

A new cropping system strategy for the poorly irrigated ricelands of the dry zone

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INTRODUCTION

There are about 120,000 ha of partially irrigated rice in the dry and intermediate zones of Sri Lanka which are served by small reservoirs (tanks). The cropping intensity in these minor irrigated schemes is low because of inefficient water management practices. Since these reservoirs will not benefit from additional supplies of water even after the on-going Mahaweli Diversion Project is completed, it is vital that other measures be adopted to increase the cropping intensity. One way to do this would be to change the current cropping system that is adopted by farmers.

Traditionally farmers have been accustomed to growing 4 months cultivars. They begin their cultivation only when the tank is nearly full and there is little risk of running short of irrigation water. This happens in late November or December, although the rainy season sets in much earlier from September to early October. Consequently they are totally dependent on tank storage for cultivation, and since a very great volume of water is utilized in land preparation, there is not enough left over to successfully mature a rice crop, except once in 4 to 5 years when the rainfall is 1000 - 1200 mm. In other years poor yields and crop failure result. The fields are allowed to lie fallow in the following dry season.

The evapotranspiration requirement of a rice crop is about 500 mm. This amount of rainfall is usually available in the dry zone during the Maha season (September to January) unless there is an exceptional drought. This means that a rice crop can be cultivated successfully almost every year if farmers can be persuaded to advance their time of cultivation from late November/December to late September/early October with the onset of the rains. Making use of the incidental rainfall would conserve tank storage, which could then be used only for supplementary irrigation of the early sown rice crop if necessary and to take another rice crop, or other short duration food crops in the following dry season. If 3-3½ months rice cultivars are substituted for 4 month cultivars the risk factor could be reduced still further.

This was the essence of the new croppings system project that was initiated in 1976 at Walagambahuwa — a typical village settlement in the minor irrigated schemes, under the Sri Lanka — IDRC Croppings Systems Program in collaboration with the IRRI Cropping Systems Network. This paper traces the development of the Walagambahuwa Project from 1976 to 1981.

WALAGAMBAHUWA PROJECT

The Walagambahuwa village settlement has 45 farmer families who own 12 ha of lowland paddy. The size of paddy allotments is around

0.3 ha puranawela which is normally found in 2 to 3 parcels. In addition, each family has around 1 ha of chena land and other 0.5 - 0.8 ha of akkarawela and olagam put together.*

The traditional pattern of agriculture which prevails in the settlement is to prepare the land in the chena by felling jungle as early as July, and crops like finger millet, maize, mustard, grain legumes etc are sown in early September to late September before the onset of Maha rains. Rice cultivation commences in mid or late December when there is sufficient water collected in the tank. The farmers use the level of water in the tank as the criterion for the cultivation of rice. Very often the rice land is allowed to lie fallow when the run-off collected in the tank is unsatisfactory. Generally a rice crop is grown once in five or six years under the tank (Table 1).

Table 1: Rainfall Frequency over past 32 years

Maha rainfall range in m.m.	600	600-800	800-1000	1000-1200	1200
Frequency in years	7	5	8	6	6

Table 1 indicates that the frequency of occurrence of over 1200 mm of rain is once in five to six years and during these years the farmers successfully reap a crop of rice. Furthermore, a comparison of the tank capacity at spill level (1800 — 2000 ac ft) and field water requirement of 6 ac ft of water per one acre of paddy confirms the traditional farmers' practice.

Taking into account the socio-economic background of the dry zone minor tank settlers (Working Group Meetings Proceedings 1975, IRRI), a technology was designed to:

1. advance the date of planting, so that the Maha rice crop is sown early by mid October with the onset of rains;
2. use 3 - 3½ months varieties, so that the rice crop could be matured with the minimum of supplementary irrigation.

This new concept of technology has been tested at Walagambahuwa during the last five years (Table 2). The performance of the cropping patterns is indicated in Table 3.

