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SRI LANKA CROPPING SYSTEMS PROGRAM

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Introduction

This paper describes most of the up to date information with respect to the Cropping Systems Research activities in the different sites in Sri Lanka. The bulk of the information referred to is mostly the continuation of the work that was reported during the last working group meeting held in Los Banos. Of the different research sites, Walagambahuwa and Katupotha which were started in late 1976 are running into the third year of activities. It is clear from our paper that the problems of first order of priority are already being sorted out and we concentrate mostly on the component technology aspects in improving individual crops or cropping patterns. The economic monitoring program has really highlighted the resource based problems and now we are moving on to another aspect of understanding better the environment by employing a full time researcher on social aspects in the given environment. Katupotha site is very close to completion having accomplished the objectives anticipated in the program.

The rest of the research sites, Paranthan, Bandarawela, Angunukolapelessa and Mannar are progressing well. Major emphasis is laid on the fully irrigated areas covered by the Mahaweli Diversion Scheme. At the moment most of the work carried out in this site is directed towards better understanding of the problems as well as documenting the identified problems which shall mature into a full fledged cropping systems program.

As the project area covered by the network of the Cropping Systems Program is vivid physically as well as biologically, each location has had to develop its own objectives and respective methodologies of operations. This has directed us towards more location specific problem oriented research within the overall program objectives. The progress reports of individual locations are reviewed accordingly.

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Walagambahuwa

This is the third year of the project activities, with the objectives of evaluating more intensified cropping patterns for the tank based agricultural system of the Dry Zone of Sri Lanka. Major objective is to utilize the rainfall to raise a crop under the paddy field below the tank and conserve water in the tank for a second or third crop by matching the crops in the rainfall pattern. All the farmers in the village (45 families) are involved in the project activities. Monitoring the farmer activities (agronomic as well as the economic) are being continued.

Following component technology was tested at the site in farmers' fields in the first season (Maha):

1. Response of paddy to varying levels of N-fertilizer application in different land classes (Table X).

2. Complimentarily of plant population and chemicals on week control (Table X).

The following studies arebeing carried out in the field:

1. Determine the consumptive use of water for Yala paddy crop under minor tank system.

2. Effect and economics of three sources of power in land preparation performances.

3. Comparison of labor and land resources profiles with the previous profiles.

4. Economic evaluation of the total cropping pattern.

Studies are also being carried out to determine the total water balance of A minor tank.

Economic Studies

Economic investigation was continued with the same sample of farmers as the previous years. It consisted of aspects, the first to make the profiles of resources used especially labor with a view of highlighting on the consistency and stability of the pattern and secondly to evaluate the overall returns for the use of resources.

Cropping Pattern

The first rice crop was successfully raised in the Puranawela making a maximum use of the rainfall using the shortage variety Bg 34-8. In other paddy lands such as Akkarawela and Olagam, Maha season rice was cultivated in early January according to the traditions (Table 1). It is striking to note that the total paddy land cultivation amounts to 60% in extent, thus showing a marked shift from previous years where the situation was the reverse. In Maha 78/79 the average extent of paddy land was approximately 1 hectare of which the proportion in Puranawela was only 18%. A 30% reduction in the extent of chena cultivation was evident. This could be partly attributed to the delayed unfavorable rains in 78/79 and partly to the unattractive prices for upland crops particularly chillie, compared to paddy. The popularity of chillie in chena has decreased from 35% in 76/77 to 13% in Maha 78/79 (Table 2).

Labor Use

The labor use pattern over the Maha season is given in chart 1. The two peak pattern is clearly seen however, the whole profile is shifted by four weeks in the case of paddy due to delay in Maha rains compared to the previous years.

The average weekly allocation of labor for agricultural enterprises was 42 hours (Table 3) comparing with Maha 77/78. It is striking to note that although the extent of cultivation of rice is 60% of the total the amount of labor allocates was only 43%.

Crop Income and Economics of the Crops

The harvest data on Olagam paddy is not available as threshing is not completed. Excluding the Olagam paddy the gross income from rice and upland crops amount to Rs. 2345/- of which 77% is contributed by rice. The crop income per month amounts to Rs. 390/- (excluding Olagam) in the Maha 78/79. This is comparable to Maha 77/78.

The cost and returns for the use of resources in paddy and main upland crops are given in Table 4. Puranawela rice appears to be attractive in terms of returns to resources. An evaluation of the overall pattern will be made after the second crop.

