CROP DIVERSIFICATION IN RICELANDS

J. HANDAWELA [1], M. SIKURAJAPATHY [2] and H. SOMAPALA [3]

[1] Land and Water Management Research Centre, Peradeniya;
[*2] Central Agricultural Research Institute, Gannoruwa;
[**3] Regional Agricultural Research Centre, Makandura, Gonawila (NWP)

Abstract: Traditionally, lowland rice farming and upland cropping have been two distinct land use systems. However, over the years the two have come closer due to limitations in physical resource availability, and economic and social pressures. As a result, upland crop farming in lands that have been traditionally grown to rice is now a common phenomenon. The biggest challenge in crop diversification in ricelands is to give the rice crop its requirements without affecting the performance of the non-rice crops and vice versa. Cropping of both crop types in the same plot simultaneously, a technology promoted by the International Rice Research Institute, Philippines has not been feasible at commercial scale because of expensive land preparation needed for it. Rotating the two crop types has been easier. The best example is the rotation of maha rice with yala vegetables in the mid and up country intermediate zones. This practice has evolved as an adaptation to water scarcity. In the low country dry zone irrigation projects too growing non-rice crops has become necessary, particularly in yala .However, in the dry zone the adaptation to this necessity has not been easy compared to that in the mid and up country intermediate zones. In the low country dry zone the relief is flat to undulating and the rice terraces are large. Further, the rainfall intensity is high and the structural stability of the soil is low. Above all the irrigation projects are large and require systems level management. Therefore, the problems that have to be solved are more serious, the major ones being water table build-up, poor drainage even in well-drained soils and the suspected ill-effects of alternating puddling for rice and upland tillage for non-rice crops on long term water economy for rice and maintenance of good soil tilth for upland crops. Research requirements include imparting sustainability to already diversified cropping in the mid and up country intermediate zones, making diversification popular and viable in the low country dry zone irrigation projects, developing water resources and moisture saving technologies for the Kurunegala district and crop diversification during the dry months in the northern part of the low country wet zone. Caution must be exercised in promoting crop diversification in ricelands as it could become a threat to national rice security and the economy of farmers practising rainfed agriculture. It could also reduce the soil fertility, and lead to pest and disease problems in the dry zone.

INTRODUCTION

The term 'ricelands' generally refers to lands that are developed and used for rice farming. Among arable crops rice is unique as it prefers saturated soil moisture levels as compared to others which do well in aerated soil containing

Present address: * Seeds and Planting Materials Division, Peradeniya;
** Central Agricultural Research Institute, Gannoruwa, Peradeniya.

water at field capacity. This wide difference in crop requirements has led to the evolution of two different types of farming: one for rice farming in the lowlands where the water table stays close to the surface and the other for upland farming (generally for non-rice crops) where the water table does not rise to the soil surface to affect aeration and drainage. Although the two systems differ widely, farmers in certain areas have been traditionally growing some non-rice crops, particularly vegetables in ricelands, either simultaneously with rice or in rotation. In standing rice crops, plot bunds, field borders and the threshing floor have been the common places for vegetable cultivation. Keeping the fields free of weeds and depriving pests and diseases of breeding grounds have been the main reasons for cleaning the bunds, field borders and threshing floor. Once cleaned they can be used for growing vegetables both to get an economic return and to prevent reinfestation of weeds.

Sequential cropping of non-rice crops after rice evolved in areas where the rainfall, phreatic water and stream flow during the secondary rainy season are not adequate to support a rice crop but sufficient for a non-rice crop. The local climatic conditions and physiography largely determine the intensity and speed of spread of diversification, crop species grown and technologies adopted by farmers.

Intensive cropping of vegetables during the yala season in rotation with rice in the maha season is now a well established practice in the Welimada, Bandarawela and Marassana areas where it is done extensively, and in the Matale area. These areas are all in the up country and mid country intermediate zones. Rotation of rice with sweet potato is another crop diversification practice that has developed only recently in the Rambukkana and Godakawela areas which come under WL_2 and WM_3 agroecological regions, respectively. In the IL_2 and IL_3 agroecological regions found in the Kurunegala district, farmers crop limited extents of vegetables during the moisture-scarce yala season.

