaruwa	P.S.S.	1,178	648 (yala 1990)
	Minneriya	1,031	486 (yala 1989)
	Kaudulla	655	203 (yala 1990)
	Giritale	372	236 (yala 1988)

Category 2. Major Schemes with Adequate Supply for the Main Maha Season and Inadequaie Supply for the Yala Season

Some typical irrigation systems within this category, the extents of well-drained lands under each system and the highest extent of OFC cultivation achieved are shown in table 4.

Over the last two decades there has been a significant increase in diversified cropping on rice lands in these systems during the yala season. All these schemes within the Anuradhapura, Badulla and Mullaitivu districts, except Padaviya, have achieved at least a 70 percent cultivation of the total extent of well-drained soils with OFCs. However, extents cultivated in different years have been highly variable because of the high degree of variability of irrigation water supplied during the yala season in each of the years.

Table 4. Extent of well-drained soils and cultivation of OFCs in irrigation schemes (Category 2).

District	Name of System	Extent of welldrained lands (ha)	Highest extent (ha) with OFCs grown and season
1. Anuradhapura	Rajangane Padaviya Huruluwewa Mahavilachchiya Devahuwa	1,590 1,560 1,050 450 430	1,146 - yala 1988 502 - yala 1990 972 - yala 1986 320 - yala 1989 345 - yala 1989
2. Badulla	Nagadeepa Sorabora Mapakade	I700	1238 - yala 1990
3. Mullaitivu	Muthiyankadi	860	653 - yala 1986

District	Main River Basin	No. of Tanks	Size Range (ha)	Total Command Area (ha)
1. Anuradhapura	Malwathu Oya Yan Oya Moderagam A N	35 20 7	80 - 350 80 - 250 80 - 150	5,182 2,432 834
2. Puttalam	Mi Oya	7	100 - 350	1,447
3. Kurunegala	*Mi Oya* Deduru Oya	*6* 10	100 - 800 80 - 150	3,723 1,163 14,781

Irrigation Management

According to studies conducted by IIMI and others, it has been found that diversified cropping in rice lands in the dry season is possible without any major modifications to the physical system. However, the delivery system should be in a desired physical status that would ensure a satisfactory degree of control and regulation of deliveries at different levels of the system. Since irrigation of OFCs need a larger volume of water during a shorter duration, field channels should have an adequate capacity. The present system of aligning field channels traversing well-drained, imperfectly drained and poorly drained soils is not conducive for efficient operation when OFCs are grown during the dry season in the upper reaches of well-drained soils and rice in the lower reaches of poorly drained soils. Separate provision of parallel field channels for well-drained and poorly drained soils would facilitate better system operation, effectively intercepting the drainage flow and increasing on-farm water use efficiency. Moreover, in such cases, the density of drainage ditches needs to be increased.

Diversified cropping needs different on-farm irrigation methods such as flat beds, raised beds, ridge and furrow etc., depending on the crop. In addition to changes in land preparation methods, OFCs need a good on-farm drainage system; particularly for plots in lower parts of the catena. Farmers generally prefer to use basin irrigation for OFCs also. Under such conditions, field leveling needs to be perfect;

otherwise micro-depressions within the basin create water stagnation. All these modifications would increase the cost of cultivation of OFCs.

Diversified cropping demands greater "joint management" efforts and interactions between the agency and the farmers. Detailed planning and implementation of scheduling irrigation as well as taking into account farmers' practices and probability levels of different rainfall scenarios are crucial for efficient water management.

Several OFCs, such as chili, soybean, green gram and vegetables, are grown during yala. The optimum irrigation frequency for each of the above crops ranges from 2 to 10 days, whereas the irrigation frequency is fixed at once in 7 or once in 10 days. In growing these crops side by side in adjacent fields which are supplied by a common source of water certain scheduling problems are encountered. To overcome this difficulty, some farmers have gone in for shallow dug-wells to supplement surface water when it is needed. Such supplementary sources need to be encouraged through proper planning and incentives. An assured, regular irrigation supply is necessary during the crop growth period for better performance of high-value crops to encourage increased fertilizer application and use of high-yielding and short-duration varieties. A crop like chili requires a minimum of 10 waterings spread over a period of 5 months. The physical infrastructure and management efforts combined together are not able to fully meet these requirements.

It should be noted that, in general, water requirements due to evapotranspiration do not significantly vary with the crop. Hence, any water savings in OFC cultivation, compared to rice, should be expected from other means such as reduced use during land preparation, change of the irrigation interval, reduction of the total duration of irrigation, etc. For instance, cultivation of a variety of crops within a single turnout may not necessarily lead to a change in irrigation frequency. Therefore, selective scheduling of crops, matching crop schedules with irrigation scheduling, etc., are of paramount importance in OFC cultivation.

ECONOMIC, SOCIAL AND INSTITUTIONAL FACTORS

Economic, social and institutional factors, together with agro-ecological conditions, essentially dictate whether a particular cropping pattern should be adopted in a particular location.

National Requirements and Current Production Levels

It is necessary to now address the issue of national requirements of Food items (OFCs) and the production levels. Table 6 presents a comparison of estimated production and estimated requirements. An immediate conclusion would be that there is little room for expansion of major OFC extents except for big onion, soybean and maize. It is possible that with better technology, productivity and profitability can be increased in existing areas of production to meet requirements than to increase the extents cultivated.

It is likely that the produce of traditional upland irrigated crops such as chili and onion from Jaffna and Killinochchi will increase and reach the market when the current civil disturbances ease. Projected population increases will undoubtedly increase requirements. From the foregoing it is clear that the search for newer crops with comparative advantages is becoming vital. More attention needs to be paid to increase agri-business opportunities that help value-adding market search and promotion, quality control and export.

Table 6. Estimated requirement and planned production of major food items 000 mt.

Food item	Requirement 1993	Production 1993	Requirement 1994	Production 1994
Maize	97.0	88.8	103.0	89.5
Potato	115.0	101.3	118.0	102.0
Sweet potato	125.0	125.0	135.0	135.0
Green gram	37.0	41.9	38.0	47.7
Black gram	15.0	18.5	15.5	16.0
Cowpea	18.0	26.5	19.5	19.5
Dhal	45.0	0	46.0	0
Soybean	55.5	9.3	59.0	30.7
Dry chili	50.0	48.4	52.0	59.3
Red onion	135.0	138.1	139.0	157.0
Large onion	60.0	37.7	64.0	48.8
Groundnut	12.0	21.6	12.5	13.5

Source: Division of Agricultural Economics and Planning, Department of Agriculture.

Markets, Prices and Trade Policy

Markets prices and trade policy in Sri Lanka act as key determinants of the level of adoption of **OFCs.** Both the profit margin and stability of income in the long run depend much on fluctuations in prices and the availability of markets and avenues for marketing.

Markets

Unlike rice, most **OFCs** commonly included in diversified cropping in rice lands do not have established networks of markets or marketing mechanisms. Moreover, some of these crops are more readily perishable than rice and require special care in handling and storage. Marketing of these crops therefore often demands a chain of activities including assembling, transport, sorting, grading, storage, packing, initial processing, and taking the risk of holding the produce until an outlet is found. Some common problems associated with the marketing of OFCs include:

* ***High marketing costs*** are due to unjustifiable profits to local buyers or middlemen as a result of the weak bargaining power of fanners; high costs incurred by retailers and wholesalers due to inadequate storage facilities, deterioration in quality, lack of organization, etc; lack of market

information; lack of competition at local levels; urgency in selling the produce immediately after the harvest; inadequacies in legislation; etc.

* ***Transport problems.*** Inadequate means of transport is often a key reason for low farm-gate prices of OFCs. Transport difficulties and lack of organization or group action result in farmers tending to depend purely on local buyers. Losses during transport are also a common feature. Such losses can be attributed to bad road conditions, bad handling and packing, irresponsibility and lack of attention, etc.

* ***Inadequate storage facilities.*** Unlike rice, OFCs are being sold for low prices immediately after the harvest owing mainly to difficulties of storage. Cold storage facilities are usually highly inadequate. The creation of additional storage capacity is restricted by lack of organization and of knowledge and capital.

Prices

The price **of** an OFC reflects the market strength of that crop. It also determines the profitability of the crop. Unlike rice production, OFC production generally involves higher risks and greater uncertainty. Price uncertainty is usually more serious for OFCs than the risks associated with physical production. There could be many reasons for wide price fluctuations such as weak marketing structures and government policies. Minimizing price fluctuations is therefore more important for the promotion of crop diversification.

Demand for Labor

Table **A-I** (refer annex) shows that labor is the most significant input in crop diversification. OFCs can be classified on the basis of relative profitability into two categories: low-performance OFCs and high-performance OFCs (Kikuchi 1990). The data show that high-performance OFCs require much more labor than rice. High-performance crops require very high labor inputs compared to low-performance crops. Labor input is almost five times as much as for rice and twice as much as for low-performance OFCs. Although high labor requirements create employment opportunities for rural people, they create a scarcity of labor in the area and thereby increase labor wages. Profitability could decline **as** a result.

In addition to labor required for cultivation activities, OFC cultivation requires mainly family labor for guarding the crops, mainly at night. Since the harvesting period for OFCs **is** long compared to that for rice, labor for protecting the crops is required over a longer period. This makes farmers **guard** their fields at night. This is another reason why many farmers are reluctant to grow OFCs in rice lands. Although the demand for labor and the cost of labor are unusually high for OFCs like onion and chili, a proper "crop-mix" can reduce the peak demands and achieve a certain degree of uniformity in labor demand over time.

A related issue is the potential for employment generation through vertical expansion, etc., in areas related to activities such as processing, packing and grading. Obviously, crop diversification presents a much higher potential for secondary activities or linkage effects than in the case of rice cultivation. **A** detailed analysis conducted by IIMI **(1996)** concluded that diversified cropping has greater potential than rice monoculture in the following labor-related aspects:

* Total labor absorption/employment generation

* Regularity in labor demand over time

* Employment in secondary activities (vertical expansion)

* Family labor utilization

Capital Requirement

Capital requirement is defined as the summation of costs for current inputs, fixed capital (tractor and draft animal rentals) and hired labor. It is often said that OFCs are more capital-intensive than rice. This is particularly true for high-performance crops.

Average cash requirements for OFCs and rice are shown in table **A-2.** Capital requirements of high performance crops are nearly twice as much as the capital needs of rice. This is mainly due to high input requirements such as fertilizer and chemicals and the high labor requirement of high-value crops. The other reason is that the prices of inputs required for high-value crops, such as seed and chemicals, are higher than the cost of inputs required for rice. Data show that high-performance crops need twice as much capital as does rice. Since capital is a constraint for most farmers, high-performance crop cultivation should be limited to small extents of land.

Economic Performance of Other Field Crops

Table A-3 provides a comparison of OFCs and rice in terms of selected financial indicators. For the 1993 yala, high-performance crops, with the exception of red onion, perform better than rice. Farmers can obtain twice as much income from chili as from rice. Farmers' income from big onion is nine times as much as the income from rice. Low-performance crops give incomes similar to that from rice. The prospects for high performance crops (except red onions) are good since the above yield levels and price levels are good and are not likely to increase significantly in the near future. The most remunerative crops (compared to rice) are chili and onion. However, these results cannot be generalized since there are variations in yields, prices and costs between districts. A comparison of costs and returns, in economic prices, of rice production and OFC production is given in table 7.

It is interesting to note that economic profitability of rice production under major irrigation schemes is higher than that of non-rice crops, except that of big onions. Among the OFCs, big onion gives the highest economic returns. This analysis shows the comparative disadvantage of the local production of green gram. The break-even yield for green gram is 1.34 mt/ha, which is a most difficult target to achieve. Production of chili, big onion and soybean locally is justifiable. However, the progress of diversification depends mainly on its financial profitability to the farmer, and input and market constraints to the cultivation of these crops.

Table 7. Economic costs and returns' on Rice and Other Field Crop production.

