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Productivity of Rice and Chilli under Village Tanks of Sri Lanka in *Maha* Season with Respect to Resource Utilization

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ABSTRACT. *The hydrological potential of village tanks is a major determinant of growing crops in the command area. Therefore, a study was conducted to evaluate the productivity of cropping patterns of command areas of two village tanks (VTs) in relation to resource utilization. The VTs selected were Ambalegoda (North intermediate zone; cropping intensity 1.92) and Elapathwewa (North dry zone; cropping intensity 1.36). The Ambalegoda scheme had a higher ratio of catchment area:command area (16.7) and capacity:tank bed area (1.44) when compared to Elapathwewa (2.1 and 1.27, respectively) indicating that Ambalegoda scheme has a high hydrological potential to grow other field crops (OFCs) or rice/OFC mixtures.*

The results of the questionnaire survey indicated that cultivation of paddy in both Maha and Yala seasons was the traditional cropping pattern for Ambalegoda VT. However, in Elapathwewa VT, farmers traditionally cultivated rice in Maha season and chilli in Yala season.

With proper land selection, a rice–chilli cropping pattern was established and evaluated in Maha 96/97 in the command area of Ambalegoda VT. In this VT, 24% of farmers decided to cultivate both rice and chilli while 76% opted for rice only. Chilli was selected based on high net returns (farmer preference), and low water requirement. The command area of Elapathwewa was left fallow because of low rainfall and low tank storage.

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Chilli recorded higher net returns than rice per unit land area, capital, water, and material cost indicating the feasibility of cultivating OFCs in the command area during Maha season in Ambalegoda VT. The results indicate that rice–chilli cropping pattern is a viable system in the selected VT for income generation and resource utilization. The probability of having a Maha season with a rain fall less than 96/97 Maha is 18% in Ambalegoda indicating the need in this VT to utilize the limited water resources more efficiently for crop production in dry seasons.

INTRODUCTION

Village tanks (VT) classified under Minor Irrigation Schemes (MIS) consist of a command area less than 80 ha, and play an important role in Sri Lankan agriculture, especially in paddy cultivation. A large proportion of the rural population depends on village tanks for their livelihood. This is the focal point of their social, economic, cultural, and religious lives (Somasiri, 1991). From the total extent of the irrigable lands in Sri Lanka (520,000 ha), 37% (192,085 ha) comes under MIS (Somasiri, 1991), and this amounts to 20% of the total paddy production in the country (Jayawardena, 1996). Approximately 70% of the area under MIS are found in the dry and intermediate zones (Upasena *et al.*, 1980; Somasiri 1991). This is a considerable portion of agricultural lands which has a capability of contributing to the gross national production of the country. According to Gunadasa *et al.* (1986), 30% of the minor tanks are either unused or under utilized.

There are about 18,000 VTs in the country (Jayawardena, 1996). These tanks are entirely rainfed, except a few in the dry zone which are fed by the Mahaweli project. Paddy cultivation in the command area of village tanks therefore, is almost exclusively restricted to *Maha* season. In most years insufficient rainfall even in the *Maha* season results in depressed paddy yields due to lack of water (Fernando, 1981; Carr and Wanasinghe, 1982; Wijayaratna *et al.*, 1994). Dharmasena (1989) reported that rainfall is uncertain even in the *Maha* season and farmers need to wait until the tank gains adequate storage for cultivation. The most critical problem in village tank systems in the dry, and intermediate zones is the severe water scarcity during *Yala* season (Dharmasena, 1996). In the recent past, farmers in most of the VTs have not cultivated their rice fields twice a year. When the tank fails to reach its full capacity, command areas under a large number of VTs are kept fallow resulting in low cropping intensity.

Wijayaratna (1996), reported that cropping intensities in the MISs remained stagnant around 1.1 from 1982 to 1992. Farmers do not cultivate Other Field Crops (OFCs) in the command area because they are restricted to the decisions taken in *Kanna* (season) meetings, and the major governing factor of planning cultivation in the command area is the rainfall. Although farmers in most VTs have the knowledge and experience of cropping patterns within traditional systems using available resources, their potential has not been exploited in most cases.

Thus, the present study had two major objectives; (1) to identify the traditional cropping systems in two village tanks in the dry and intermediate zones of Sri Lanka in *Yala* and *Maha* seasons, and (2) to estimate the productivity of rice and selected OFCs in farmer fields in the command area of each village tank in *Maha* season 96/97 in order to increase resource utilization.