Table 2: Cropping Patterns tested at Walagambahuwa from 1976 to 1981

Year	Maha precipitation (mm)	Cropping Patterns
Before 1976	—	Rice — fallow
1976/77	817	Rice — pulses
1977/78	1036	Rice — Rice — OFC
1978/79	925	Rice — Rice
1979/80	742	Rice — Rice
1980/81	1065	Rice — Rice + OFC

Rice is cultivated once in five or six years. Otherwise the rice land is allowed to lie fallow throughout the year. OFC = Other field crops.

- * Chena = forest allotment temporarily cleared and cultivated.
 Puranawela = old paddy fields immediately below tank.
 Akkarawela = new paddy fields developed at higher elevations.
 Olagama = paddy fields outside the village.

Table 3: Rice Production trends at Walagambahuwa from 1976 to 1981

Year	Yield in kg/ha/year	Yaya in kg/year
1976	1290	38,770
1977	1548	46,440
1978*	3509	105,264
1979*	3973	119,196
1980*	4644	139,320

* Double Cropping of rice.

Farmers' average yields per year have more than doubled during the past 3 - 4 years. Furthermore, the new technology has allowed them to practise double cropping which has increased rice production by five to six times.

Varietal Evaluation

The best 3 - 3½ months variety available at the inception of research project was 63-355. This variety was liked by the farmers, but because of its inability to give high yields in comparison with other varieties, it was replaced gradually by other varieties from the Central Breeding Station, Batalagoda. There was no significant difference in yield performance between the 3 month and 3½ month varieties. If at all there were differences, they were inconsistent (Table 4).

Table 4: Rice Varietal Evaluation — Walagambahuwa Project

Age	Variety	Yield in kg/ha					
		Maha 1979/80		Yala 1980		Maha 1980/81	
		C	D	C	D	C	D
	62—355	4088	3492	—	—	—	—
3 M	BG 34-8	4264	3003	—	—	6676	5210
	BG 276-5	5119	4002	4962	3838	7452	6276
	BG 33-2	2877	3277	—	—	—	—
3½ M	BG 34-6	3748	2591	—	—	6914	6252
	BG 94-2	4043	2899	—	—	—	—
	BG 94-1	4219	4019	—	—	6220	6428
		4051	3326	4962	3838	6815	6041

These figures are averages of 3 replications

(C) — Low humic gleys in association with alluviums of variable drainage and textural properties.

(D) — Deep, poorly drained, fine textured low humic gleys on level lands.

Fertilizer Practices

Farmers at Walagambahuwa used nitrogen fertilizer at 30 - 40 kg/ha. Earlier fertilizer trials had demonstrated that the most economic level of nitrogen under these levels of management was 30 - 40 kg/ha. But very often it was observed that there was hardly any response to added nitrogen in the farmers' fields. It was also observed that hardly any P and K was used by farmers. Therefore, an experiment was designed to test whether there was response to added N with basal application of P and K. This experiment gave positive results.

In another experiment it was seen that there was no difference in yield by increasing the number of top dressings of nitrogen from two to three — the third application of TDM containing N and K. The

conclusion is that farmers at Walagambahuwa are able to double their yields by adding 50 kg of V, mixture as basal, in addition to their normal practice of top dressing with urea 14 and 45 days after establishment of the rice crop (Tables 5 and 6).

Table 5: Effect of Basal Fertilizer Application together with the Farmers' Level of Nitrogen — Maha 1979/80

Treatment	Yield in kg/ha	
	Land Class C	Land Class D
1. Farmer's practice (FN)	2004	2070
2. Farmer's practice + basal (B + FN)	4753	5144
3. Twice farmer's practice + basal (B + 2 FN)	4934	5543

The difference between application and non application of basal is highly significant.

Table 6: Effect of Two and Three Top Dressings of N with and without Basal Application of P & K — Yala 1980 and Maha 1980/81

Treatment	Yield in kg/ha			
	Maha 1980/81		Yala 1980	
	C	D	C	D
1. Farmer's practice (2 TD)	1920	1760	1880	3220
2. Farmer's practice + basal (B + 2TD)	3703	3573	3750	5500
3. Farmer's practice + basal + top dressing of T.D.M.	3680	3040	4330	4210

Farmers' practice of 2 top dressings plus basal mixture is significant.