Under the village tanks of the dry zone, during the yala season water is not enough even for a non-rice crop. Often, these lands are fallowed between the maha rice crops. Ricelands in the Jaffna peninsula, on the other hand, are blessed with shallow groundwater. Here the rainfed maha rice crop is alternated with vegetables and other field crops in the yala season using irrigation water from shallow wells.

Thus, it is clear that rice and non-rice crops may be grown in the same field. Crop diversification may be viewed as a strategy to optimize the production in ricelands, especially in areas where continuous monocropping of rice offers little chance of realizing fully the production potential of the land.

RATIONALE

Riceland and ecological balance

The total extent of the land set apart for rice farming in 1990 is about 772,000 ha which is about 12% of the country's land area. We have to think of the ecological consequences and risks associated with farming such a

large percentage of the country's land area to a single crop. The 'Yellow disease' which affected rice in the Hambantota district in 1984 and 1985 coincided with almost continuous rainfall and continuous rice cropping very extensively, with little or no intervening dry weather or fallow period. Therefore, the wisdom of total reliance on only one crop species grown in a relatively high proportion of land, season after season needs to be examined.

Health and nutrition

Health and nutrition opinion points to the advantages of supplementing the staple diet with vegetables, legumes and other sources of food. In order to realize these advantages it is necessary to grow crops that yield non-rice food as well.

Underutilization of developed land

Over the past half-century or so, the major effort on increasing food production has been placed in the dry zone. It involved developing water sources for irrigation and land for irrigated paddy. The expected result of this effort was double cropping of rice. However, contrary to expectations it has not been possible to realize this goal. As illustrated in Fig. 1 the intensity of rice cropping in the dry and intermediate zones has not risen above 125%, which is 75% below the intended 200%. In the wet zone however, the cropping intensity for rice is higher at 175% (I.Balasuriya, Personal communication). The extent of land available for rice farming and the extent actually grown to rice in the maha season, the yala season and the total for the year are shown in Fig.2 for the past 3 decades. It shows that it is not possible to cultivate the total land area even during maha. During the yala season which is the less favourable of the 2 seasons, the performance has been bad. The current situation is that about