MATERIALS AND METHODS

The experimental sites were randomly selected based on the list of the village tanks (VTs) rehabilitated by the National Irrigation Rehabilitation Project (NIRP) from the dry and intermediate zones. Some characteristics of the selected VTs are given in Table 1.

Table 1. Basic data and characteristics of the selected VTs.

Character	Ambalegoda	Elapathwewa
Capacity at fsl* (ha.m)	25.7	44.8
Tank bed area (ha)	7.3	14.5
Tank co-ordinates	I/3[11.35×1.45]	F/10[10.4×8.3]
Catchment area (ha)	267.0	47.0
Irrigable area (ha)		
Maha	16	22
Yala	06	09

* fsl: full spill level

A questionnaire survey was carried out to identify the traditional cropping systems and production pattern of the selected sites in *Yala* 1994 and *Maha* 1994/95 seasons. The questionnaire was prepared based on the information collected from farmer participatory workshops and from available literature. All farmer families in both sites (58 in Elapathwewa, and 42 in Ambalegoda) were considered for the questionnaire survey.

The cropping patterns for the selected VTs were decided based on the farmers' preference at the "*Kanna* meeting" (a meeting held before each cultivating season to take important decisions on crop selection and timing of cultivation). The suggested cropping pattern for Ambalegoda VT was rice (*Oryza sativa* var BG 300) in the *Maha wela* (area in the paddy tract irrigated by the lower level sluice) and chilli (*Capsicum annum* var MI 2) in some *Akkara wela* (area in the paddy tract irrigated by the higher level sluice) fields. Fields with well–drained sandy soils were selected for chilli. Although the "*Kanna* meeting" at Elapathwewa was held, decisions on crop cultivation were not taken due to uncertainty of rainfall. As predicted, low rainfall and low tank storage of Elapathwewa tank during the 96/97 *Maha* season kept its command area fallow. One cropping pattern was introduced to Ambalegoda.

Ten farmers cultivated both rice and chilli in command areas of the Ambalegoda VT (0.04 ha of chilli and 0.04 ha of rice per farmer) and 32 cultivated only rice. Of the 32 farmers who cultivated only rice, an area equivalent to 0.08 ha per farmer was harvested and data were used for statistical analysis. All the farmers were provided with materials including seeds, fertilizers, agro–chemicals and required advice for chilli cultivation. Seedlings of chilli (21 day old) were planted in the fields at a density of 37000 plants/ha in raised beds. Pre–germinated rice seeds were broadcasted on to puddled fields at a rate of 140 kg/ha. The weight of sun–dried chilli pods and fresh weight of rice grains (15% moisture) were recorded. Number of labour days (family and hired labour), and cost of labour, material and machinery were recorded and net returns were calculated for each crop on individual farmer allotments.

Irrigation water supplied for both paddy and chilli cultivation was measured by Washington flumes fixed in all selected fields. Rainfall was recorded using a non–recording type rain gauge installed in an open field close to the command area. Tank water level was measured by using calibrated gauge posts. The capacity of the tanks were calculated using area capacity curves (Irrigation Department, 1992). Long–term rainfall data from 1940–1997 (Nakagawa *et al.*, 1995) of the two sites were used to estimate the probability of occurrence of a "dry *Maha*". In this study, a *Maha* season with less or equal rainfall of that of *Maha* 96/97 was considered a "dry *Maha*".

RESULTS AND DISCUSSION

Hydrological limitations and potentials

The command area of Ambalegoda and Elapathwewa tanks were 16 ha and 22 ha, respectively (Table 1). Ambalegoda tank had a catchment area 17 times larger than its command area with a higher ratio of capacity : tank bed area. Both sites had almost similar average annual rainfall. The catchment area of the Elapathwewa tank was twice the size of its command area, and its ratio of capacity : tank bed was less than that of the Ambalegoda tank (Table 2). This implies that the Ambalegoda tank has a relatively high hydrological potential than that of the Elapathwewa tank. As suggested by Wijayaratna *et al.* (1994) and Dharmasena (1996), these physical conditions lead to a very low water storage in the Elapathwewa tank. Thus, could lead to limitations in cultivating rice or any other field crop in its command area.

Table 2. Hydrological potential of two tanks.