Tillage Operations

Farmers at Walagambahuwa do two ploughings before seeding the rice crop. It was noticed that tillage is one of the most serious constraints to production. Very often farmers fail to complete the ploughing operation either due to lack of draft power or inability to afford such an expensive and costly operation. Experiments were accordingly designed to test the conventional method against alternative tillage practices. That there is no difference in yield whether the crop is seeded after one operation or two operations of tillage, provided the proper weed control methods are employed, is indicated in Table 7. That there is no significant difference in yield with different methods of establishment is shown in Table 8, although there is a marked difference in the cost of production. The row sown crop where weeds are controlled by rotary weeding is the least expensive, almost half the cost of the broadcasted crop where weeds were controlled by chemical means (3, 4 DPA followed by MCPA), and half that of the transplanted crop which was hand-weeded.

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Table 7: Effect of Number of Tillage Operations on Yield of Rice

Tillage Treatment	Land Type	Broadcasted		Row Sown	
		79/80	80/81	79/80	80/81
1. Post harvest tillage + one tillage operation before sowing	C	3377	6420	5020	5103
2. Post harvest tillage + two tillage operations before sowing		4843	5056	4683	4386
3. No post harvest tillage but two tillage operations (farmer's practice)		4966	5070	4560	4920
		<u>4395</u>	<u>5182</u>	<u>4754</u>	<u>4803</u>
1. (as above)	D	4313	5213	4060	4076
2. (as above)		4703	5370	3695	3960
3. (as above)		3503	4916	4823	3840
		<u>4173</u>	<u>5166</u>	<u>4192</u>	<u>3958</u>

These figures represent an average of three replications.

Table 8: Effect of Different Combinations of Stand Establishment and Weed Control Methods on Yield of Rice — Yala 1980

Treatment	Yield of rice	Cost of Operation
	kg/ha	Rs/ha
1. Broadcasted with chemical weed control	3070	1526.60
2. Transplanted with hand weeding	2754	1564.00
3. Row sown with mechanical weeding	2780	842.00

These figures represent an average of three applications.

HYDROLOGY OF MINOR TANKS

The water supply for a village tank is entirely the rainfall run-off from its own catchment. Run-off, however, varies with the characteristics of each catchment. At any given time, the storage in the tank is related to the total inflow less the total out-flow. The inflow consists of the rainfall and the run-off from the catchment. The total outflow or losses consists of over-flow from the spill, irrigation supply through the sluice, deep seepage, bund leakage and evaporation from the surface. What is most important in the hydrology of the small tank is the evaluation of the inflow at a certain probability of rainfall. This requires the estimation of the run-off coefficient for the catchment. For reliability, several years of data would be needed. In our study three years data have been collected and processed. We need two years more to arrive at a reliable coefficient of run-off from the catchment. This would form a guide to the management of water resources in the small tank environment.

PROJECT EVALUATION

The improved rice technology developed at Walagambahuwa has increased the rice yields from 1.2 t/ha to 2.5 t/ha. It has shown that double-cropping is possible where only a single-cropping was adopted before, and that too only in years of heavy rainfall.

The cultivated extent under different categories of lands such as akkarawela and olagam have increased (Table 9). The extent in 1976/77 which was only 6.0 has increased to 60.7 ha in Maha 1980/81. This by itself is a magnificent achievement in rice production under the minor tank system.

Regarding the use of a correct mix of fertilizer it is very encouraging to note that the farmers seem to recognize the importance of both basal and nitrogen top dressings (Tables 10 & 11).

The shift in the labour allocation pattern too is encouraging: farmers prefer family labour for paddy cultivation, employing less hired and exchange labour. (Table 12). The main contributory factor in this shift in labour allocation may be that they get higher returns for paddy compared to any other crop in the agricultural system in the given production environment (Table 13). In fact, the shift is in the positive direction towards more production, which could be a good criterion in evaluating the success of the new technology developed and practised at Walagambahuwa.