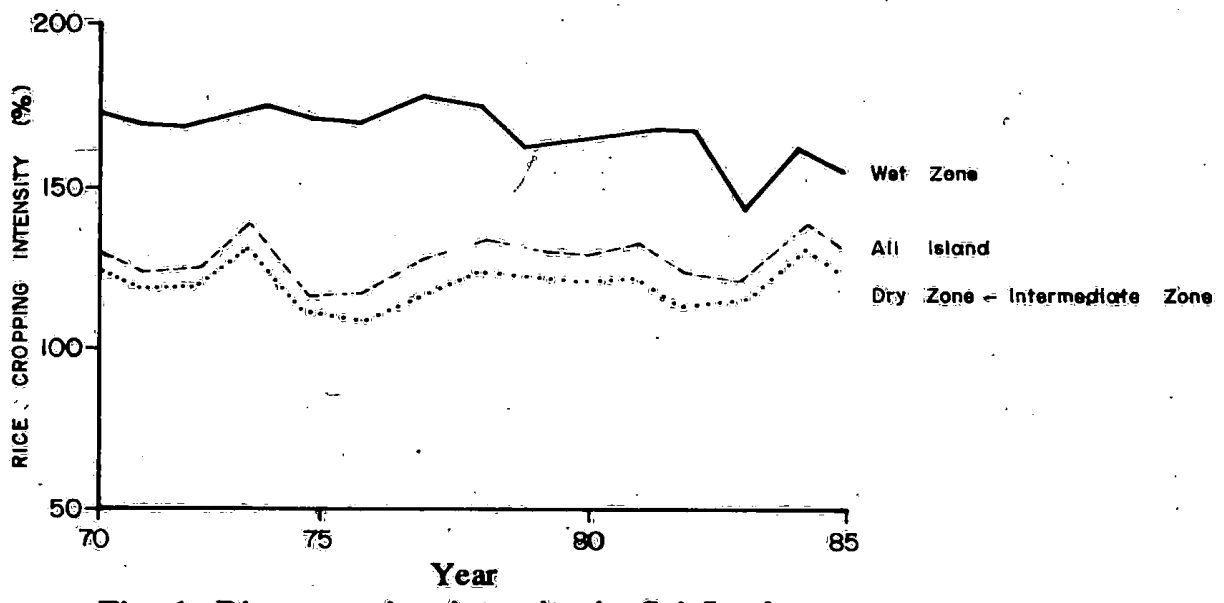

Fig. 1. Rice cropping intensity in Sri Lanka

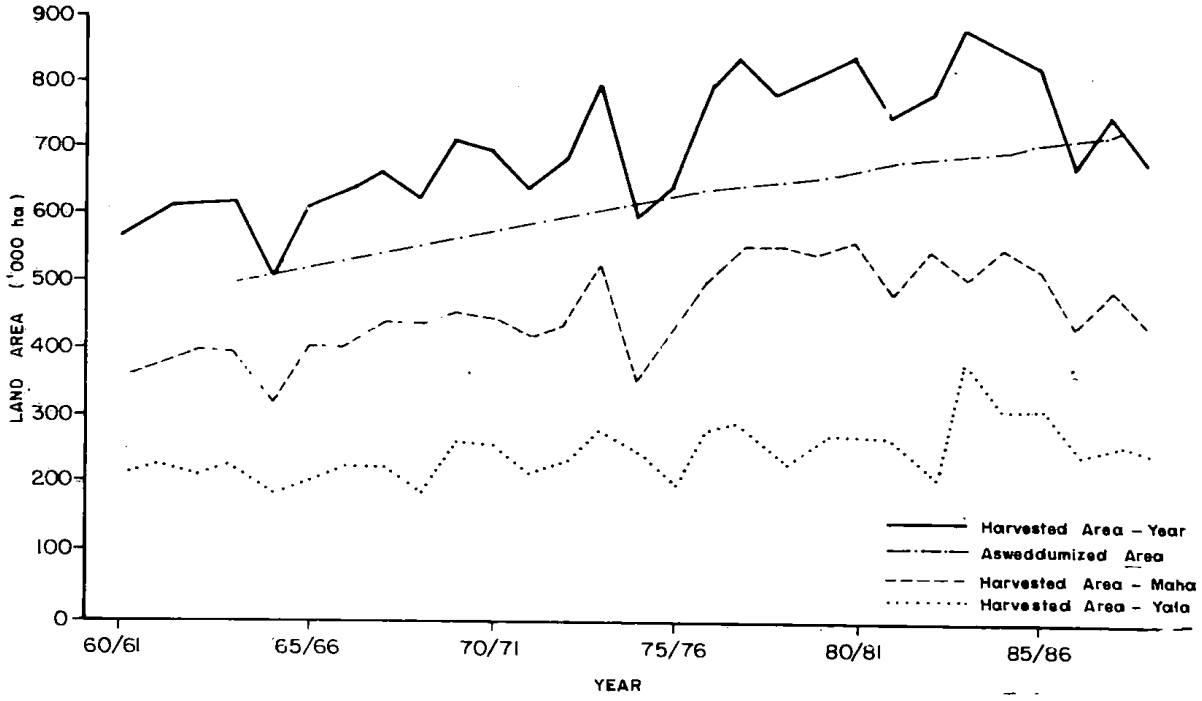

Fig. 2. Seasonal and annual extents of riceland from which rice is harvested and the extent of land available for rice cropping

(Source: Adapted from Dept. of Census and Statistics Seasonal Reports)

25% of the available land is not cropped to paddy in maha. The area not cropped to rice in yala is about 66%. This has been consistently so over the years with only small annual changes. This proves that our inability to grow rice in all ricelands during both maha and yala is real.

The performance of some of the dry zone irrigation projects shows that often the extent of land cropped to rice falls short of the land available (Table 1). This situation applies even to the Walawe Project which is generally viewed as one not suffering from water scarcity. The condition is worse in irrigation projects such as Mahakanadarawa, Wahalkada and Huruluwewa, and in village tanks.