Tank	Rainfall (m)	Catch.[1]/CA[2]	(Catch.* RF)/CA (m)	Capa.[3]/Tank bed (m)
Ambalegoda	1.440	16.7 a	24.0 a	1.44 a
Elapathwewa	1.342	2.1 b	2.8 b	1.27 b

[1] Catchment area (ha), [2] Command area (ha), [3] Capacity of tank (ha.m)
Within each column, means denoted by the same letter are not significantly different by the "t" test at p = 0.05.

The *Maha* season 96/97 was "dry" and rainfall received was 546 mm in Ambalegoda and 459 mm in Elapathwewa (Table 3). Long–term rainfall data (1940–1997), showed that the probability of occurrence of a "dry *Maha*" is 18% for Ambalegoda and 14% for Elapathwewa. The total amount of *Maha* rainfall and capacity of each tank is illustrated in Figure 1. The effect of having a larger catchment area and high capacity : unit area of the tank bed of the Ambalegoda tank was observed.

Table 3. Probability of occurrence of a "dry *Maha*" season when compared to *Maha* 96/97.

Tank	Rainfall (RF mm)			Probability of occurrence of a "dry *Maha*" (%) (RF<550 mm)
	Ave. Annual	Ave. *Maha*	96/97 *Maha*	
Ambalegoda	1440±308	790±260	546	18
Elapathwewa	1342±339	851±274	459	14

Survey information

The traditional cropping patterns of the command area of Ambalegoda tank was identified as cultivation of rice during *Maha* and *Yala* seasons, and in Elapathwewa, as cultivation of rice in *Maha* season, and chilli in *Yala* season using the "*bethma* system" (sharing of land in part of the paddy tract with assured supply of water in a season of drought). This also indicated that Ambalegoda VT has a higher hydrological potential than Elapathwewa VT. However, the monthly average income of farmers at Ambalegoda was 52% of that of farmers in Elapathwewa (Table 4). The higher income levels of farmers at Elapathwewa was mainly due to the higher income generated from uplands by cultivation of chilli and maize. The farmers at Ambalegoda relied more on cultivation of rice in the command area as the major source of income.

The cropping intensity (CI) of the command area was 1.92 in Ambalegoda and 1.36 in Elapathwewa (Table 5). The low cropping intensity at Elapathwewa was due to the lower extent cultivated in *Yala* season because of water scarcity.

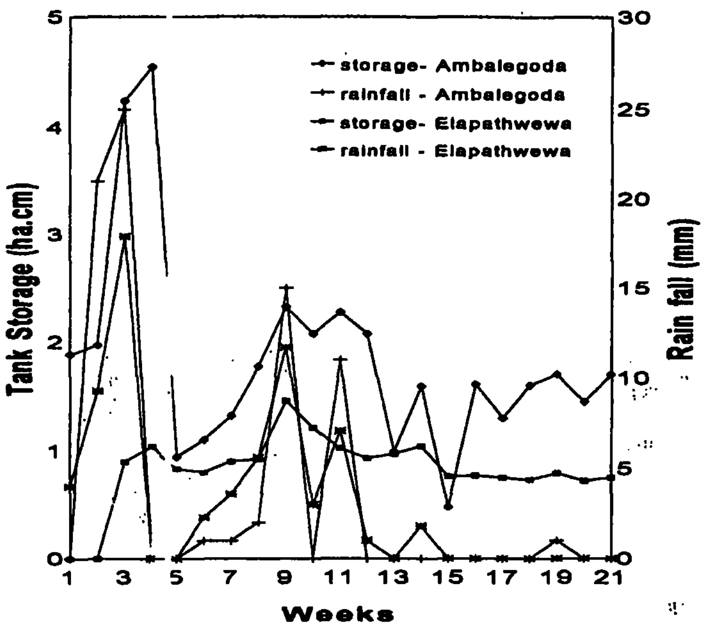

Figure 1. **The weekly rainfall and tank storage of Ambalegoda and Elapathwewa in *Maha* season 96/97 (October 1996 to February 1997).**

Table 4. **Average monthly income per farmer in *Maha* 94/95, and *Yala* 95 in the selected VTs (Rs/month).**

Tank	Command area	Upland	Off farm income	Total income
Ambalegoda	594 (44.5%)	114 (8.5%)	626 (47%)	1334
Elapathwewa	524 (20%)	1118 (44%)	939 (36%)	2581

Table 5. Cultivated extent and cropping intensities (CI) in command areas in *Maha* (94/95) and *Yala* (95).