Crop	Economic farm-gate* Price Rs/kg	Total cost '000 Rs/ha	Total returns '000 Rs/ha	Cost of production Rs/kg	Yield mt/ha	Minimum yield mt/ha
Chili	**49.25**	**42.62**	**7.62**	**41.78**	**1.02**	**0.86**
Big onion	**11.79**	**42.96**	**22.83**	**7.70**	**5.58**	**3.64**
Green gram	**15.61**	**20.86**	**-2.42**	**32.09**	**0.65**	**1.34**
Soybean	**18.05**	**14.39**	**13.40**	**9.35**	**1.54**	**0.79**
Rice	**7.29**	**17.03**	**13.44**	**4.07**	**4.18**	**2.34**

Notes:* Economic price = C.I.F price + port charges + economic transportation cost + economic handling cost + economic storage cost. Economic prices are for the Anuradhapura area. Minimum yield is the break-even yield. Economic values were obtained by multiplying financial values by a conversion factor **(0.723).**

Source: Report on Shadow Prices for Sri Lanka, Development and Project Planning Center, Bradford University, UK, **1991**.

Comparative Advantage of Other Field Crop Production in Sri Lanka

Domestic Resource Cost (DRC) is used as a tool to evaluate the comparative advantage of OFCs over rice production in Sri Lanka. DRC is defined as the ratio of domestic cost to border price of output minus foreign cost. It is expressed as:

$$\text{DRC} = \frac{\text{domestic cost in shadow prices per unit of output}}{\text{(border price of output) - (foreign cost per unit in border price)}}$$

Resource Cost Ratio (RCR) indicate the relative comparative advantage of an economic activity for a country. RCR is the ratio of DRC and Shadow Exchange Rate (SER). Thus if,

(a) RCR < 1, a comparative advantage exists,

(b) RCR = 1, neutra,l

(c) RCR > 1, a comparative disadvantage exists.

Table **8** presents the efficiency indicators for production of other field crops and rice during the yala season under irrigated conditions.[1] All crops were analyzed as import substitutions. The results clearly show that rice and all OFCs analyzed except green gram have a comparative advantage. It is interesting to note that rice is more economical than other field crops except soybean. Among the OFCs soybean is the most economical crop with an RCR of 0.51. The major problem for green gram lies in its low yield.

Since comparative advantage analysis is a dynamic concept, the above results should be considered as static indicators of economic efficiency of OFCs and rice for 1993. Comparative advantage is mainly determined by yield levels, resource endowments and input-output ratios. Important factors that determine yield include technology, agro-climatic factors and farm-level management. The optimum interplay of these factors should therefore determine the sustanability of comparative advantage in the long run.

Table 8. Economic efficiency indicators forproduction of OFCs and rice under irrigation on rice lands in Sri Lanka.

crop	Trade Regime	Efficiency Indicators	
		DRC	RCR
High Performance OFCs			
Chili	Import Substitution	43.15	0.91
Big onion	Import Substitution	33.08	0.69
Low Performance OFCs			
Green gram	Import Substitution	62.21	1.30
Soybean	Import Substitution	24.43	0.51
Rice	Import Substitution	27.43	0.51

Notes:
* The analysis is only for the Anuradhapura District, North Central Province.
* The calculations are based on 1993 prices.
* Irrigation cost and land rent are not taken into account.
* Conversion rate of official exchange rate into Shadow Exchange Rate=1.
* Average official exchange rate is US$1.00=Rs 48

The break-even yields for different crops at given border prices with existing cost structure is given in table 9. The data show that there is a considerable gap between the actual yield and potential yield. Since the break-even yield is less than the potential yield, there is a possibility of increasing the actual yield beyond the break-even yield. However, this could affect the cost structure and hence the

[1]Cost of cultivation for OFCs and rice during the year 1993 was obtained from the Department of Agriculture. Conversion factors were developed on the basis of a study on DCR analysis of rice in 1993, conducted by the Agrarian Research and Training Institute, to convert the financial values of primary inputs for other field crops into economic values. Labor was valued under surplus labor conditions. A conversion factor of 0.722 was developed by the Bradford University, UK, in 1991 to convert financial value of labor into economic value of labor. The ratio of domestic cost to foreign cost was obtained from a study conducted by the Agrarian Research and Training Institute for the rice-producing rector. Domestic and foreign costs were separated by using this ratio. Irrigation and land costs were not taken into account because irrigation cost is a sunk cost for diversification of existing irrigated rice lands. Land cost was ignored because land would be idling during the yala season if rice was cultivated because of the limited availability of water.

economic efficiency. Therefore, yield improvements should be attempted without any major change in the cost structure. Factors beyond control that determine the break-even yield are the border prices of outputs and imported inputs. Changes in border prices of outputs and imported inputs may be brought about by changes in the supply of these items to the world market. These changes are difficult to predict. These results cannot therefore predict the efficiency of the crops in the log-run.

Table 9. Actual, potential and break-even yields for different irrigated OFCs and rice at given border prices, Anuradhapura District, 1993 yala season.

Crop	Border price* Rs/kg	Yields (mt/ha) Actual	Potential	Break-even
High performance crops				
Chili	48.61	1.02	2.50	0.95
Big onion	11.15	5.58	25.00	4.25
Low performance crops				
Green gram	14.97	0.65	1.25	0.81
Soybean	17.41	1.54	2.00	0.83
Rice	6.65	4.18	5.00	***3.06***

Source: Sri Lanka Annual Customs Returns.

Notes * Annual average C.I.F price

Other Potential Crops

Vegetables are the other non-rice crops that have the potential for cultivation in rice lands However, cultivation of vegetables entails very high risks when compared with other non-rice crops Price drops during the harvesting period are a major constraint to vegetable cultivation Since good infrastructure facilities for the marketing of vegetables are not available in most irrigated areas, it could be difficult to promote large-scale cultivation of vegetables in these areas.

Banana is another cultivable crop that gives high profits to farmers. A significant extent of rice land in Uda Walawe has been cultivated with banana The other promising non-rice crops besides bananas that can be cultivated in rice lands are tuber crops

Credit

Credit and marketing are tied together more often than not. For instance, "middlemen" finance farmers in return for the produce, a commitment made much in advance of the harvest. It is argued that this limits the opportunity for new markets to get started and that it may also lead to *inflexibilities* in

marketing which hamper the free flow of goods to the best market outlets. Farmers are often obliged to sell produce to
moneylenders at prices substantially below those in the free market. Good characteristics of advanced competitive future markets or "forward buying" mechanisms are not seen in these transactions because of *the weak bargaining position of the farmer.*

Provision of *credit* is also crucial to the *effective use of a variety of inputs* in crop diversification. In lending to small farmers, lending mechanisms (or institutions) may have to adopt a more liberal approach with acceptable procedures and interest rates. The provision of *timely and 'heed-based" credit* must also be closely supervised. The following factors may also be considered along with others in lending/providing credit to these farmers:

* Provision of credit not only for short-term or seasonal production, but also for medium and long-term investment needs associated with handling and processing of farm produce and for sprayers, threshers and processing equipment, etc.

* Catering to the financial needs of farmer organizations and marketing institutions

* Instilling the habit of saving as well as motivating farmers and farmer organizations to mobilize to carry out the aforementioned functions

* Adequate supervision and follow-up, and the concurrent deployment of sufficiently trained staff to supervize and provide extension services

Research and Extension

A wealth of knowledge on different aspects of crop diversification has been accumulated over the recent past through research and development. This knowledge may be required in tackling agro-ecological, economic, social and institutional issues relevant to diversification. In *the long run, the demand for factors ofproduction (including water) for a given cropping pattern derives not only from the nature of the soil and climatic factors but also from prospective markets for crops included in that cropping pattern, the ability and willingness ojthe farmers to make efficient use ofthe water and other factors of production. variability in income over time, etc. AN these aspects need close examination.*

Farm incomes, for example, vary from time to time for different reasons. Fluctuations in prices and weather, innovations and introduction of new technology, changes in institutions and the economic structure are among the factors that cause variations in farm incomes over time.

Unplanned entry of numerous procedures from different areas in a given season may also affect the variation and stability of incomes. From a national point of view, *basic resources such as land, labor and capital must be used efficiently in all farming areas of the country; they must be distributed efficiently between alternative opportunities. In* the long run, *regional specialization based on the principle of comparative advantage may become aprime consideration by respective economies.* These aspects which are related to supply and demand may be considered in formulating an agenda for further research in crop diversification.

Group Action by Farmers

Benefits of group action by farmer participants are much higher in a ***diversified cropping pattern*** than in a ***monocropping situation.*** Different crops demand different cultivation practices and different inputs at different times. When a group of farmers use a common source of input such as irrigation water, group action is necessary to maximize the benefits of such an input, especially if the supply is limited. Group action can benefit from economies of scale in respect of other inputs or outputs.

Many of the problems discussed in this report may not be difficult to overcome, once the farmers are organized into groups. Transportation in marketing is a good example. Bulk handling could lower the cost of transportation and thereby reduce per-farm costs. Overdependence on local outlets can also be reduced by group action: farmers can then look for more profitable outlets elsewhere. Moreover, collective bargaining is usually helpful in obtaining a fair price for the farm produce. Likewise, many other activities in the purchase of inputs and in the marketing of outputs can be conveniently organized and effectively handled by farmer organizations.

Impact on Living Standards

In addition to those actively engaged in diversified cropping, others may also benefit from crop diversification owing to linkage effects or vertical expansion; for example, ***employment generation through handling, processing, expansion of input and output markets and through the increased demand for agricultural labor. It may also be argued that the increased availability of a variety of food crops would improve the general living standards of the large number of consumers.***

As ***food production,*** it may also be assessed in terms of ***efficiency in the production of nourishing foods per unit area of land (or water) during a unit of time.*** One may consider protein and energy **as** the major factors in the diet of people living in rural areas. The type of amino acids in protein is also a crucial factor. Methionine and lysine, for example, are important in tropical diets.

In general, ***crop diversification provides foods of higher nutritive value.*** For example, while a monoculture of rice may yield a higher amount of energy per unit of land, rotating it with ***legumes*** can provide more protein as well. Moreover, the quality of proteins in legumes is generally superior to that **of** rice. Soybean, for example, contains about 45 percent of protein with higher levels of methionine.

The factors affecting the volume of production and profitability have been discussed earlier in this paper. Profitability influences the capacity to spend on non-food items as well. The overall impact of crop diversification on living standards of people engaged in producing those crops would mainly depend on the distribution of factors of production in respective areas. The composition of the labor force engaged in diversified cropping (owner-cultivators, tenants, agricultural laborers, etc.), is a decisive factor in the success of such efforts.

Other factors affecting food distribution would include: ***economic*** aspects such **as** price policies, income disparities, marketing problems, national and international trade policies; ***demographic*** factors; ***cultural*** factors such as social status, modernization and food benefits, and health and nutrition services. Obviously, food preferences may also vary from one area to another or from person to person.

CONCLUSIONS

Agro-Ecological Factors

The present status and future potential of different categories of irrigated rice land for diversified cropping as revealed by this study analysis could be summarized as shown in table 10.

The maximum irrigated area brought under OFCs (in rice lands) so far in one cultivation season has been around 40,000 ha. This has not exceeded 10 percent of the total area cultivated with rice in any given season. Diversification in recent times has been mainly confined to both major and minor tank systems that have a deficit or inadequate irrigation water supply during the dry season. However, because of the high year-to-year variation in this limited dry-season water supply, the total extent of dry season OFCs that can be cultivated will also show a high degree of variation between years.

Despite the fact that seasonal as well as annual variations in production are prominent, it can be concluded that the country has achieved a very high degree of self-sufficiency in regard to major OFCs: chili, onion (red and large), green gram, black gram, soybean, groundnut and vegetables. Irregularities in supply of these products can be reduced to some extent by assisting farmers and farmer organizations in key producing areas to program their production, improving database and forecasting supply-demand on a seasonal basis, proper timing and adjusting of competing imports based on local supplies, proper storage and improved post-harvest technologies and better organization, including transport.

It has been estimated that the extent of well-drained land in major irrigation schemes of the dry zone is approximately 80,000 ha. The greatest extent of non-rice crops grown in the major irrigation schemes in Category I in the Mahaweli (Kalawewa), Uda Walawe and Polonnaruwa districts was around 16,700 ha; and in Category II of the Anuradhapura, Badulla and Mullaitivu districts it was around 5,200 ha. Assuming that all this is on well-drained land, there is yet a considerable extent of more than 40,000 ha of suitable land available for dry-season crop diversification under the major irrigation systems of the dry Zzne of Sri Lanka.