It is clear that much of the land developed in the dry zone remains underutilized because of insufficient water for rice farming causing much hardship to the farmers, and economic and financial problems to the country. This situation should not be allowed to continue. It is possible that crop diversification could provide an answer to these problems as upland crops require less water than rice.

In the WL_2 and WL_3 agro-ecological regions which are located close to Colombo hence to the consumer areas, ricelands could be put to good use by growing vegetables during February-March and August-September. There are clear skies, aerated soil and groundwater at shallow depth in addition to flat terrain and proximity to markets. But during these months the land remains fallow. Attempts to improve

Table 1. Extent of land developed for irrigation and the actual extent cropped to rice during maha and yala under selected major irrigation projects

Season	*Mahaweli System-H (ha)*	*Mahaweli System-G (ha)*	*Walawe (ha)*	*Inginimitiya (ha)*
Total area developed for irrigation	30034	4567	14883	2612
Area cropped to rice				
Maha 85/86	28967	3467	11437	1653
Yala 86	8566	1005	11466	2080
Maha 86/87	28817	3533	11470	1556
Yala 87	4274	2286	10589	0
Maha 87/88	29519	3831	10353	0
Yala 88	4978	1741	10441	1985
Maha 88/89	21294	4104	10586	2742
Yala 89	1382	1773	10406	272

Source: Project Monitoring Unit, Mahaweli Authority of Sri Lanka and Inginimitiya Project Office, Inginimitiya.

the production potential of these lands beyond the currently realized 200% rice cropping intensity have to be pursued on the lines of crop diversification.

Farmer incomes

For social and political reasons most countries keep the price of the staple food of the people low to moderate. Sri Lanka is no exception. Therefore, the income that is possible from a unit area of riceland would remain more or less static if the crop grown is rice, and the opportunity for the farmer to raise his standard of living through rice cultivation alone is limited. Therefore, a suitable course of action to earn higher incomes from land is to grow crops whose market prices are not kept low by the government. In Sri Lanka chilli, onion, potato, vegetable and sweet potato fall into this category.

OBJECTIVE

The main objectives of crop diversification in ricelands should be improved land use efficiency

contributing to higher economic returns, sustainable resource use, ecological stability, environmental quality, social security and contentment.

METHODOLOGY

The methodology to accomplish the objectives of crop diversification will include identification of the factors that limit land use efficiency in lands developed for rice cultivation, selection of land areas or farming situations where land use efficiency could be improved by crop diversification, and formulation and development of methodologies for such diversification. The best approach to tackle this problem is to use the agroecological regions as a basis for selection of areas suitable for crop diversification.

Low country wet zone

The rice growing areas in the major part of the low country wet zone are waterlogged and defy easy drainage. The climate is wet and not more than a maximum of two-month long rain-free period can be expected. Therefore, the most suitable arable crop for the area is rice. However, in the WL_2 and WL_3 agroecological regions which are found adjacent to the low country intermediate zone, non-rice crops could be promising. Up to now very little research and development effort has gone into these lands for crop diversification except perhaps farmer-initiated cropping of sweet potato in Rambukkana and Godakawela areas. The areas that need to be studied are characterization of the length, duration and the frequency of occurrence of the dry periods, the depth of groundwater table, water quality and recharge rate, methods for lifting groundwater and the impact of pumping on soil, water table and on the environment, and social, economic and environmental impacts of crop diversification.

In other parts of the wet zone too there is a need to maximize returns from the land. To what extent crop diversification can help to achieve this needs study.

Mid country and up country wet zone

This area has a hilly and mountainous terrain, and as a result ricelands are limited in extent. The amount of rainfall is comparable to that of the low country wet zone, but is lower in intensity. The temperature is milder. The ricelands too are not so waterlogging. Because of the high relief, even short duration climatic droughts can limit water availability to rice. Thus, the soil and climatic conditions seem more conducive to crop diversification. Somasiri and Ratnayake (1988) have recognized the availability of a riceland element called 'Godakumbura' which is better drained and hence is more suitable for crop diversification than the poorer drained land elements. Here too traditions to draw from are limited. Therefore, methodology for non-rice cropping in ricelands has to be developed anew.