Tank	Total extent (ha)	Maha		Yala		CI
		Rice (%)	OFC[1] (%)	Rice (%)	OFC (%)	
Ambalegoda	16	97	-	95	-	1.92 a
Elapathwewa	22	95	-	7	34	1.36 b

[1]OFC: Other Field Crops
Within a column, means denoted by the same letter are not significantly different by the "t" test at $p = 0.05$.

Land fragmentation and labour shortage (Jayawardena, 1996), market uncertainties and higher cost of production (Wijayaratna, 1996) are major constraints for cultivation of other field crops in rice lands. Low land fragmentation index (8.5) and larger command area (22 ha) in Elapathwewa than that of Ambalegoda (Table 6), showed a high potential of cultivating other field crops in the former. However, in agreement with the findings of Dharmasena (1996), the low hydrological potential has become the major factor of determining the cultivation of other field crops in the command area of Elapathwewa.

Table 6. Land parcel distribution of the command area in Ambalegoda and Elapathwewa.

Tank	No. of Farmers	No. of parcels	No. of parcels		LFI*
			per farmer	per ha	
Ambalegoda	42	84	2.00	5.25	10.5 a
Elapathwewa	58	104	1.79	4.73	8.5 a

* LFI - Land fragmentation index (No. of parcels per farmer × No. of parcels per ha)
Within a column, means denoted by the same letter are not significantly different by the "t" test at $p = 0.05$.

Crop selection

Based on the discussion at the "*Kanna* meeting", chilli was selected as the other field crop to be grown in the well–drained sandy soils within the command area. The ten (10) farmers who preferred to cultivate other field crops (OFC) selected chilli (Table 7) considering high market price per kilogramme (Rs. 95.00), uncertainty of rainfall, and low water requirement of the crop (120 ha.cm). In addition, with predictions of delayed rains, well–drained sandy soils in some of the *Akkara wela* lands in the command area also favoured the selection of chilli. It is important to note that the farmers in the Ambalegoda VT had no experience in cultivating other field crops other than rice in the command area of the VT. Thus, at the "*Kanna* meeting", 32 farmers opted to cultivate rice only, and decided to be observers until there is a satisfactory out come of the suggested rice–chilli cropping pattern.

As the command area in Elapathwewa scheme was not cultivated during *Maha* 96/97 due to severe water shortages, only the results obtained from Ambalegoda VT are discussed.

Table 7. Crop selection in Ambalegoda VT (*Maha* 96/97).

Crop	No. of farmers	Percentage (%)
Rice only	32	76
Rice + OFC	10	24
OFC		
Chilli	10	-
Other	0	-

[1]OFC: Other Field Crops

Labour utilization

The total labour requirement for the rice–chilli cropping pattern was five fold when compared to that of the rice only cropping pattern (Table 8). In addition, the ratio between family and hired labour for rice–chilli cropping pattern was 316% higher than that of the rice only cropping pattern. In the rice–chilli cropping pattern, chilli utilized 90% of the total labour input. This confirmed the results of Wijayaratna (1996) and Jayawardena (1996) who reported that chilli required higher labour units than rice.

Table 8. Labour utilization for the cropping patterns in Ambalegoda VT in *Maha* 96/97 season (man days per farmer unit).

Cropping pattern	Family labour	Hired labour	Family/ Hired	Total labour
Rice (0.04 ha) - chilli (0.04 ha)				
Rice	2.6	2.0	1.3	4.6
Chilli	30.1	10.2	3.0	40.3
Total (0.08 ha)	32.7	12.2	2.5 a	44.9 a
Rice only (0.08 ha)				
Rice	3.8	5.9	0.6 b	9.7 b

Within a column, means denoted by the same letter are not significantly different by the "t" test at $p = 0.05$.

In the rice–chilli cropping pattern, the farmers had to depend more on family labour as there was a shortage of hired labour. This is mainly due to the fact that farmers who cultivated only rice utilized the majority of the available hired labour as a result of higher cultivated extent.

Productivity and net return

In the rice–chilli cropping pattern, rice illustrated a higher productivity per unit land area when compared to chilli (Table 9). The cost of production of rice-chilli cropping pattern was significantly higher when compared to that of rice alone. This was mainly due to the higher labour requirement for cultiva ion of chilli. Net return of the rice–chilli cropping pattern was also highe in the case of both excluding and including family labour (227% and 12% higher, respectively) when compared to that of rice–only cropping pattern indicating the profitability of the former system (Table 9).