Table (X). Effect of different levels of nitrogen fertilizer on yield (land element C) variety Bg 34-8.

Levels of nitrogen N-kg/ha	0 N	30 N	45 N	60 N	75 N	90 N
Mean yield T/ha	2.945	3.615	3.703	3.642	4.203	4.432

Table X. The effect of plant population and method of weed control on yield rice - seed rate kg/ha.

	100 kg/ha	150 kg/ha	200 kg/ha	Mean
Hand weeding after	2.839	3.840	3.127	3.286
No weeding	3.694	3.660	3.526	3.626
MCPA 32A43/ac	2.571	3.830	3.503	3.301
3.4 DPA	3.915	3.280	3.908	3.701
Mean l	3.254	3.652	3.516	

ANOVA

Source of variation	Degrees of freedom	Sum of squares	Mean squares	Observed F	Tabular 5%	Tabular 1%
Block	3	1.041	0.347	.635	3.29	5.42
Treat	5	5.453	1.094	1.996	2.9	4.56
Error	15	8.200	0.546			
Total	23	14.694				

Yield of paddy - 2.985 + 0.0154 (N) 0-90 kg/ha

r - 0.579 (Significant at 5%)

ANOVA

Source of variation	Df	SS	MS	Observed F	Tabular 5%	Tabular 1%
Block	3	3.203				
Rates	2	5.597	2.798	4.119*	3.29	5.36
Methods	3	6.079	2.026	2.992*	2.89	4.44
Rate and methods	6	1.157	0.192	.283	2.39	3.40
Error	33	22.324	0.677			
Total	47	38.296				

LSD Rates - 0.6859

LSD Methods - 0.5940

Table 1. Paddy land and highland cultivations in Walagambahuwa Maha 78/79.

	Farmers		No. of parcels	Total	
	No.	%		Hectare	%
Puranawela	19	95	56	3.56	10.7
Akkarawela	8	40	9	3.42	10.3
Olagam	18	90	33	12.78	38.6
Chena	19	95	26	11.17	33.7
Homestead	8	40	4	2.20	6.6
Total				33.13	100.0

Table 2. Extents and yields of major chena crops, 20 families Maha 78/79.

	Extent		Mean yield kg/ha
	Ha	%	
K rakkan	3.31	29.6	1387
Cowpea	2.11	18.9	714
Soybean	1.03	9.2	653
Chillie	1.44	12.9	194
Paddy	1.72	15.4	1819
Others	1.56	13.9	-
Total	11.17	100.0	

Table 3. Mean weekly labor allocation Walagambahuwa Maha 78/79.

	Hours	%
Puranawela	5	11.9
Akkarawela	4	9.5
Olagam	9	21.4
Chena	19	45.2
Homestead	5	11.9
Total	42	100.0

Table 4. Mean costs and returns of main crops - Walagambahuwa Maha 78/79.

	Puranawela	Kurakkan	Cowpea
Family labor (m.d.)	106	115	167
Hired labor (m.d.)	9	-	-
Cash costs	1267	45	168
Crop yield	2705	1118	824
Crop value	5304	1287	3992
Total costs	2329	1195	1838
Return over cash costs	4037	1242	3824
Return over all variable costs	2974	92	2154
Return/m.d.	40	11	23
Return/mp	4	3	13.8

Katupota

Background

The Cropping System Research activities in Katupota are continued to be concentrated for the third successive year in the two rainfed lowland paddy tracts namely Alakara and Moragane. Low yields are characteristic of the rice lands. The low yields are very often associated with nutrient deficiences and flash flood damages during heavy rains in the Maha season in particular. Yet, the new high yielding varieties of rice are popularly cultivated in these lands under the two rice crop pattern. Thus, plant nutrient studies particularly that of P_2O_5 is considered an important aspect of component technology. Further, in the upper land elements prone to moisture stress, substitution of upland crop for rice during the dry season is given consideration in the cropping pattern improvements.

Agronomic Studies

The Maha season 78/79 marks a season with delayed but heavy rains unlike the previous two Maha seasons. This resulted in seasons flood always in the early establishment of rice crop particularly in the valley bottom. Some fields were sown for the third time, yet with little success. Several experimental plots were damaged.

Fifteen farmers at Alankara and twelve at Maragane cooperated in the studies.