Mid country and up country intermediate zone

This is the land area which possesses the best conditions for

vegetable farming in the country. It is not as wet as the wet zone or not as dry as the dry zone. Elevation gives the advantage of mild temperature. Already much of the ricelands in this area is used for vegetable farming one season of the year (Welimada, Bandarawela, Marassana and Matale). As a result the field problems that need resolution are associated more with rehabilitation than development. Yield stagnation, depletion of water resources, soil erosion, fertility depletion and soil related diseases are some of the basic issues that have been diagnosed and to some degree quantified. These problems require to be investigated further in order to ensure the long term sustainability of crop diversification. Already some work is in progress at the Regional Agricultural Research Centre, Bandarawela.

Low country intermediate zone

The IL_1 and IL_3 agroecological zones found in the Kurunegala district have coarse-textured rice soils which are good for growing non-rice crops during the yala season. Favourable infrastructure and proximity to markets are additional benefits available here. Already some non-rice crops are being grown here, but considering the large extent of land available, the percentage land use is not sufficiently high, the reason being inadequate water availability. The major water resource in the yala season, the tanks, seldom contain more water than is necessary for domestic use. The groundwater dries up and the major rivers Maha Oya and Deduru Oya are reduced to a trickle. There are no large irrigation projects either. Thus, the major problem in the area is water availability. This has to be solved by water resource development, improvement of irrigation water use efficiency and development of dry farming methodologies. Regional Agricultural Research Centre at Makandura has ongoing programmes on improvement of water management.

The IL_1 agroecological region found in the Hambantota and Ratnapura districts benefits from water resources in the adjacent wet zone. Double cropping of rice is possible in better years. Farmers are gradually getting used to vegetable and sweet potato cropping in the yala season. Here too, the main research requirement is improved water management.

The IL_2 agroecological region located in the Bibile-Mahiyangana area differs from the rest of the intermediate zone by not being contiguous with the wet zone and being almost surrounded by the dry zone. Due to this reason the problems and potentials of crop diversification in the ricelands of this region have much in common with that of the dry zone.

Low country dry zone

As mentioned earlier the mainland dry zone has no tradition of growing non-rice crops in land developed for rice. This could be due to two reasons, abundant availability of opportunity for non-rice cropping under shifting

cultivation and possible difficulty of non-rice cropping under the given soil and moisture conditions found in the lands developed to rice. In the low country dry zone, rice has traditionally been grown in the poorly drained and imperfectly drained land elements of the catenary landscape. These lands are characterized by low infiltration rates, low hydraulic conductivity and moisture saturated soil profile in most parts of the wet season, conditions ideal for rice farming. Non-rice crops requiring good drainage have difficulty in fitting into traditional ricelands in the wet season. In the dry season non-rice crops cannot be grown because of water scarcity.

The dry zone land development projects have almost always been designed for irrigated rice. Both well-drained and poorly drained soils have been treated in the same manner by forming rice plots with little or no gradient and with a bund to retain water. During terrace formation, earth cutting has been sometimes unavoidable, and has brought the gravel layer to the surface. Thus, well-drained soils which in their natural state are suitable for non-rice cropping even during the maha season have been transformed into a form more suitable for rice than for non-rice crops. The agricultural development programme in the dry zone is now constrained due to having transformed the land surface to suit rice, and not having enough water to grow rice on it. Crop diversification may be viewed as a possible way out of this situation. The technical possibility of growing non-rice crops in land developed for rice in irrigation projects, particularly in the well-drained soil has been demonstrated by many workers (S. Dimantha and W.D. Joshua, 1986, Unpubl.; W.D. Joshua, 1980, Unpubl.; S.H. Upasena, 1982, Unpubl.).