Table 9. The average productivity and average net return of farmers in Ambalegoda VT (*Maha* 96/97).

Item	Rice (0.04 ha)	+	Chilli (0.04 ha)	Rice (0.08 ha)
Yield (kg)	179		59	367
Cost of production (Rs)				
Excl.fam.lab*	910	[2592]#a	1682	1538 b
Incl.fam.lab**	204	[6406] a	5202	2013 b
Net return (Rs)				
Excl.fam.lab	782	[4988] a	4206	1523 b
Incl.fam.lab	487	[1173] a	686	1048 b

* Excluding Family Labour ** Including Family Labour
\# Total value of the cost of production and net return of (rice-chilli) cropping pattern is given in the square brackets.
Within each row, means denoted by the same letters are not significantly different by the "t" test at p = 0.05.

The return to capital of the rice–chilli cropping pattern was 94% higher than rice–only cropping pattern when family labour was not considered. However, the return to capital of the former was 65% less than that of rice–only cropping pattern when family labour was considered. In the rice–chilli cropping pattern, the return to capital in chilli was three times higher than that of rice (Table 10) as indicated by many researchers (Jayawardena, 1996; Wijayaratna, 1996). Due to higher labour use for chilli, net return to labour unit was low in the rice-chilli cropping pattern when compared to rice alone, in both situations; excluding and including family labour, although the former procured higher net returns.

Table 10. Average return to resource unit in Ambalegoda VT (*Maha* 96/97).

Resource unit	Rice (0.04 ha)	+	Chilli (0.04 ha)	Rice (0.08 ha)
Return to capital (Rs/Rs)				
Excl.fam.lab	0.86	[1.92]#a	2.50	0.99 b
Incl.fam.lab	0.41	[0.18] a	0.13	0.52 b
Return to labour (Rs/man day)				
Excl.fam.lab	167	[52] a	104	258 b
Incl.fam.lab	104	[26] a	17	108 b
Return to water unit (Rs/kg)				
Excl.fam.lab	$3.02*10^{-4}$	[$16.85*10^{-4}$] a	$4.6*10^{-4}$	$2.9*10^{-4}$ b
Incl.fam.lab	$1.88*10^{-4}$	[$3.96*10^{-4}$] a	$0.7*10^{-4}$	$2.0*10^{-4}$ b
Return to material cost (Rs/Rs)				
Excl.fam.lab	1.7	[6.40] a	7.7	2.54 b
Incl.fam.lab	1.1	[1.50] a	1.3	1.75 b

Within each row, means denoted by the same letter are not significantly different by the "t" test at $p = 0.05$.
Return to resource unit for the rice-chilli cropping pattern is given within brackets.

The net return to unit of water in rice–chilli cropping patterns was significantly higher, both in terms of excluding family labour (479% higher) and including family labour (95% higher), when compared to that of a rice–only cropping pattern. In the rice–chilli cropping pattern, the net return to unit of water in chilli was 53% higher than that of rice excluding family labour. This indicated that chilli has a low water requirement than rice. However, when family labour was considered, the net return to unit water in chilli was 61% lower than rice indicating the significance of higher labour requirement in chilli in determining the resource use efficiency of the rice–chilli cropping pattern.

When family labour is not considered, the rice–chilli cropping pattern gave a significantly higher return to unit material cost when compared to that of the rice–only cropping pattern. However, due to higher labour utilization, the return to material cost of the former was 14% low when compared to rice–only cropping pattern. In agreement with Dharmasena (1996), in the rice–chilli cropping pattern, the net return to material cost (cost for seeds, fertilizer, and other agro-chemicals) was high for chilli when compared to rice.

CONCLUSIONS

The results of the present study indicated that the hydrological potential is a major factor that governs the productivity pattern in command areas of minor irrigation schemes. The rice–chilli cropping pattern in command area could be viable as in the case of Ambalegoda scheme, where there is a 18% probability of experiencing a "dry *Maha* season". In this regard land selection could be of critical importance. Cultivation of chilli is profitable in terms of resource utilization except for labour.

Further studies are currently being undertaken to evaluate the performances of cropping systems in the command area of these two minor irrigation schemes with respect to resource utilization.

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