In addition, there is a possibility of growing OFCs under minor irrigation schemes by availing of the short April/May rainy period, and making provision for adequate drainage in case of unseasonal rains. This is already taking place in some minor tank systems in the Anuradhapura District in ***combination with agro-wells.*** Due to water scarcity, unsuitable soil conditions and other reasons, it may not be possible to bring the entire 185,000 ha in Category 4 lands under OFC cultivation in the dry season. Close monitoring of dug wells is necessary to assess the "supply conditions," including quantities, spacing/density of wells and costs. This may lead to a "regulated expansion" of OFC cultivation in such systems. ***This may be assigned high priority on an experimental basis in the initial phase.*** An increase in overall cropping intensity may be expected here.

Thus, there is no shortage of suitable land for dry-season crop diversification under the various categories of irrigation systems. Water supply, rather than extent of suitable land, is therefore recognized as the major physical constraint.

Irrigation-Related Factors

The present procedure of aligning field channels traversing well-drained, imperfectly drained and poorly drained soils is not conducive to efficient operation when OFCs are grown in the upper reaches while rice is being cultivated in the lower reaches. This is found to be particularly true for certain major irrigation systems designed for rice cultivation. In such systems, provision of separate parallel field channels for "rice" and "OFC" soils would therefore facilitate better system operation, effectively intercepting the drainage flow and increasing on-farm water use efficiency. The density of drainage ditches in such systems also needs to be increased for efficient cultivation of OFCs.

OFC cultivation in rice-based systems may, in addition, require seasonal adjustments in land preparation--perfect leveling, raised beds, etc. Further, when compared to rice, OFC cultivation demands greater flexibility in control structures including individual farm outlets. Operationally, ***detailed planning and implementation*** of irrigation schedules and matching them with crop schedules **are** also necessary for OFCs.

However, as greater flexibility exists in the "supply" side of suitable lands, these difficulties in irrigation management may not seriously inhibit the expansion of diversified cropping in rice lands.

Table 10. The present status and future potential of different categories of irrigated rice lands for diversified cropping.

Category	Potential		Achievement in the "best" season
	Maha (wet)	Yala (dry)	
1. Major irrigation systems with adequate water supply during both maha and yala	All rice, except for water-deficit systems like Kirindi Oya and Huruluwewa	Only in well-drained areas	• Mahaweli H and Walawe 75-80% • Someother systems 40-50%
2. Major irrigation systems with adequate maha supply and inadequate supply in yala	All rice, depending on water supply	Only in well-drained areas.	• SO-70% of well drained areas.
3. Medium schemes with moderately stable water supply in maha (yala supply unreliable[1])	Mainly rice, depending on water supply; but, improved organization and management can enhance potential up to about *25%*	But, conjunctive use and improved organization can increase the potential up to about **25%**	• Very low—less than 10%
4. Minor irrigation systems (with unstable water supply)	Only in well-drained areas; conjunctive use and improved organization can enhance potential	Conjunctive use and improvements in management can enhance potential	• Negligible

[1]Extent under well-drained soils is about 25 percent.

Economic Factors

Economic factors, especially markets, prices and trade policies, can be identified as the most important determinants in the future expansion of diversified cropping in rice lands. The price analysis shows a general trend toward declining prices for most OFCs, despite high variation over time and space. According to trend analysis, the profitability of almost all major OFCs shows a declining trend. Analysis of the price factor and the comparison of predicted demand/supply conditions support this argument. As stated earlier, the study revealed that the gap between national requirements and current production levels is narrowing down or is nonexistent in the case of most of the major OFCs. This phenomenon of narrowing the gap between demand and local production coupled with the increase in cost of production explains the declining trend in profits.

This analysis leads to the conclusion that, if the "supply" from non-rice areas remains unchanged, the rice area that should be diversified in order to satisfy local demand is around 40,000 ha. The country has reached this level during the recent past.

It is likely that the produce from areas such as Jaffna and Kilinochchi will increase the supply once the current civil disturbances ease.

The cultivation of special crops for identified captive markets should be encouraged. Farm-level profits should be the major consideration in any future efforts in OFC cultivation. Because the country has approached a very high degree of "self-sufficiency" in regard to almost all the major OFCs, large-scale expansion of any such crop, if not market-oriented, may result in a decline in farm-level profits. Any large-scale expansion of diversified cropping in rice lands should therefore be focused on "special crops for special markets." It is clear that the search for new crops with comparative advantages is vital. More attention needs to be paid to increase agri-business opportunities that help value-addition, market research and promotion, quality control and export.

A preliminary analysis of comparative advantage of OFCs and rice production revealed that the local production is advantageous for many crops (including rice). Green gram was an exception. Economic profitability of rice production under major irrigation schemes is higher than that of other OFCs included in the analysis, except for big onion. It should be noted, however, that the cost of water was not considered in this analysis.

Role of Farmers vis-a-vis the Government

With the increased emphasis on diversified agriculture, value-added production and improved linkages between agriculture and industry, the service needs of the agricultural community will be changed--they need more intensive and varied services. The government intervention pattern should be changed from one of nurturing and perpetuating a dependency syndrome to one of motivating and assisting farmers to organize and manage their own system of production and support services. These may include technical and organizational assistance for planning and scheduling of crop production, storage, packing and grading, transport, and linking small farmer organizations and small farmer companies (in a legally binding and efficient manner) with commercial lending institutions and with the organized private sector in marketing and processing and in maintaining the quality and the supply of different raw/processed commodities on time, based on demand. There is evidence in many developing countries that farmers, even those with smallholdings, make production responses to the economic environment, especially when they *can* exercise greater control. This can be achieved through collective action—through federated fanner organizations and through small farmer companies.

There appears to be an obvious need for continued government intervention in diversified agriculture, mainly in policy, organization, institutions, marketing and extension work but with approaches different from those adopted in the past. For example, extension work should support farmers in their intensified and strengthened organizational activities. It is imperative here to encourage group action by farmers, for example, through farmer organizations, to ensure progressive expansion of users' role in the management of resources and services. The government should "catalyze" or facilitate this process.

The government should also play a dominant role in sponsoring appropriate research in **areas** such **as** newer crop varieties for special markets, off-season production, programming/scheduling production through group action by farmer organizations, demand and markets, market information systems, storage and postharvest technologies, semi-processing at farm/village level, processing of value-added products/agro-based industry, transport, quality control, legal mechanisms and environmental concerns. The government should also perform a regulatory role in the areas of quality control and environmental conservation.

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Annex

Table A-1. Labor requirement for OFCs and rice (man days per ha)

	Family labor	Hired labor	Total
High performance crops			
Chili	286 (60)	187 (40)	473
Big onion	390 (73)	141 (27)	531
Red onion	169 (20)	697 (80)	866
Low-performance crops			
Green gram	188 (80)	48 (20)	236
Soybean	107 (67)	53 (33)	160
Groundnut	128 (61)	80 (39)	208
Rice	44 (45)	54 (56)	98

Notes: Percentages are given in parentheses. Averages are based on data for 1985 to 1992.
Source: Cost of Cultivation of Agricultural Crops, Department of Agriculture, various issues.

Table A-2. Costs ofproduction for OFCs and rice during 1993 yala season, in Rs 000 /ha.

	High-performance crops		Low-performance crops		
	Chili	Big onion	Green gram	Soy-bean	Rice
Seed	1.63 (4.1)	8.82 (20.4)	2.89 (24.1)	1.58 (14.2)	1.37 (7.4)
Fertilizer	6.46 (16.2)	13.14 (30.5)	0	0.49 (4.4)	4.92 (26.7)
Chemicals	10.57 (26.6)	3.30 (7.6)	0.48 (4.0)	0.92 (8.2)	1.53 (8.3)
Implements	6.50 (16.3)	5.66 (13.1)	1.77 (14.8)	2.30 (20.6)	4.38 (23.7)
Hired labor	14.59 (36.7)	12.20 (28.3)	6.84 (57.1)	5.86 (52.6)	6.24 (33.8)
Total 1	39.75	43.12	11.98	11.15	18.44
Total 2	53.19	54.53	16.51	17.28	22.02

Source: For chili, big onion, soya bean and rice, data are taken from Cost of Cultivation of Agricultural Crops, Yala 1993, Department of Agriculture, 1994. Data for green gram are from Kirindi Oya On-Farm Demonstration, 1989 Yala Season, published in Final Report of a study on Irrigation Management for Crop Diversification, Vol. II, IIMI, 1990.

Notes: Opportunity cost of family labor is valued by taking 0.7 of wage rate for hired labor.
Total cost 1: Total cost excluding family labor.
Total cost 2: Total cost including family labor.

Table A-3. Farm Level Profitability of OFC cultivation under irrigated conditions, 1993 yala season, in Rs 000/ha.

crop	Yield mt/ha	Price Rs/kg	Gross revenue	Farmers' income 1	Farmers' income 2	Labor Pro-ductivity
High-performance crops						
Chili	1.02	76.27	71.80	38.05	24.61	153.14
Big onion	12.86	13.67	175.80	132.68	121.27	434.33
Red onion	8.59	13.38	114.93	7.93	4.88	10.16
Low-performance crops						
Green gram*	0.65	27.89	18.19	6.21	1.68	53.23
Soya bean	1.54	18.00	27.72	16.57	10.44	157.59
Rice	4.18	7.70	32.19	13.75	10.17	214.50

Source: Data for chili, red onion, big onion and soybean were taken from Cost of Cultivation of Agricultural Crops, **Yala** 1993, Department of Agriculture, 1994.

*Notes:** Data for green gram were taken from Kirindi Oya Crop Demonstrations in 1989 **Yala,** published in the Final Report **on** Irrigation Management and Crop Diversification Vol. II, IIMI, 1990.

Farmers' income 1: Without taking opportunity cost of family labor
Farmers' income **2:** Including opportunity cost of family labor.

Discussion

C.M. Wijayaratna

THE DISCUSSION WAS centered on the concept of regional specialization of crops. Identification of specific areas and developing the specialization program over a period of time, and consideration of the broad perspectives were discussed as these concepts have been implemented by other agricultural countries. Since greater future demand for other field crops is expected, regional specialization was considered a viable solution to cater for the food requirements in Sri Lanka.

Participants from the Department of Agriculture suggested that the proposed system would have advantages such as improved marketing channels. Site specialization in crop cultivation is currently observed in some highlands. However, intercropping or mixed cropping could provide more economic and agronomic benefits to the farmers than monocropping. It was indicated that the concept of regional specialization is not for a particular crop or an area, but for a better cropping pattern.

Regarding the stagnation of all production aspects over the recent years, it was indicated that major factors concerned are stagnation of extents of cultivation and yields. Low expansion in irrigation investment is a major determinant of the extent of cultivation. Stagnation of yield is mainly due to the achievement of the technological ceiling set by the breeders, problems encountered in soil rehabilitation and renovation.

A breakthrough in the production system could be achieved by the exploitation of the nontraditional uplands, soil regeneration via intercropping, addition of organic manure, and the development of value-added products. However, there is limited scope for the improvement of irrigation management. In future, water and soil management in uplands could be more important than irrigation management in lowlands.

Exploitation of international markets drew the attention of many participants. However, in the current situation, strategies to achieve self-sufficiency in food crop production were suggested to be more important than looking for export markets. The export market depends on the crop and processing technologies. Exportation could be initiated for crops with seasonal production and in situations with excessive production. However, the present foreign markets such as in India, favor mainly the processed products. An efficient extension system was considered the key to increase rice production early in the 1980s in Sri Lanka. The decrease in rice production during the recent past, however, is not only because of poor extension facilities, but also due to other secondary factors. The technical extension services of the country have given the technical know-how to the farmers. However, marginal developments observed in the credit facilities and markets, and high pest and disease incidence have resulted in the low production of agricultural crops.