Many have voiced the need to take precautions against poor drainage following rain and irrigation when growing non-rice crops in ricelands. There is also a need to change the irrigation stream flow from 14 l/sec, which is normally applied to rice, to 5 l/sec required for non-rice crops. The high rainfall intensity is another factor to contend with. For example, 60% of the total annual rainfall as recorded at Maha Illuppallama fall at intensities exceeding 25 mm/day and 30% at intensities exceeding 50 mm/day. The low structural stability of the well-drained Reddish Brown Earths makes them vulnerable to breakdown by rain drop impact and precautions against erosion are also necessary when growing non-rice crops (Joshua, 1988).

At present many farmers in irrigation projects resort to growing of non-rice crops, particularly chilli during the yala season in the well-drained soil. They take precautions against water table build-up by adopting surface drainage, raised beds, ridge and furrow etc. One problem they encounter is having to change the physiography of riceland from upland to lowland in one season and from lowland to upland in the other. It is accepted that puddling reduces seepage and percolation losses, and when repeated season after season it has a cumulative

effect as observed in new irrigation projects where the water demand markedly declined after some years of rice cropping. This poses the question whether upland land preparation for non-rice cropping reverses the permeability of soil from low to high and negates the contribution made by puddling to reduce seepage and percolation losses. The same argument holds true for good tilth development that is needed for non-rice cropping. Puddling breaks the secondary soil structure and reduces tilth. The question is whether tilth could be built up fast enough to enable successful non-rice cropping immediately following rice cultivation. In view of these uncertainties it might seem more desirable to confine the growing of non-rice crops to suitable lands and make permanent improvements to them to promote drainage and aeration and maintain good soil tilth instead of alternating with puddled rice. Similarly, lands that are better suited for rice can be maintained to satisfy the specific requirements on a continuous basis. This suggestion needs field level testing, and if found workable can be implemented on a project or turnout basis. Expected advantages of specialization on rice and non-rice crops separately over rotation are many. These include saving in irrigation water, saving in cost of land preparation, ability to handle larger extents of land for non-rice crops than today per farmer and ease of extension, input supply and of marketing.

IMPLICATIONS

Growing of non-rice crops in rice fields is not without negative impacts of both social and economic significance. Therefore, it must be pursued with caution.

Self-sufficiency in rice

One of our foremost development goals has been achieving self-sufficiency in rice. Land development, agricultural research and production effort have all been geared towards this for many years. As a result of these efforts, the country is now close to self-sufficiency in rice. The drive for crop diversification should not negate the gains made in rice security and not jeopardize the achievements made in rice production.

Rainfed farming

The extent of land that has been developed for irrigated farming in the dry zone is only a small part of the total land available for development, much of which has to be developed for rainfed farming. If crops that are suited for dry farming are grown under irrigation, will it not interfere with the prospect of developing rainfed farming in non-irrigable lands? Will the farmer producing higher crop yields per unit area under irrigation deprive the farmer practising rainfed agriculture of his market share? It has already happened to chilli. The upland chena cultivator's 'Wanni miris' is no more in the market that is saturated with irrigated chilli. What would be the plight of the upland rainfed cultivator, whose choice of crops is very limited, if the same thing were to happen to cowpea, mungbean, blackgram, pumpkin, etc.? Therefore, crop selection for irrigated farming must be done with some concern for the welfare of the farmer who is totally dependant on rainfed agriculture.

Year round irrigation

Some argue that year round irrigation in the dry zone is a requirement for efficient crop diversification. What are the likely ecological consequences of such a proposition? Better soil fertility and relative freedom from pests and diseases in the dry zone when compared to that of the wet zone can be attributed to the dry months that break the wet cycle. Will the continuous wetness and availability of arable crops in the dry zone make pest and disease multiplication easier? If the well-drained soils in the dry zone are kept wet throughout the year will they become less fertile? These are some issues that need to be addressed when we consider year round irrigation.

REFERENCES

Joshua, W.D. 1988. Physical properties of Reddish Brown Earths (Alfisols) and their relationship to agriculture. Jour. Soil Science Society of Sri Lanka 4:1-43.

Somasiri, S. and R.M.K.Ratnayake, 1988. Wet and semi-wet ricelands in Sri Lanka. Land and Water Use Division, Department of Agriculture, Peradeniya. 114 p.