Table 9: Trends of Cultivated Extents (ha) under Different Types of Land Categories

	76/77	1978	77/78	1978	78/79	1980	79/80	80/81
	Maha	Yala	Maha	Yala	Maha	Maha	Yala	Maha
Puranawela	0.2	0.02	0.2	0.2	0.2	0.2	0.2	0.2
Akkarawela	0.3	0	0.4	0.3	0.4	0.6	0	0.5
Olagam	0.2	0	0.6	0	0.7	0.6	0	0.6
Chena	0.9	0.7	0.7	0.6	0.6	0.7	0.4	0.7
Homestead	0.2	0.02	0.2	0.2	0.3	0.3	0.3	0.4

Table 10: Percentage of Farmers who have applied Fertilizer

	76/77	77/78	78 Yala	78/79	79 Yala	79/80	80 Yala	80/81
Basal + TD	53	70	15	25	5*	35	45	62
B(O) + TD	47	20	25	65	65	45	35	23
B(O) + TD(O)	0	10	60	15	30	20	20	15
Total	100	100	100	100	100	100	100	100
Insecticides	93	—	70	05	10	10	15	0
Weedicides	13	—	10	20	50	25	50	70

Table 11: Amount of Fertilizers used per Farm for "puranawela" paddy by farmers — Walagambahuwa

	76/77	77/78	1978	78/79	1979*	79/80	1980	80/81
	Maha	Maha	Yala	Maha	Yala	Maha	Yala	Maha
Basal (kg)	78	78	14	21	0.28	48	68	93
TD (kg)	145	81	50	74	12	95	128	97

* Low inputs caused by mismanagement of supply sources.

Table 12: Percentages of various types of Labour used for various Farm Operations at Walagambahuwa

Operation	Labour Family (F)	Puranawela	Akkarawela	Olagam	Chena	Homestead								
Land preparation	88	88	83	77	78	69	79	89	92	*	100	100	100	1+
Weeding and after care	Hired (H)	11	04	03	01	15	19	12	16	6	03	07	—	—
	Exchange (Ex)	01	08	06	15	02	04	10	15	15	03	01	—	—
	F	94	86	90	95	95	90	100	100	95	99	95	100	100
	H	6	—	10	—	04	01	—	—	2	01	0	—	—
	Ex	—	14	10	5	—	09	—	—	0	—	05	—	—
Harvesting	F	71	80	79	51	52	58	55	52	56	88	84	100	100
	H	6	11	06	17	40	15	26	26	21	07	09	—	—
	Ex	22	09	15	32	08	17	19	12	23	05	07	—	—

Note: Labour data for chena and homestead are not included.

Table 13: Per Farm Input - Output Relationship for Paddy Cultivation at Walagambahuwa

	76/77	77/78	78/79	79/80	80/81
Extent (ha)	Maha	Maha	Maha	Maha	Maha
	0.2	0.2	0.2	0.2	0.2
Lagour (man days)	27	35	23	21	21
Cash costs (Rs)	286	178	291	335	339
Total variable costs (Rs)	502	489	536	712	760
Paddy yield (t/ha)	2.0	2.5	2.5	2.2	2.9
Gross returns (Rs)	707	1019	1220	854	1452
Net returns (Rs)	198	530	684	142	692
Return over cash costs (Rs)	421	841	929	519	1113
Return/Rupee spent (Rs.)	1.41	2.08	2.28	1.20	1.91
Return/Manday (Rs)	15	23	40	26	54

CONCLUSION

There is a positive potential for intensive cropping patterns to be adopted under controlled irrigation in the minor irrigated schemes of the dry zone. More information however, is necessary on minor tank hydrology to permit careful management of tank storage.

In the Maha season, cropping patterns with rice and a selection of high value cash crops eg. chilli, onion, vegetables and grain legumes like green gram, cowpea, blackgram and soyabean will give a well balanced food base, increased production and a profitable return to farmers. In the following season a second crop of rice may be taken if there is adequate water left in the tank. In the alternative, short-aged other food crops with a low water requirement may be raised.

The physical parameters for such a cropping system exist, but their interaction with human resources will have to be carefully scrutinized to ensure success, specially the supporting services to agricultural production which have to well co-ordinated to permit timely cultivation which is the crux of new technology.

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