In conclusion, the chairperson suggested that several districts in Sri Lanka have recorded high yields mainly due to the adoption of better plowing techniques, i.e., plowing into a shallow depth. Incorporation of organic matter would also be a good solution to overcome this problem. In addition, use of adulterated fertilizer in crop cultivation should be avoided. Encouraging farmers to trade activities via development of value-added products is a viable solution since the yield per unit area and the cultivated extent have reaches the ceiling. Farmers should be encouraged to get involved in trade. However, approaching the Indian market would be a difficult task since Indian fanners are supplied with free power by the government, thus encouraging them to develop value-added products.

Planning Strategies for Crop Diversification in Minor Irrigation Schemes

P.B. Dharmasena[6]

ABSTRACT

The processes of changing crops in an agro-sphere' due to various external **as** well **as** internal **factors** can be broadly categorized under the term, ***crop** diversification*. **In** farming systems under minor irrigation, especially in the dry zone of Sri **Lanka,** crop diversification has first appeared in rain-fed uplands due to decline in soil fertility and in searching for crops which provide financial benefits. **The** nature of crop diversification taking place in the lowland farming situation is mainly due to **two** main reasons; water scarcity and low profitability of rice cultivation.

Crop diversification fails mostly when it is imposed **as an** alternative without realizing the determining factors of the agro-sphere. **The** concept of diversification must be induced to undergo an evolutionary process which allows a reasonable time span to be economically, socially, physically and ecologically sustainable. However, some of the planning strategies can catalyze **the** process of crop diversification. They are: a) physical planning of the area, b) integrated water resources planning, c) integrated seasonal cultivation planning, d) production analysis for **correct** input **use,** and *e)* input-output service planning for diversified cropping. The participatory role of fanners is vital in achieving the expected objectives of planning which would lead to sustainability of crop diversification. The paper discusses these planning strategies in detail.

INTRODUCTION

In the dry and intermediate zones of Sri Lanka, about 120,000 ha are cultivated under minor irrigation schemes (Upasena et al. **1980).** In general, rice yields and cropping intensity are comparatively low in minor irrigation compared to major schemes due to shortage of water. Although rice cultivation is less profitable compared to other fields crops, farmers still prefer it due to various other **reasons such as** low labor requirement, considerable return to labor, affordable cash cost and satisfactory return to capital (table **1). Due** to low labor utilization in rice cultivation the farmers are able to earn a high annual income from off-farm employments.

In the recent past, farmers in minor irrigation schemes have hardly cultivated twice a year.in their rice fields. Even in a maha season **farmers** have to wait until sufficient water is stored in the tank and thus, fail to use maha seasonal rains for cultivation. **In** some years, farmers could not cultivate even in the maha season and, in most years, crop losses and partial abandonment of rice fields due to water **shortage** were common incidents **in** the minor irrigation schemes (Dharmasena **1989). Reasons** for the occurrence of water shortage are: (a) limitation of the tank catchment areas; (b) high **losses** of

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'Research Officer, Field Crops Research and Development institute, Mahaillуppallama

[7]The term **agro-sphere is used here in the cintext of "an environment where agricultural activities are taking place, and its wide process is determined by the input and output parameters both of which are influenced by external as well as internal factors."**

Table 1. Economics of cultivation of some important field crops in Sri Lanka.

Crop	Cash cost (Rs/ha)	Labor (man- days/ha)	Net returns (Rs/ha)	Return to labor (Rs/manday)	Return to capital (Rs/Rs)
Rice	15,460	100	13,500	185	1.90
Chili	27,175	325	56,850	210	3.10
Onion	50,760	610	79,560	170	2.95
Cowpea	7,690	120	7,160	100	1.95
Soybean	8,150	140	9,055	90	2.10
Gingelly	1,765	90	6,560	90	4.70

Source: Division of Agricultural Economics and Planning, Department of Agriculture 1993.

tank water; (c) delayed cultivation; (d) failure to make the best use of seasonal rains; e) inefficient water management; and (9 adherence. Project undertaken by the Field Crops Research and Development Institute, Mahailluppallama during 1975-1980 at Walagambahuwa aimed at devising a more efficient cropping pattern and water management system taking most of the above mentioned reasons into consideration (Fernando 1981).

In the Walagambahuwa Project, the farmers were motivated to advance the maha rice cultivation using early rains for land preparation and to grow short-age rice varieties. The Walagambahuwa fanners succeeded in cultivating two crops during the given time frame. Subsequently, this concept was introduced to about 700 minor irrigation schemes in the Anuradhapura and Kurunegala districts. Although the results of the Walagambahuwa Project were encouraging the sustainability of its recommended practices was debated. Two main difficulties that the farmers experienced were the dry tillage and sowing and weed control (Fernando 1981). In addition, timeliness of field operations, interaction with rain-fed cultivation on resource utilization, nonavailability of inputs in time and inability of adjusting themselves for the new package of practices were also of importance.

After 15 years since the completion of Walagambahuwa endeavor, today, with the availability of new cultivars, the advancement in production, and more experience and technology, it is necessary to reconsider the issue of crop diversification in minor irrigation schemes not only because of water scarcity but also for increasing the agricultural production and water productivity. Thus, it is essential to discuss the implications of the 'Walagambahuwa Concept' of crop diversification in the minor irrigation farming situation and then develop a compatible module of strategies.

Implications of the 'Walagambahuwa Concept' can be broadly grouped into hydrological, socioeconomic and institutional aspects.

Hydrological Implications

The potential of tank catchments to generate adequate amount of runoff for achieving the full storage status in an average rainfall year is an important factor in minor tank hydrology. Dharmasena (1989) suggested that to achieve the above status, the catchment area must be 10 times larger than the command area under prevalent land use and crop management conditions. However, later it was found that more than 50 percent of minor tanks in the dry zone do not have this hydrological situation but the Walagambahuwa Tank is somewhat closer (8 times) to the above requirement (Dhannasena 1994). It appears that as far as its hydrological potential is concerned the Walagambahuwa tank does not represent minor tanks of the dry zone. Therefore, these results of the Walagambahuwa Concept cannot be generalized.

The other criticism is that storing water for yala cultivation is not an efficient management strategy as the rate of water loss from minor tanks is very high. Studies indicate that the storage half life of these minor tanks is 12-16 weeks and the Walagambahuwa Tank recorded 14 weeks. Therefore, an extrapolation of the Walagambahuwa experience for general use is questionable. It would be better to group the tanks based on their ability to store water and develop crop diversification strategies for each group separately. However, a hydrological investigation and physical planning before introducing the crop diversification into these farming systems are imperative.

Socioeconomic Implications

Traditional dry-zone village farmers are accustomed to a series of field activities in a maha season, and finally they reap harvests from their chena and rice fields to meet the major part of their dietary requirements. It includes rice, coarse grains, legumes and some vegetables. With the experience gained over generations, the family labor is efficiently distributed to accomplish the simultaneous activities in their rice fields, chena and home gardens. It would be difficult to change this habit unless a proper labor distribution system is incorporated into the crop diversification plan. Otherwise, the fanners would return to their old style of farming with some experience on crop diversification as has happened in the Walagambahuwa Village.

At present, the farmers have little faith in tank water availability but they are certain on well water for limited cultivation. Fanners who own wells were found to be 'early farmers' for maha season in rice fields as their crop is assured with a supplementary source of water. During yala season they are completely dependant on well water. This practice has been realized as a wasteful way of managing available water sources, and it stresses the importance of having an integrated plan for rain, tank and groundwater resources to maximize the productivity of water resource (Dhannasena 1995).

Institutional Implications

In 1978, crops such as grain legumes, chili, onion, etc., were introduced to rice fields at Walagambahuwa during the second year of the project. Even with the intervention of the project some farmers were reluctant to use fertilizers and chemicals due to the risk of crop losses (Seasonal Report 1978). However, there were no apparent constraints from service agencies in input supply during the project period. The artificial conditions created by the project management might have led fanners to obtain high income masking the real constraints on institutional services. At present, the supply of fertilizer as well as seeds is a continuous problem. This would make more institutional conflicts for crop diversification especially with subsistence fanners in smallholder farming.

Crop diversification as a strategic solution to overcome the fanning difficulties in minor tanks areas is a new concept to the farmers. In fact, they practice crop diversification under rain-fed conditions in upland areas. Fanners change crops according to the fertility condition of the soil. A crop such as mustard is grown only in newly cleared fertile lands after burning a large quantity of biomass. As fertility gradually declines the farmers grow a mixture of crops including maize, legumes and vegetables. Further, decline of soil fertility compels fanners to grow coarse grains such as millet. With continuous cultivation for several seasons the land becomes so infertile to grow any crop in the maha season, except gingelly in the yala season. Ultimately, the land is abandoned leaving nature to rejuvenate it through a series of successions of natural vegetation which would take nearly 20 years.

This traditional crop diversification process has recently been affected by selecting crops not only according to the soil status but also based on the commercial value of crops.

In the lowland farming situation rice cultivation still sustains due to the reasons described earlier but a necessity has arisen to diversify the cropping situation due to following reasons:

* keeping lands fallow each year for comparatively larger periods
* abandoning of some lands in some years due to low rainfall in the maha season
* lack of off-farm employment opportunities to farmers in some areas
* inability to venture into high water-demanding crops because of the storage status of some minor tanks
* returns to applied water being low in rice cultivation
* impossibility of justifying the use of shallow groundwater through open dug wells as a supplementary source for rice cultivation alone

In a situation which drives toward a crop diversification process in an agro-sphere, two basic factors restricting its success should be realized. First, the crop diversification cannot be imposed as a blueprint package without understanding the nature of internal as well as external factors affecting the concerned agro-sphere. Second, the concept of crop diversification must be induced to undergo an evolutionary process because it is more than simply a change of crops. It needs time to adjust the farm economy, change social attitudes, identify physical problems and evaluate ecological changes. However, some of the planning strategies can catalyze the process of crop diversification. The objective of this paper is to introduce these planning strategies and discuss the related aspects which would create a favorable environment for the diversified cropping systems.

Participatory Role of Farmers

It is farmers who should realize the need of diversification. In most development projects, fanners follow the recommendations of the implementing agency expecting project benefits rather than realizing the worth of doing it. For this reason, almost all recent agricultural development projects rely on the farmer participatory strategy. However, in practice, it is still difficult to understand which sense of participation is expected from farmers in these implementing programs. Therefore, it is vital to recognize what participatory role farmers are supposed to play in crop diversification processes.

In an area, identification of the need and potential for crop diversification is a prerequisite. This exercise has to be done with farmers' participation. The following conditions would indicate the need for crop diversification:

* non-satisfaction of farmers with the benefits accruing from present cropping

* lack of easy access to off-farm income generation opportunities that **are** more attractive than their own farming

* farmers' awareness of declining trends in their income

* the belief of farmers that changing of crop in their farms would bring them a satisfactory income

Physical Planning of the Area

The process of crop diversification can be one of the alternatives that the farmers would consider to solve their problems. In an exercise of problem identification farmers may find some other activities as more important than crop diversification. For example, the tank bund has to be repaired because it cannot store water efficiently or the spill water takes its way over the rice field damaging the crop. In such situations, farmers would lose interest on crop diversification unless some steps are taken **to** solve the prioritized problems. Therefore, a complete agricultural development plan must be prepared with farmer participation for the area including crop diversification as one component. The planning area should at least cover the entire irrigable area, the tank and the adjoining portions of the upland. Steps to be taken in preparation of a physical plan are listed below:

* participatory mapping of the area in question

* identification of hydrological situation, soil and agro-sphere

* farmer participatory problem identification workshop

* preparation of the development plan

The development plan must include options based on physical ***status*** of the resources. Changing of the crop may be one option. The most suitable option needs to be identified by considering technical feasibility, profitability and the farmers' view. The resource conservation aspect must be emphasized at every stage.