1. The residual effect of basal fertilizer (3-31-14) on the growth and yields of paddy.

This study was initiated to evaluate the effect on the second crop of rice of application of fertilizer for the first crop. Three rates were tried with 62-355 as the first rice crop.

The following was the mean yield (kg/ha).

	0 P_2O_5	187 kg P_2O_5	375 kg P_2O_5
Alakara	2710	4066	3614
Moragane	3067	4601	4090

Bg 34-8 has been planted as the second crop (Yala 79) without any P_2O_5 in the above plots. Observations on residual effect are being made.

2. Response of paddy varieties to application of P_2O_5. This was an observation trial without replications and the varieties used were Bg 400-1, H4 and Bg 90-2.

Variety	P_2O_5	
	0 kg/ha	78 kg/ha
Bg 400-1	2075	2850
H4	895	3132
Bg 90-2	962	1345

The trials at Moragane was damaged by flash floods.

In plots where no P_2O_5 was applied, the rice crop showed uneven growth, low tillering and short stature. Further the flowering and harvesting were delayed by two weeks compared to the plots treated with P_2O_5.

3. Effect of plant density of rice on the weed growth and yield. Five seed rates viz, 100, 150, 200, 250, 300 kg/ha were used with the variety 62-355.

This trial is repeated in the Yala season as the maha season crop was damaged.

Cropping Pattern Monitoring Studies

Systematic evaluation of a few selected rice-based cropping patterns were initiated in the Maha 78/79 season. The selected patterns are:

a. Upper land element at Alankara

1. Bg 34-8 - Cowpea
2. Bg 34-8 - Green gram
3. Bg 34-8 - Groundnut

b. Lower land elements at Alankara and Moragane

1. Bg 34-8 - Bg 34-8
2. Bg 34-8 - Bg 34-1
3. Bg 34-8 - 62-355

The yield performance of the first crop (Bg 34-8) is as follows:

Field		Land Elements		
		Upper	Slope	Valley Bottom
Alankara	$\bar{X}$	2825	damaged	2773
	CV	31.4	-	36.0
Moragane	$\bar{X}$	-	2318	damaged
	CV	-	18.4	

The rice crop (Bg 34-8) was dry-sown at 130 kg/ha and the fertilizer were applied at the recommended levels. A conclusive evaluation of the patterns will be made after the second crops are harvested.

Economic Studies

The economic studies were geared to monitor the resources use profiles, evaluation of the designed cropping patterns and the overall economic of production. In addition attempts were made to assess the impact of management application of yields and returns and also to compare the two villages using the past two years information.

As for the size of farm operated hardly any differences is found from the previous years. The average extent of rice lands operated by Alankara farmers remained at 1.47 hectares of which 60% was found in the experimental tract, while at Moragane 81% of the 0.77 hectare rice land was found in the Moragane tract. No change in tenurial conditions was observed the sizes of highland and coconut holdings did not change appreciably and remained in the order of 1 hectare per family.

The average family size is 6 and family labor constitutes the chief labor force. The average weekly allocation at Alankara was around 65 hours while at Moragane it was around 35. Around 40% of the allocation at Alankara goes to off-farm work while the portion for Moragane is only 15%. Of the labor allocated to farming enterprice 80-85% has gone to the rice production.

Comprising the three years, a consistency in the pattern of allocation of labor was found. However, when the weekly allocation to farming is considered it was found that compared to the first year the allocation has dropped by 40% in the second and 3rd years when the rainfall was heavy.

Comparison of yield and Returns

When the five seasons yields were studied they seem to be stabilized in these villages around 1-1.5 ton and the difference, if any in different years seem to be caused by losses due to flash-floods. At Morgane the level is stabilized at the significantly higher level (1.6 tons/ha) than at Alankara (1.1 ton/ha).

No significant difference in income from coconut was evident between the villages as well as over the years. However, the income from off-farm work seemed to be higher at Alankara than Moragane as expected.

No significant difference in management levels in terms of labor inputs and cash inputs was found between years conforming with the expectations.

Economics of the Maha 78/79 Rice

Table 1 shows the performance of the main rice varieties in the different land elements. Upper land elements gave higher yields compared to the lower land elements where losses due to heavy rains and flash floods were drastic. This led to low income from paddy lands at Moragane in particular (Table 2). Paddy income at Alankara was twice as high as at Moragane. The monthly income at Alankara and Moragane were Rs. 617/- and Rs. 375/- respectively.