Integrated Water Resources Planning

Conjunctive use of water resources needs to be well planned to obtain the maximum benefit of water for agricultural production. In attempting such an integrated effort for the efficient **use** of available water following aspects need to be considered:

i. Cropping periods need to be matched as much **as** possible with the rainfall pattern.

ii. In-situ **use** of rainfall (soil moisture) must be given priority in water management planning.

iii. Loss of water from tanks must be minimized.

iv. Tank catchments must be managed to generate more runoff during rainy periods.

v. Command area cultivation should be planned through tank water budgeting.

vi. Productivity of water has to be maximized.

vii. Use of groundwater must be planned as the last alternative.

viii. Moisture conservation must be given priority.

ix. Water productivity can be increased by advocating farmers on correct use of inputs. Farmers can be made aware of this through a production function analysis.

x. Farmers need to be trained for an integrated seasonal cultivation plan. This may be successfully attempted through participatory seasonal planning workshops.

A minor watershed-based integrated water resource management model can be developed using the following information.

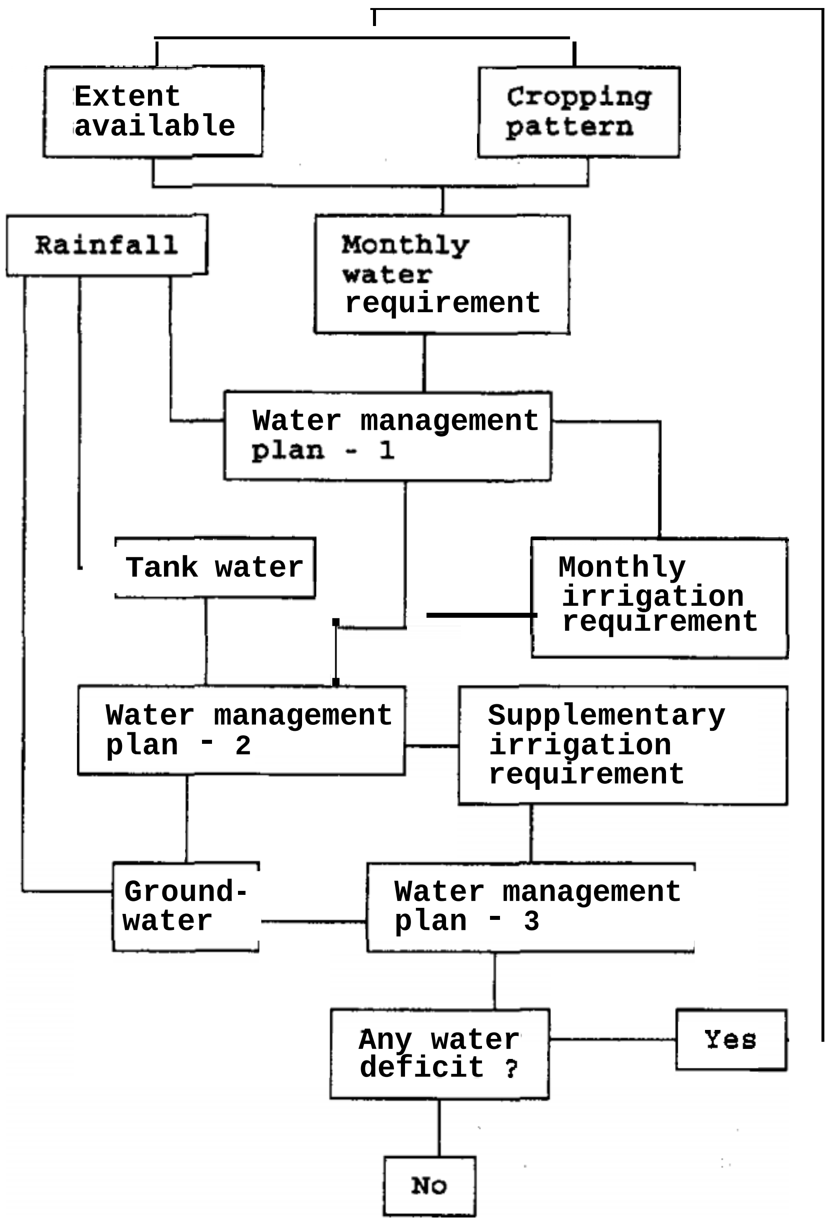
* Minor watershed water balance
* Transbasin contribution
* Tank water balance
* Availability of groundwater
* Land use options for different land categories
* Crops and cropping patterns

A sample water management model is shown in figure 1 to elaborate the concept of integrated water resources management planning. The proposed model would differ according to the hydrological situation of the region and the variation of its quantitative parameters. It is very difficult to imagine the agricultural prospects of a minor watershed without a proper understanding of the quantified hydrological situation.

Hydrological Situation

The catchment of the tank alone provides runoff water as inflow to the storage.

Figure 1. Integrated Water Management model.



Improved Water Management Using Groundwater

The success of the adoption of improved water management practices depends mostly on the nature of water source, the water user and the farming environment. It can be envisaged that farming with groundwater through lift irrigation would have additional advantages and would provide opportunities for farmers to adopt improved crop and water management practices which must ultimately increase the water productivity and monetory returns to the farmer. When farmers have access to groundwater they may get the following additional benefits:

* land preparation can be completed in advance without waiting for seasonal rains.
* limited well water available during dry periods prior to the season can be utilized for raising nurseries
* soil moisture stress; the major problem for establishment **of** perennial crops can be overcome through agro-wells
* high monetory returns from off-season cultivation
* assurance for water is high so that farmers tend to invest more on cultivation.
* ability of farmers to grow high value crops like vegetable, chili, onion, etc.

However, our experience indicates that farmers engaged in cultivation with well irrigation do not gain much benefit from this water resource and consequently receive less income due to the following reasons:

* lack of understanding of the availability of well water
* non-planning of cultivation by farmers to obtain the maximum benefit from rainfall
* moisture conservation techniques not being adopted by farmers even if their crops **suffer** from moisture stress
* the continuing practice of most of the agro-well farmers cultivating according to the seasons without taking advantage of wells
* fanners' lack of experience on irrigation layouts for conjunctive use of water resources

Therefore, on-farm water management has to be given priority in research as the farmer alone cannot face the challenge of avoiding conflicts in integrated water management. The following suggestions for future research are made with respect to on-farm water management in the conjunctive use of groundwater:

* irrigation layout and scheduling
* reduction of water conveyance losses
* moisture conservation methods
* crops and cropping patterns aiming at achieving maximum benefits from water

Finally, it is noteworthy that water management planning should not be targeted at keeping water resources unused, but using them while maintaining the hydrological balance to become an ecosystem sustainable in every aspect.

Integrated Seasonal Cultivation Planning

One of the constraints that farmers face in changing cultivation activities is that they do not realize the labor requirement at the beginning for different operations. Sometimes, high labor-demanding activities will overlap as farmers will be engaged in both upland and lowland crops at the same time. For example, during the second and third week of March a farmer may need to harvest the rice from lowland and plant gingelly in upland simultaneously. As a result, he may ignore the yala gingelly cultivation which provides high return to capital with low labor use (table 1). Planning of all cultivation activities before the commencement of the season has several advantages as follows:

* reduction of periods of excess labor requirement by identifying and adjusting cultivation activities before the commencement of the season

* farmers' ability to schedule the 'yaya' cultivation and complete operations such as plowing during a short period of time so that wastage of water would be minimized

* the plan can be used to estimate inputs and make arrangements to purchase them in time

* farmers can be organized to obtain credit from banks and to make arrangements to hire tractors for plowing

* total production of a crop from an area can be estimated and early marketing arrangements made to obtain a better price

Further, fanner organizations are benefited by the cultivation plan to render an effective and efficient service to the farmers.

The following procedure should be followed in cultivation planning:

* listing of all activities under different types of cultivation

* preparation of a tentative schedule for all activities

* estimation of labor requirement for each activity

* computing of the weekly labor

* adjusting of activities to reduce the weekly labor requirement below its optimal level

* deciding on other common amenity works when there is low labor or during idling weeks

* finalizing of the schedule, estimate input needs and discuss how inputs can be made available in time

This farmer participatory planning procedure can be introduced as an improvement to the '*kanna meeting*' which is practiced by farmers at present in minor irrigation schemes with the Agrarian Services Department.

Production Function Analysis

Economic studies carried out at the Field Crops Research and Development Institute, Mahailluppallama indicated that most of the farmers do not achieve optimum levels of net-returns and yield of crops such as rice, chili and onion mainly because of incorrect application of inputs such as fertilizer, agro-chemicals, water, labor, etc. A considerable improvement can be made on yield and net profit if farmers could be educated on this matter. For example, in a study conducted at Mahailluppallama during maha 1994/95, detailed farm records were maintained observing all cultivation activities and input applications in 31 rice fields and in 16 chili cultivated fields. Labor use, machinery cost, water application, use of chemicals, application of fertilizer, yield output, etc., were recorded. Production functions were attempted through multiple linear regression using input parameten and the yield and net-return. Average values for input parameters and correspondent net returns and yields observed for 16 chili and 31 rice cultivations are reported in tables 2 and 3.

Table 2. Input records of rice and chili cultivations (maha 1994/95).

Input	Rice		Chili	
	Cost (Rs/ha)	% cost	cost (Rs/ha)	% cost
Labor	5,900	43	29,700	62
Fertilizer	1,100	8	4,700	10
Agro-chemicals	500	4	4,900	10
Machinery	3,600	26	3,400	7
Water (supplementary)	700	5	800	2
Others	1,900	4	4,300	9
Total	13,700	100	47,800	100

Table 3. Output records of rice and chili cultivation (maha 94/95).

Output	Rice	Chili
Net return (Rs/ha)		
Including family labor	8,700	15,800
Excluding family labor	13,000	38,675
Grass income (Rs/ha)	22,400	63,600
Yield (t/ha)	3.300	0.90

The production functions of chili cultivation indicate that the cost for labor has reduced the net return. Investment on fertilizer and agro-chemicals could result in increasing the net return of chili distinctly. The average cultivated extent was 0.21 ha but the study indicates that the farmers who cultivate larger extents receive higher net return than others.

The optimized net return calculated from functions for chili cultivation in the maha season was 26,700 Rs/ha. The average net return was 15,800 Rs/ha, and it is only 60 percent of the optimum value. Only two farmers out of 16 have achieved the optimum.

According to the production function developed for the chili yield, use of machinery and agro-chemicals has a positive effect on yield. The optimum yield from chili cultivation was found to be 1.54 t/ha. Thus, under the prevalent environmental conditions in the maha season at a particular location, the MI-2 variety could give this maximum yield with correct input use. However, results showed that the average yield obtained by farmers was 0.90 and it is only about 60 percent of the optimum value.

The production function of rice cultivation indicates that the cost for agro-chemicals has reduced the net return drastically. The optimum net return for rice cultivation was Rs 12,040/ha and the average value of farmers was about 70 percent. Only about 20 percent of the farmers could achieve this optimum value.

The production function developed for rice yield indicates that the yield might have been affected by the use of chemicals. Use of machinery and fertilizer could increase the yield of rice. The optimum yield from rice cultivation was found to be 3.69 t/ha or 68 bushels/ac under prevalent environmental conditions. The results showed that the average yield obtained by farmers was 3.3 t/ha and it is closer to the optimum value. About 55 percent of farmers have achieved this optimum yield.

An exercise of this nature would convince farmers of the benefits of crop diversification as they can compare the net returns of different crops.

Input-Output Service Planning

The most important factors, which are unfortunately absent in most cases, are the availability of inputs in time and an attractive market for their produce. The success of the whole effort in introducing crop diversification ultimately rests on these two aspects. One responsibility of farmer organizations must be to work out mechanisms for input supply and the marketing process. It is essential and high time that research is initiated in these fields to influence policymakers to facilitate farmers for developing effective input-output service systems for these farming situations. Planning of such a system is the responsibility of marketing specialists, but its importance has to be realized by all who **are** involved in the crop diversification process. Farmer participation in all these planning efforts is the key factor without which the efforts would go waste even though the most suitable technical solution for the problem is crop diversification.

At some point of time, the term ***crop diversification*** will be too narrow when a need is identified to introduce a livestock component to the agro-sphere. With or without changing the crop, livestock can be incorporated into the farming system. In some situations, mechanization of farming may be a better option than crop diversification. Thus, it is always important to select the correct option with farmers in a participatory discussion rather than attempting ***to*** impose crop diversification **as** the only alternative.

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Discussion

P.B. Dharmasena

LAND TENURE AND land fragmentation were considered as major constraints in implementing crop diversification programs and in the planning process. Although there are no immediate solutions for this under present situations, land consolidation was suggested as a temporary solution.

Participants indicated that meetings of farmer organizations were rare and attendance was poor. This is mainly because many farmers do not cultivate their land continuously. In such situations planning becomes extremely difficult. Planning for the next cultivation season is essential to have a smooth flow of farming practices. Legalizing the fanner organizations to give them more administrative powers in determining cultivating land was one viable solution to this problem of this poor attendance.

Researchers have experienced that farmers do not carry out cultural practices in time. Problems related to landownership are the major socioeconomic factors related to this aspect.

Land has become a limited factor in minor imgation schemes and the number of farmers with small extents of land has increased in the recent past. This has been a major determinant of the shift of farmers to cultivate chena (highland cultivation), thus, neglecting the rice lands. Participants agreed that this aspect has to be highlighted in decision making to implement crop diversification strategies.

Elaborating views regarding delivery of water at the root level, the presenter indicated that information is available on conventional systems where the Department of Agriculture trains farmers using standard imgation layouts. Drip imgation would be useful for cash crop cultivation. However, there is a scarcity of information on agro-wells.

Participants from Hambantota indicated difficulties in convincing fanners of the beneficial effects of crop diversification. The fanners always start cultivation with the onset of rains resulting in high water losses. Land tenure was another major constraint for crop diversification which makes it difficult to decide the *ande* (share) system when cultivating other field crops. Thus, farmers are at a risk since their income is not guaranteed. This would direct the farmers to grow rice where income is assured through a crop insurance scheme, when water is available.

An integrated approach was suggested that would convince farmers of the beneficial aspects of crop diversification. For example, water supply could be assured with agro-wells, thus promoting cultivation of other field crops.

Since there is a strong correlation between rainfall and cropping intensity the participants suggested that effective utilization of groundwater through agro-wells would be a good solution. However, integration of agro-wells in crop diversification is an aspect that is still under debate. Critical evaluation of its potential to be integrated with crop diversification programs and institutional support to the development of facilities are essential prior to implementation.

Socioeconomic Constraints and Future Prospects for Crop Diversification in Minor Irrigation Schemes

S.N. Jayawardena[8]

ABSTRACT

MINOR IRRIGATION SCHEMES in Sri Lanka play a significant role in food production and providing employment to the rural sector. it has been estimated that area under minor irrigation schemes is around 38 percent (185,000 ha) of the total irrigable area and accounts for about 20 percent of the total rice production in the country. However, due to inadequacy of water, the cultivation of crops in these lands has been mainly confined to maha (the wet season). In yala (the dry season), land area is seldom cultivated

The strategy for crop diversification was adopted in rice fields through cultivation of less-water-demanding non-rice crops during yala to obtain the maximum economic benefit from water, the most scarce resource. This practice helped increase cropping intensity in rice fields as a whole, but minor irrigation systems did not gain much. Hence, the need for improvement of existing productivity in minor irrigation schemes still remains a great challenge to gain maximum economic benefit under prevailing socioeconomic conditions.

The Department of Agriculture has recently introduced some cost- effective technologies to improve the existing cropping systems. These include (i) the use of residual soil moisture to cultivate early maturing (55-75 days) crops in the tumround time between maha and yala and, (ii) the efficient use of limited yala rains to cultivate early maturing crops in fallow rice lands. These technologies have already been evaluated under farmers' field conditions for their adaptability and acceptability. In addition, during maha seasons some moisture-tolerant crops such as *taro* (Colocasia spp.), sweet potato and other horticultural crops can be grown to increase the productivity.

In such crop diversification endeavors, some of the aspects which need careful coordinations are (i) transfer of available technologies through an effective extension mechanism, (ii) improvement and expansion of marketing facilities in major production areas, (iii) improvement in access to credit and other facilities, (iv) promotion of consumption of local foods through the development and expansion of processing industry, and (v) the adaption of a favorable trade policy.

INTRODUCTION

Minor irrigation schemes in Sri Lanka play a significant role in the country's economy by producing food and job opportunities to the rural sector. From the early period the minor irrigation schemes have been the focal points for the community life--socially, economically and politically. Today, this sector accounts for 33 percent of the total imgated rice extent and produces nearly 19 percent of the total rice production in the country.

Yield Crops Research and Development Institute, Mahailluppallama.

Among the several forms of minor irrigation schemes, the minor tanks **are** the most important. **There** is no definite information on the number of minor tanks found in the country. However, it has been reported that **as** many **as** 18000 tanks exist in the country. These numbers signify the role they play in the agriculture of the country. According to Gunadasa *et al.* (1980) 30 percent of these minor tanks are either unused or underutilized. Therefore, there is a great potential for increasing national food production by expanding the extent of cultivation under these tanks either through the rehabilitation of the abandoned or underutilized tanks, or improving **the** existing production systems. Little attention has been paid in the past to improve agriculture under the minor tanks. As a result, **the** extent under major imgation schemes has increased rapidly. Although the minor imgation schemes have a small proportion of rice lands, the number of dependent families is much higher than that in the major imgation schemes. Therefore, to improve the crop productivity it is important to improve productivity of the minor-tank-based farming systems.

CROP DIVERSIFICATION IN RICE FIELDS

Crop diversification in rice fields can be defined **as** the cultivation of field crops other than rice. The primary objective of crop diversification is to increase the income and productivity from the limited resources of land, labor and water. Although the concept of crop diversification in lowlands is relatively new to Sri **Lanka,** it has been practiced in China, Taiwan and Japan for centuries, **where *5-6*** crops ***are*** cultivated within a **year** by adopting the multiple cropping techniques coupled with other efficient management practices. **In** the 1960s, this technology was improved **at** the International Rice Research Institute, the Philippine and it was able ***to*** obtain more **than** 30 t/ha of food by increasing the cropping intensity to 400-500 percent. This technology **was** later introduced to many other Asian countries including Sri Lanka.

Advantages **of** Crop Diversification in Rice Fields

Some of the advantages of crop diversification in rice fields are give below:

* comparatively higher net return from OFCs
* higher productivity per unit of water
* higher net returns per unit of labor
* increased cultivable **area**
* a balanced diet to the **rural** sector
* increased job opportunities to the dry-zone farmers in yala
* improved soil **structure** and fertility

Diversified cropping not only helps increase farmer income but also helps increase employment opportunities in the dry **zone,** where considerable amount of farm labor idles during yala without farm activities. Further, it helps lower the pressure on upland resources which are shrinking gradually.

Needs **for** Crop Diversification

Increasing rice production of the country was the government's policy in agriculture prior to 1960. It provided several incentives such as guaranteed price schemes, input subsidies, imgation facilities, etc. These resulted in achieving the self- sufficiency in rice production. Aluwihare and Kikuchi (1990) reported that the expansion of extent cultivated (32%) and the introduction of seed and technology **(68%)** were the two major factors for this achievement. With the increasing area under imgated rice, water became limited for rice cultivation and also increased the cost of production, thus affecting the farmers' income. Presently, around 50 percent of the rice fields are not cultivated during yala. This situation is more serious in minor imgation schemes where more than 60 percent of the rice fields are left fallow during yala. Therefore, the government emphasized the need for crop diversification to increase farmers' income.

Potential **for** Crop Diversification

Local Demand

About 20,000 ha of new lands need to be cultivated during the **next** five years or 4,000 ha per year to meet the local requirement of **OFCs** in the country (table 1). At present, with the exception ***of*** onion and chili around 75 percent of almost all OFCs are grown during maha in uplands under rain-fed conditions. A greater proportion of this requirement *can* bc met by bringing the rice lands under cultivation during yala. At present, the government spends a great deal of foreign exchange to import chili, maize, large onion and soybean. These **are** imported annually, but they *can* be produced in rice fields during yala. Thus, increasing OFC production in rice fields will not only increase income employment opportunities, but will also save foreign exchange.

Area Available **for** Crop Diversification

The potential extents of rice lands under minor imgation schemes for crop diversification in different provinces are given in table 2. This indicates that a considerable extent is available for crop diversification. The suitable **areas** are mainly confined to Uva, North Central, North Western, Northern and Eastern provinces of the dry zone.

Past Attempts

Historically, in Sri Lanka three phases **are** distinctly important for crop diversification activities in rice fields. In the 1960s, cultivation of OFCs was introduced in rice fields for the first time in the Elahera imgation scheme. However, this effort was not successful due to the lack of understanding of complexities of the system.

Table 1. The estimated land extent (00ha) that needs to be cultivated for OFCs during next five years (1995-2000).

Crop	1995	1996	1997	1998	1999	2000	Extra land needed to meet the requirement* in 2000
Chili	54.7	54.7	56.1	56.7	57.3	58.1	3.36
R' onion	13.3	13.5	13.6	13.8	14.0	14.0	0.82
B' anion	5.9	5.9	6.0	6.1	6.2	6.2	0.37
Maize	93.6	94.7	95.9	97.0	98.1	99.3	5.27
Kurakkan	15.0	15.1	15.2	15.5	15.7	15.8	0.88
Greengram	47.5	48.5	48.6	49.2	49.8	50.3	2.87
Blackgram	20.3	20.6	20.9	21.1	21.4	21.7	1.31
Cowpea	21.6	21.8	22.2	22.4	22.7	23.7	1.33
Soybean	40.1	40.6	41.6	41.6	42.1	42.5	2.44
Groundnut	10.7	10.9	11.2	11.2	11.9	11.3	0.69
Total	323.1	327.3	330.9	335.4	339.0	342.8	19.77

Source: Ratnayake et al. (1995)
* Under constant yield

Table 2. Potential areas for crop diversification in minor irrigation schemes in Sri Lanka.

Province	Irrigated area (ha)			Potential area for CD (ha)	
	Major irrigation	Minor irrigation	Total	Minor irrigation Maha	Minor irrigation Yala
Western	2,974	6,692	9,666	340	1,680
Southern	24,570	11,980	46,550	2,990	4,490
Uva	10,824	14,678	25,502	4,405	10,275
Sabaragamuwa	1,937	12,095	14,302	3,055	7,320
Central	11,069	21,770	32,839	3,340	9,630
North Western	21,380	45,826	67,206	13,750	31,070
North Central	57,964	45,401	103,095	15,775	20,430
North & East	120,387	29,193	149,580	10,080	13,200
Total	250,335	187,935	438,770	53,735	98,095

Source: DOA 1989-90 Agricultural Implementation Programme Adopted from Jayawardena, Jayasinghe and Dayaratne (1991).

In the mid-1970s under the International Development Research Center (IDRC) Cropping Systems Project an attempt was made to increase the productivity of rice lands under minor tanks in the dry zone through the effective use of rainfall, using early maturing rice varieties and cultivation of less-water-demanding OFCs, thus increasing the cropping intensity from 100 to 250 percent (table 3).

In mid-1980, a massive crop diversification program was launched in the rice fields of Mahaweli System H during yala with the help of many agencies including the Department of Agriculture, the Mahaweli Development Board (MDB), the Mahaweli Economic Agency (MEA), etc. This effort resulted in a significant increase in extent of OFCs in the area.

Present Situation

The most common crops used for crop diversification in rice fields were, chili, large onion, green gram, black gram, cowpea, soybean and groundnut. However, high-value crops such as gherkins, baby-coms, cantaloupe were also introduced in some areas. Cultivation of OFCs in rice fields during yala introduced through crop diversification, made rapid progress and it reached its peak in 1986 and then declined gradually due to various reasons (figure 1). At present, the extent used for crop diversification in minor imgation schemes is negligible.

***Table 3. Cropping patterns tested under Walagambahuwa minor tank** (1979-1981).*

Year	Maha rainfall (mm)	Cropping pattern	Cropping intensity (%)
Before 1976		rice - fallow	100
1976/77	817	rice - pulses	200
1977/78	1,036	rice - rice - OFC	250
1978/79	925	rice - rice	200
1979/80	742	rice - rice	200
1980/81	1,065	rice - rice - OFC	250

Source: Upasena et al. 1980.