Table 3 shows the costs and returns of successful cultivation of rice as in Maha 78/79. Inspite of the lower yields the returns to labor and cash inputs were high because of the generally lower level of application of these inputs.

Table 1. Performance of rice varieties in the different land elements - Maha 78/79.

	Crest		Slope		Valley Bottom		Overall mean yield kg/ha
	No. of farmers	Mean yield kg/ha	No. of farmers	Mean yield kg/ha	No. of farmers	Mean yield	
ALANKARA							
Bg 34-8	5	2485	6	1755	5	1290	1838
Bg 94-1	1	1020	8	1322	1	767	1236
Bg 90-2	1	2484	1	1380	2	1175	1243
All varieties		2276		1499		1196	1558
MORAGANE							
Bg 34-8	-	-	9	2069	-	-	2069
Bg 94-1	-	-	7	1763	-	-	1763
All varieties	-	-	-	1935	-	-	1935

Table 2. Mean farm income at Alankara and Moragane Maha 78/79.

	Alankara		Moragane	
	Rs.	%	Rs.	%
Paddy tract	1079	29	582	27
Other paddy	733	20	279	13
Coconut	865	23	1051	49
Off farm work	1025	28	229	11
Total	3702	100	2141	100
Rs/month	617	-	357	-

Table 3. Mean labor and cash use and return in a hectare of rice in Maha 78/79.

	Alankara	Moragane
Labor (m.d.)	96	109
Cash costs (Rs.)	737	818
Yield (kg)	1558	1935
Gross returns	2960	3676
Return over cash costs	2223	2858
Return over all variable costs	1263	1768
Return per rupee cash investment	271	3.16
Return/man day	23	26

Mahaweli

The Cropping Systems analysis of the Mahaweli is designed to provide a primary data bank of what is actually occuring on farms in the Mahaweli.

The immediate objectives is to systematically observe the operational activities of farms in the system, compare this to the established norm for the system and estimate wether deviations from the norm are the result of shaking down of newly settled land or more fundamental causes. To do this a statistical sub-sample of nine randomly selected farms was made from each of six settlements within the Mahaweli Scheme. The settlements were selected to represent new settlements from H area with 2½ acre paddy allotments and contrasted these with old 5 ac and 2 ac settlement scheme from Polonnaruwa. From each scheme the sampling was paired to provide a sample set from two areas located several miles distance along the same main canal. The scheme selected were:

New Areas

H_1 304)
H_2 306) with 2½ ac allotments

Old Areas

Minneriya D 13)
Minneriya D 28) with 5 ac allotments

Kaudulla Tract 2)
Kaudulla Tract 6) with 2 ac allotments

The two new H area scheme also represented different settlement dates. 304 was initially settled for Maha 1976, while 306 was settled for Yala 1978. A micro catchment of each scheme was identified. The individual farms within the micro catchment were listed as to anticipated soil type. Three from each soil type was then randomly selected from each group so that each set of 9 farms were blocked according to soil type. A system and format was designed to monitor the activities on the farm on a weekly basis. The results were then graphically prepared (Fig. M1, M2, M3) for analysis and standarized to water issue date and expressed on weeks after water issue.

For the Maha cultivation the water issue runs for approximately five months with an encouragement to grow a 4 or 4½ month crop for which Bg 11-11 is recommended. For the areas studied the water issue commened in mid to late October, shifted to rotational in mid to late November and all terminated on March 20 (Table M1).

The crop establishment is summarized in Table M2. The summary shows the percent of seeding done which includes sowing of nurseries broadcasting and percent of land prepared. This is recorded for weekly intervals from week 14 to week I 11. It is then summarized in terms of time span by the absolute span or outer limits. This corresponds to the interval between the first and last farm or fraction of a farm are seeded or established. In addition a 7/9 inner limit is also used. This simply removing the equivalent of one farm from the beginning and one from the end. This is designed to remove any wild anomolies picked up in the sampling procedures. This is roughly an 80% confidence span and would be a better measurement for planning, and adjustment purposes than provided by the outer limits.

The results in Table 2 indicate that the water issue changed from continous to rotational most areas had less than 50% of the last established. Most of the land was actually established 2 to 3 weeks after the rotational issue had commened. The fastest area to be established was Minneriya D 13 essentially being completed in 15 and 16. Minneriya D 28 lagged behind by two weeks, but then moved rapidly to get completed. The very rapid rate at which both areas became established with a 2 weeks time lag between areas would suggest a possible shift of a migatory work force from one to the other took place.

The Kadulla tracts appeared to start faster, but than move at a more gradual uniform pace over about a four week interval without a major difference between the two tracts. Given the smaller areas involved this would appear indicative of a slower power source as discussed later, but also a more interval labor supply, perhaps operating largely on an exchange labor bases. Overall it was no more efficient than Minneriya even though the Kaudulla allotment size was less than half that of Minneriya.

The new H area settlements were even more spread out than Kaudulla. This would probable be temporary and the spread of activities expected to collapse towards that of Kaudulla.

Down Canal Effect

Table M2 also illustrates some of the difficulties that farmers experience as they get further away from the water source, and the reliability of the water deminishes. There appears to be a general trend for later establishment at further distance. This clearly apparent in the Minneriya and new H area samples. It is less clear for Kaudulla. Of greater significance is the percent of the area broadcast instead of transplanted. This clearly apparent in all cases Minneriya, Kaudulla and new H area. This appears to be a corrective response tc unsure water making timing of transplanting less certain.

Soil Catena Effect

The effect of soil catena was not highly pronounced and most cases the variability would be too high for statistical significance. In all the five acre allotments of Minneriya there appeared a slight trend for the natural; more moisture enriched areas to be established earlier. In the Kaudulla and new H area, the trend was for a dip to occur for the imperfectly drained areas with both the well drained and poorly drained being soils more delayed. A distinct down canal trend was also apparent among the Minneriya and Kaudulla samples. For the yala this soils effect is expected to be more intensive but perhaps the order reversed as proximity to the canal becomes of greater concern than natural enrichment.

Variety Use

The variety used was overwhelmingly the recommended Bg 11-11 (Table M3). The second variety used was Bg 34-8. This is an earlier maturing variety, 3½ month. It was frequently used as a broadcast catch up crop when establishment got delayed well past the rotational issue date. It could be broadcast up to week 18 or 19 and still mature before the water issue terminated. It is important to note that the 2 or 2½ acre farms in Kaudulla and the new H area broadcast a large percentage of their land than did the 5 ac farmers of Minneriya.

Type of Operation

Virtually all farmers irrespective of farm size or location divided the work into two nearly equal portions (Table 4). For most farmers this was two nurseries and two transplanting. It is interesting to note that those farmers with 3 operation were concentrated among the smaller farmer of Kaudulla and new H area. The time lag between successive operations in any farm was generally less than a week. This would imply the farmer had his activities well planned in advance and moved from one operation to another in an orderly manner. There did appear a mild down canal effect in which further away areas had there lag times slightly longer. This is apparent in the Minneriya and the new H area. It did not hold for Kaudulla. The extended time lag for the new H area would appear largely a settling down effect that should disappear with time. The time lag within farms is generally less than the time difference between farms. This would imply a mobility or sharing of resources such as draft power and/or labor forces, that move from one farm to the next.

Power Use

The evaluation of power used for each area made some clear separations of allotment size and may indicate why the 5 ac allotments were equally as efficient as the 2 or 2½ ac allotment (Table M1). The 5 ac allotments overwhelming resorted to tractors while the 2 ac farmer used buffalo. This is particularly noticeable in Polonnaruwa where the Minneriya and Kaudulla area are essentially adjacent to each other and have been settled for approximately equal periods with ready access to major roads and other infrastructure. Yet tractors just are not going into the Kaudulla area. This may be an indication that the small farmers just cannot affort the cost of tractors tillage and that overall operations are slowed down accordingly. The new H area was nearly evenly divided between tractors and buffaloes with one farmer actually resorting to malmote. There did appear a minor down canal effect in which the further away farmers resorted more to buffaloes and less tractors. This was true of both the Minneriya and Kaudulla.

The project maturity of the crop generally followed seeding date and showed most of it maturing prior to termination of water issue (Table M6). Actual harvest dates are still being checked, but generally they occured slightly after maturity. This was because farmer tend to allow the crop to dry in the field before harvesting so it can be heaped without spoilage for up to 3 or 4 weeks after cutting. To some extent the apparent delay between maturity and harvest was less than expected because the crop as a whole appeared to mature about 2 weeks earlier than projected. Crop cut data for the entire area showed an average of 4.8 + 1.3 (Table M7).