CONSTRAINTS TO CROP DIVERSIFICATION

Constraints to crop diversification in minor imgation schemes are multifaceted and they are summarized in figure 2. However, in this paper only the social and economic constraints are discussed.

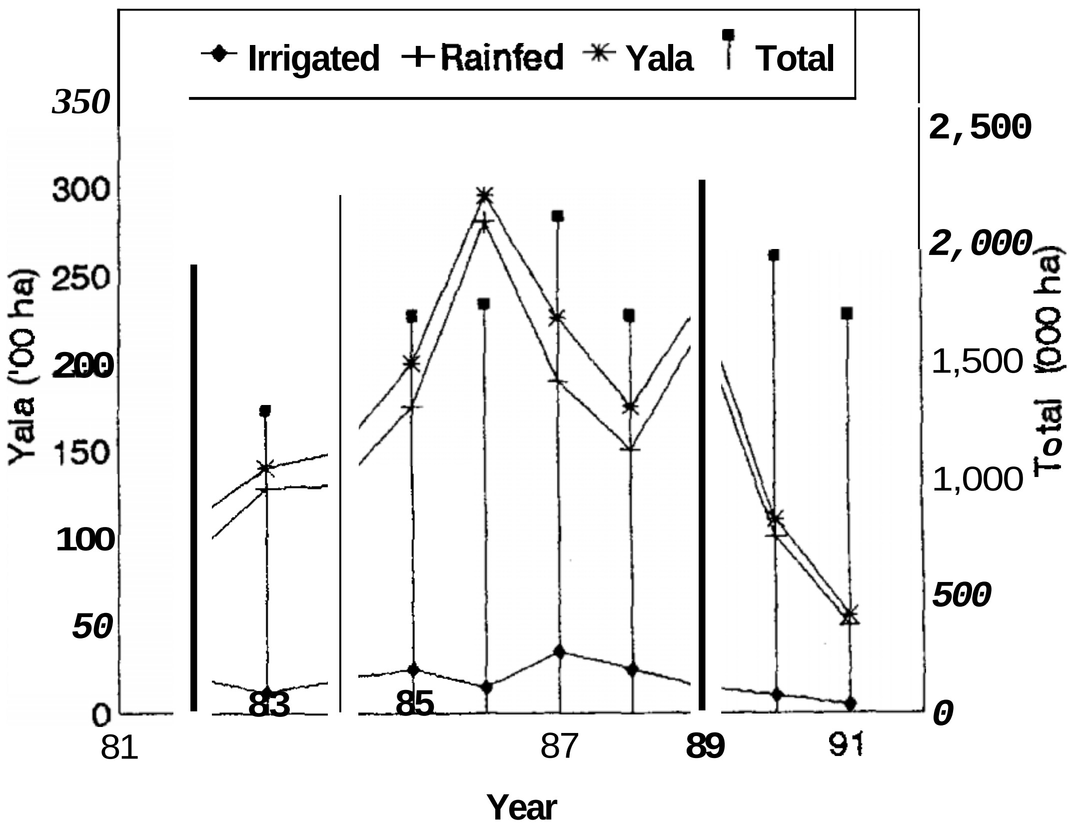
Economic Constraints

Except for a few crop species, greater economic risks are involved in the cultivation of OFCs than in the cultivation of rice. Factors such as price levels and stability, cost of production, demand for labor, profitability and marketing structure influence decision making in the selection of a crop; either to grow rice or OFCs or which crops of OFCs.

Fanners are concerned about the price and price stability of the crops and tend to wait and observe for a few seasons to initiate the cultivation of a particular crop. After adoption, if prices and stability vary, farmers change the crop to another. Big onion is a good example as far as price fluctuation is concerned. In 1995, at the harvesting time (September to October) the price of big onion was below

Rs 10/kg and then rose to Rs 40/kg within two months. Such fluctuations may be more significant in the case of highly perishable vegetable crops.

Figure 1. Cultivation of OFCs in rice fields during yala (1982-92).



Among the crops that can be cultivated in rice fields during yala, only chili, big onion **and** red onion can be considered **as** cash crops. However, these crops are capital- and labor-intensive (tables 4 and 5) and may not be compatible with the risk- bearing capacity and capital availability of many small-scale farmers. This can be compared with the investments in rice cultivation under minor and major irrigation schemes (table 6). This suggests that many farmers in minor irrigation schemes **are** not capable **of** cultivating high input cash crops.

Figure 2. Summary of constraints identijed in crop diversification in minor irrigation schemes.

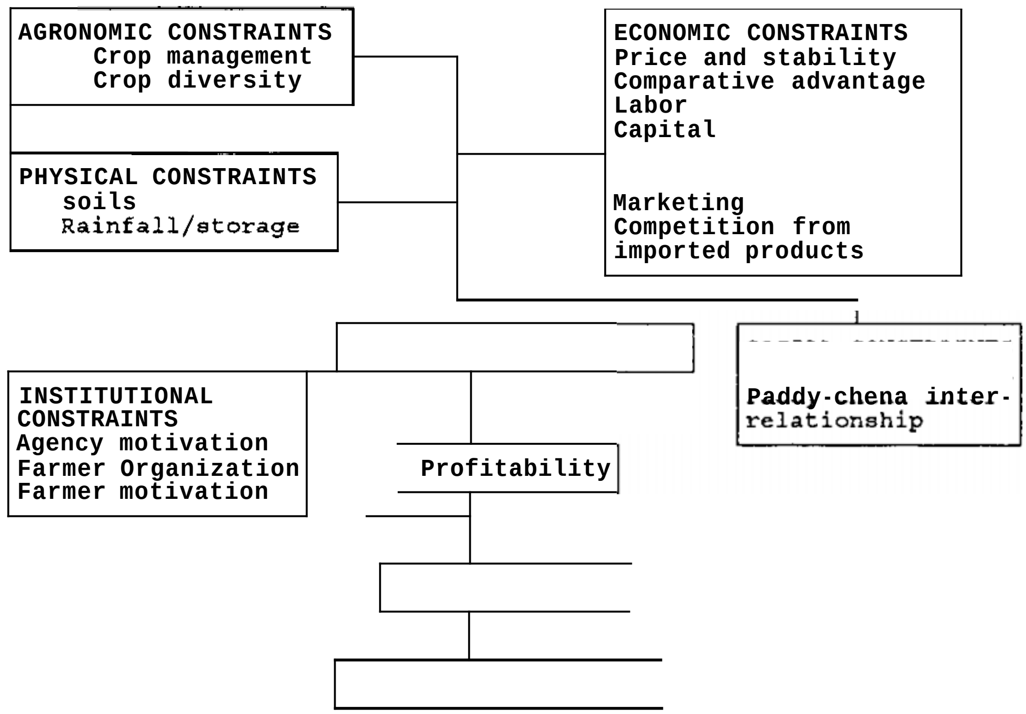


Table 4. Cost of production and net returns for commonly grown OFCs in selected districts.

Crop	District	Cost (Rs/ha)				Net returns (Rs/ha)	
		Labor	Material	Draft	Total	(1)	(2)
Chili	(KW)	18.198	25,738	3,050	46,986	9,209	35,308
B' onion	(KW)	14.318	22,825	6,658	43,160	60,737	88,988
R' onion	(PU)	16.045	105,968	8,295	129.991	57,463	63,424
Maize	(AP)	11.396	118		11.537	8,283	13,525
Cowpea	(AP)	7,624	1,321		8,865	2,023	16,205
Greengram	(KG)	1.480	1.115		9.095	9,033	28,302
Blackgram	(VN)	3.117	2.008	4.396	10.465	10,880	18,745
Soybean	(KW)	3,920	2.305	2,143	8,368	5,203	12,808
Groundnut	(MN)	4,845	4.651	963	10,465	1,874	20,255

KW - Kalawewa PU - Puttalam . VN - Vavunia
AP - Anuradhapura MN - Monaragala KG - Kurunegala
(1) - Net returns including imputed cost.
(2) - Net returns excluding imputed cost.
Source: Cost of cultivation of agricultural crops, DOA.

OTHER PROBLEMS

Marketing

Unlike in the rice sector, there is no organized government marketing network for OFCs. Therefore, marketing continues to be one of the most significant bottlenecks for enhancing the production of OFCs in many potential areas. With the exception of chili most of the OFCs grown in rice fields are perishable under normal conditions. Therefore, these products should be marketed soon after harvesting. Even for the relatively non-perishable OFCs the floor/guaranteed price schemes are ineffective or inadequate either due to the low procument prices or the lack of an operational system. Farmers also tind it difficult to store large quantities of their products due to capital constraints and lack of technical knowledge. Therefore, in most cases, the middlemen take advantage from this situation. This has been identified as one of the most important reasons for the decline of extent of soybean cultivation from 12,000 ha in 1982/83 to around 1,000 ha today.

Table 5. Labor usage in some OFC production.

Crop	Labor use (MD/ha)		
	Family	Hired	Total
Chili	289	71	359
B. onion	301	226	527
Red onion	81	222	303
Maize	90	9	99
Cowpea	88	25	114
Greengram	100	15	115
Blackgram	6	34	39
Soybean	88	34	122
Groundnut	110	16	126

Source: Cost of cultivation of agricultural **crops,** DOA maha **1989190** to **1992/93**.

Table 6. Farmers' investment in rice production (Rs/ha) in major and minor irrigation schemes.

Season	Minor (Anuradhapura)	Major (Kalawewa)
Maha 89/90	8,988	11,735
Maha 90/91	8,533	14,085
Maha 91/92	11,838	15,828

Source: DOA, cost of cultivation reports, (1990-93)

Competition from Imported Products

Production of most of the legumes in the country has been affected adversely due to the importation of mysoor dhal, soybean and other related processed products. In the last few decades the imports of mysoor dhal have considerably increased. A greater proportion of the imported mysoor dhal can be substituted by greengram, cowpea and blackgram. However, to encourage the farmers, the Ministry of

Agriculture, Lands and Forestry (MALF) has taken a decision to import large onion and chili only during the off season.

SOCIAL PROBLEMS

Fragmentation and dispersion of rice land holdings, chena-rice land interrelationship and unequal land distribution are major constraints to effective crop diversification in many small irrigation schemes.

Land Fragmentation

One of the major problems related to low production in minor irrigation schemes today is land fragmentation. Each newborn individual is entitled to inherit property from his or her parent; the progressive subdivision of limited agricultural lands takes place, resulting in many smallholdings. Unlike major irrigation schemes, minor schemes are scattered smallholodings, especially in the Puranawela (table 7).

Table 7. Average rice landholding size and number of parcels under different irrigation systems,

Schemes	Size (ha)	Parcels (No.)
Mahaweli System H	1.0	1
Katiyawa	**2.0**	1
Minor tanks (Puranawela)	**0.2-0.5**	**1-5**

Fragmentation of rice lands has resulted in many uneconomical size holdings which limits the use of farm machinery, reduce labor use efficiency and net cultivated extent. When these smallholdings are dispersed over the rice tract, resources use efficiency is further reduced. Many farmers with small extents of rice lands do not give priority to rice fields but depend on other source of income. In many cases they work as part-time farmers (table 8). This condition aggravates further during yala season when the ***bethma*** cultivation is practiced due to inadequacy of water. This adversely affects the collective decision about cultivation, and often results in delayed sowing. This consumes a greater proportion of storage water in rice cultivation in maha, which otherwise would have been used for OFC cultivation in yala.

Chena-Rice Interrelationship

Typical dry-zone village production systems are tankbased with a threefold system. Resource allocation for each of the components is based on priority. Chena is the most stable and important component which provides high income and food with minimum risk. The chena system also produces early (within 2 months after planting) food for the farmers. This is very helpful due to empty households in terms of food during December-January after investing all the resources for cultivation. However, rice fields take about 3 months (February-March) to harvest. As a result, the farmers give priority to chena cultivation over rice lands. This practice automatically delays the rice cultivation which consumes most of the stored water and leaves little quantity for yala irrigation. Therefore, in many instances the minor tanks are not able to support the cultivation of a successful yala crop. Early rice cultivation, to save water for the subsequent yala, should be able to meet the early food requirement of the farm families. In addition, labor-saving technologies for the rain-fed upland should be introduced to complete farmer activities within a short period. The cropping system project initiated at the Walagambahuwa Village in mid-I970 tried to increase the food production in rice lands through crop intensification including diversified cropping. This attempt, however, was not very successful because attention was paid only to rice component while the other components of the system were neglected.

Table 8. Summary of inputs and alternative practices related to input use under different irrigation systems in the Kurunegala District during yala, 1984.

	Percentage farmers		
Practice	**Major Irrigation**	**Minor Irrigation**	**Rain-fed**
K fertilizer	99	100	100
P fertilizer	94	77	62
Weeding	50	53	48
Transplanting	61	35	0
Broadcasting	33	65	15
Pesticides	63	85	85
Herbicides	0	0	0
Full-time farmers	65	41	65
Part-time farmers	35	59	35
Owner/part-owner	63	62	57
Tenant	31	38	43

Source: **Shand and Samaratunge (1984).**

Other Problems

Many farmers in Sri Lanka prefer to produce their own rice to secure a food supply, even though the soils are good for OFCs. Though there are many advantages of OFCS, rice farmers are still prepared to cultivate rice in their low lands, if water is made available. Some reasons for not growing OFCs are given in table 9.

These results suggest that besides inadequacy of water there are some social problems that do not permit cultivation of OFCs in rice fields in yala. Lack of adequate technical knowledge is one of the constraints to crop diversification. For example, a heavy build-up of the thrips population in chili during the past few years has resulted in significant decline in yields and has increased the cost of cultivation. These facts reflect the necessity of a well-integrated implementation program for crop diversification in the minor irrigation schemes.

Table 9. Distribution of farmers in the Moneragala District by reasons for not cultivating OFCs in rice fields during yala (N = 66).

Reason	Number	%
Lack of water	15	20.5
Land not suitable for OFCs	13	17.8
Lack of experience	9	12.3
Difficulty in crop protection	21	28.7
Rice farming more profitable	6	8.2
Rice needed for home consumption	5	6.8
Lack of marketing facilities	0	0
Others	4	5.5

Source: Gunadasa *et al.* (1980).

Other than these problems, many farmers in Sri Lanka have experiences in seasonal rice farming, where they have free times. However, farmers are reluctant to engage in diversified cropping due to high labor intensiveness resulting in less free time. Another reason is that many farmers in potential areas have a custom of spending longer periods in social activities without attending to the farming activities. For example, the rains during yala (March-May), which is the best time for the establishment of most of the crops in the dry zone are not utilized for crop cultivation because of the new year activities.

FUTURE STRATEGIES

The success of any crop diversification program in rice fields primarily depends on the profitability, availability of marketing facilities and the collective approach of farmers. Under present conditions it appears that with the exception of crops like chili, large onion, maize and soybean, important crops including pulses do not have much scope for expansion. The proposed future strategies in promoting diversified cropping in minor imgation rice fields are given below:

1. Expand the local market by increasing local consumption of local food products through the development of value-added products by improving the local food-processing industry. During the past two decades food consumption habits of the people have changed considerably by reducing the consumption of processed foods.

2. Increase the profit margins of less-profitable crops by adopting cost-effective production technologies, such as relaying of black gram, cowpea, and green gram with rice by broadcasting seeds into the standing rice crop.

3. Shift the cultivation of less-economical crops, especially the legumes, to fallow areas in rice fields. The experimental results have shown that green gram, black gram, cowpea and pigeon pea are capable of generating 1,000 to 1,500 kg/ha of grain yield from this system with minimum inputs. Both these systems are low cost and will help in cutting down the labor requirements for land preparation, planting, weeding and irrigation.

4 Introduce moderately high income crops such as banana, sweet potato and Colocacia spp. (kirala and taro) to the rice fields where supplementary irrigation can be provided from the agro-well. However, economics of well irrigation need to be worked out. These crops are much more suitable for the akkarawela areas where there is a considerable extent of well-drained soils. This increases the cropping intensity of rice fields in both seasons.

To achieve success through the crop diversification strategy in rice fields, it is necessary to consider the following factors: (i) improved marketing and storage facilities, (ii) transfer of available technologies through an effective extension system to upgrade the farmers' knowledge on irrigated crop cultivation, storage and marketing information, (iii) develop strong farmer organizations, (iv) restrict imports of all possible food items that can be locally produced, and (v) improve credit and supply services.

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Discussion

S.N. Jayawardena

The steps taken by the Department of Agriculture to implement crop diversification strategies in minor irrigation schemes were elaborated. These include field-testing of two cropping systems namely, (a) the introduction of catch crops or sandwich crops,
and (b) the cultivation of short-age legumes, gingelly and pigeon pea. Based on the successful results of the experiments on the above cropping systems the Department of Agriculture has already decided to promote pigeon pea **as** a rain-fed crop in yala.

It was revealed that the Ministry for Agriculture, Land and Forestry has already made a policy recommendation to reduce the import of pulses. Approximately Rs 300 million could **be** saved if the import of mysoor dhall is reduced by 75 percent. This would also help promote legume crop cultivation under minor irrigation schemes.

One of the biggest constraints in growing OFCs in the command areas was identified **as** the cost of land preparation. Participants indicated that preparation of beds in puddled soils was costly. However, the presenter replied that preparation was not a major constraint. The procedure is less-costly in the minor irrigation schemes **than** in the major irrigation schemes. Farmers in some minor irrigation schcmes are already doing bed preparation in rice fields for **OFCs** without major difficulties.

The trend among fanners in the aspect of land preparation is to look for easier and more comfortable techniques deviating from the recommended practices. Therefore, farmers should be advised regarding the land preparation techniques, in **terms** of profit margins, for successful implementation.

With reference to a comment on cultivation of tobacco in the rice fields, especially in the Galewela area and in other parts of the dry zone, it was indicated that this practice is not recommended by the Department of Agriculture. However, tobacco cultivation takes place in the rice fields of Mahaweli System C areas mainly due ***to*** economic benefits.

It is important to note that although total production of **OFCs** in rice-growing areas reached a peak level in **1986** and declined thereafter, the total national production has not shown such significant changes. The major reason is the expansion of cultivated extent in highlands. However, **the** availability of marketing channels for fanners' products is a major determinant for increased production of **OFCs.**

The participants felt that, during the Walagambahuwa Project, there was a favorable competition in the chena-rice system. However, at present the productivity of chena and rice fields has declined significantly. In this regard, stabilizing the production aspects in chena with the introduction of perennial crops would be a viable solution.

RECOMMENDATION SESSION

Chairperson

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Reports of the Working Groups

THE PARTICIPANTS WERE divided into *two* small groups, after the discussion on papers presented, to look into the problems related to implementation of crop diversification strategies in minor imgation schemes. In this regard, the suggestions listed were recommended by the working groups for consideration in national policy planning for crop diversification in minor imgation schemes.

A. Working Group on Socioeconomic Aspects and Institutional Support

Presented** by: S. **Piyadasa, Irrigation Department

As listed below, the working group considered several socio-economic constraints for implementation of crop diversification strategies in minor imgation schemes.

Social constraints

i. Tenurial system
ii. Eating habits
iii. Lack of high technology and knowledge
iv. Attitudes/behavior of farmers

Economic constraints

i. Open economy
ii. High cost of production
iii. Unfavorable market and prices
iv. High land-development cost

Institutional constraints

i. Organizing of farmers
ii. Sustainability of farmer organizations
iii. Poor market facilities
iv. Inefficient extension system
v. Poor access to credits and experts
vi. Lack of crop insurance schemes for cultivation of OFCs
vii. Conflicts between central and provincial governments

Upon identification of the constraints, the working group made the following recommendations to be forwarded to the policy planners for consideration with a view to promote crop diversification under minor imgation schemes.

National production plan

The development of a national production plan based on long-term demand and supply is recommended to prevent drastic price fluctuations in the market.

Matching importation with local production

Food crops, that are also locally produced, should be imported only in urgent situations.

Availability of production and marketing information systems

Development of market linkages using this information would motivate farmers to grow other field crops.

Establishment of linkages between departments and ministries involved in the production and marketing programs

These links are imperative for the smooth functioning of the production and marketing system in the country and to support agricultural production.

Promotion of agro-processing technologies

These technologies would help farmers to develop value-added products from their agricultural produce, and encourage them to grow other field crops.

Changes in trade policies

Changes in the government trade policies to reduce imports and promote export of agricultural products would assist the promotion of crop diversification programs.

Expansion of rural credit systems

Availability of a credit system with easy payment terms and less formalities would assist the farmers in obtaining credit facilities and thus ensure the smooth functioning of their cultivation practices.

Minor irrigation schemes under one governing authority

This would avoid bureaucratic constraints in implementing crop diversification programs in minor irrigation schemes.

Awareness programs

Launching of awareness programs should assist to convince farmers regarding shifts in the cultivation patterns.

Introduction of low-cost technologies

The objective is to reduce cost of production and to encourage farmers to grow other field crops.

Introduction of a crop insurance scheme for other field crops

A crop insurance scheme would give an assurance to the farmers of their income and would encourage them to practice diversified cropping.

Integrated planning at the grass-root level

A national plan should be initiated at farmers' level and then expanded further.

B. Working Group on Technical Aspects (Agriculture, Irrigation and Hydrology)

Presented** by: **W.R. Ratnayake, Department of Agriculture

The working group decided to consider a total farming system approach, rather than an approach limited to minor irrigation schemes, by looking at chena, homestead and rice cultivation as one unit. With the objective to increase farmer income, the working group also decided to consider crop-livestock integration and inland fisheries (aquaculture) under the minor irrigation schemes.

The group focused mainly on the conflict between farmers' interests and national expectations in crop diversification programs. Thus, it was decided to propose several recommendations to national policy planning to overcome this limitation. The working group also suggested that a policy paper should be forwarded in terms of incentives (i.e., nutritional, etc.)

The following strategies were suggested by the working group:

i. Improve water retention capacity of existing minor tanks.
ii. Investigate rainfall, surface water and groundwater that order for their potential uses (conjunctive use of water).
iii. Investigate the availability of other resources (solar radiation, etc.)
iv. Plan cultivation in yala and maha through farmer participation (decision making on crop selection and cropping pattern).
v. Investigate the techniques and processes involved in harvesting, utilization and conservation of agricultural products.
vi. Propose options available for a year-round cropping pattern to the farmers.

Water availability	Proposed cultivation
(a) sufficient water	rice
(b) insufficient for rice	high-value crops (chili, red onion)
(c) low water	maize, blackgram
(d) life-saving water	cereal-pulse intercropping (maize-pigeon pea)
(e) drought	pigeon pea, short-age legumes

vii. Investigate the potential for cultivating perennial crops such as banana under water-deficit conditions.
viii. Use of agro-wells as supplement for tank water.
ix. Adoption of water conservation technologies(i.e., conservation farming, mulching, etc.).
x. Increase water **use** efficiency through proper application technologies.
xi. Develop marketing channels through institutional support.

General Discussion

LAND FRAGMENTATION AND land tenure were considered as major constraints to the implementation of crop diversification strategies. These limitations could be overcome to a certain extent withthe help of farmer organizations. In some areas, the farmer organizations have taken necessary steps to help farmers to cultivate the land, The success of this procedure depends on the size of the capital investments owned by the farmer organization. However, there is no information to predict how far the aspect of land tenure would affect the crop diversification programs in the future. Participants from the southern part of the island indicated that landowners do not favor cultivation of OFCs. The involvement of the respective Agrarian Services Centres was suggested as a remedy for this problem.

De-siltation of tanks during rehabilitation is considered to be uneconomical. However, a particular section of the tank could be de-silted, and the accumulated water could be utilized for aquaculture securing an additional income for the farmers. Thus, inland fisheries was suggested as a measure of increasing water use efficiency, but only when the resources are available. Participants indicated that in the present situation inland fisheries has become a possibility with higher profit margins where fingerlings could be harvested in a short period.

Changing land usage or the farming practices to generate more runoff during wet seasons and then to increase absorption during the dry seasons was suggested as a system to allow water flow into the reservoirs.

The participants also agreed that policies regarding nonimport of crops which are also locally produced should be reconciled. Since complete restriction of imports is not possible matching imports with local production could be done.

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