This was reasonable consistent between different areas. The highest yield actually come from the newest area and may be a result of residual fertility from the cleared jungle. There was no apparent effect of soil type on yield, with each soil type having the highest and lowest yield within an area twice. This would indicate the blanketing affect of fully irrigated systems to reduce natural soil difference within a catena.

Summary of Maha

1. Although nurserys were planted most of the land was not established until two to three weeks after the rotational water issue began.

2. However, because the nurserys were sown prior to rotational issue and the crop was maturing faster than budgeted most of the crop would mature before the water issue terminated.

3. Areas further from the water source tended to be later in crop establishment than those closer.

Table M1. Mahaweli Maha 78/79 water issue summary.

Area	Initial Issue	Rotational Issue	Final Issue[a/]	Duration Weeks
Minneriya				
D13 + D28	October 15	November 15	March 20	23
Kaudulla				
T2 + T6	October 15	November 15	March 20	23
H_1 304	October 27	November 27	March 20[a/]	21
H_2 306	October 27	November 27	March 20[a/]	21

[a/] Extended to April 14.

4. Further away areas broadcast more area than those closer.

5. Further away areas tended to have larger time-lag between successive on-farm operations.

6. Further away areas tended to use more buffalo power in contrast to tractors.

7. The 2 ac allotment farmers were no more efficient in crop establishment than the 5 ac farmer. It anything the 5 ac were more efficient.

8. The 2 ac farmers broadcast substantially larger percent of there land than 5 ac farmer who transplanted more.

9. The 2 ac farmer used sunstantially more buffalo power compared to tractor power used by the 5 ac farmers.

10. The entire area averaged 4.8 l/ha with no apparent soil interactions.

Table M2. Mahaweli Maha 78/79 crop establishment summary.

Area		Issue Weeks 1 4	1 5	1 6	1 7	1 8	1 9	1 10	1 11	Outer Limit Weeks	Outer Limit Span	7/9 Inner Limit Weeks	7/9 Inner Limit Span
		- - - - - - - - - - % - - - - - - - - - -											
Minneriya	Seed	93	100	-	-	-	-	-	-	12-15	4	12-14	3
D13	Land	11	67[a]	93	100	-	-	-	-	14-17	4	15-16	2
Minneriya	Seed	38	82	91	97	-	-	100	-	12-110	9	14-16	3
D 28	Land	0	20	22	60	91	-	100	-	15-110	6	15-18	4
Kaudulla	Seed	83	-	-	89	94	-	-	-	11-18	9	11-14	5
Tract 2	Land	33	53	61	89	94	-	-	-	11-18	9	14-17	4
Kaudulla	Seed	39	88	100	-	-	-	-	-	11-16	7	11-15	6
Tract 6	Land	38	50	61	86	100	-	-	-	14-18	5	14-17	4
- 1 304	Seed	44	67	77	95	100	-	-	-	10-18	10	13-17	5
	Land	22	-	44	73	89	-	-	100	12-111	10	14-18	5
- 2 306	Seed	47	50	-	73	82	87	100	-	11-110	11	12-18	7
	Land	14	22	43	69	78	82	93	-	13-113	11	14-110	7

[a] Underscored week indicates week in which 50% land establishment was surpassed.

Table M4. Mahaweli Maha 78/79 crop establishment style summary.

Area	Types of Operations[a]							Time lag between	
	1 TP	I BC	2 TP	2 BC	TP + BC	Any 3	Any 4	Nursery	Land
	- - - - - - - -		Number of Farmers		- - - - - - - - - - -			- - - Weeks - - -	
Minneriya D13	1		8					0.8	0.7
Minneriya D28			8	1				0.5	0.8
Kaudulla T2			3	2	1	2		0.8	1.4
Kaudulla T6		2	2	1	2	2		0.6	0.8
H_1 304			6	1	1			1.2	1.5
H_2 306		2	1	1	2	3		3.4	2.4
Total	1	4	28	6	6	7			

Number of farms with single operation - 5
Number of farms with double operation - 42
Number of farms with trible operation - 7

[a] TP - transplanted
BC - broadcasting

Table M5. Mahaweli Maha 78/79 crop establishment power summary.

Area	Tractors	Buffalo	Malmote
	---------- Number of Farmers ----------		
Minneriya D 13	7 - 2 wheel 2 - 4 wheel		
Minneriya D 28	2 - 2 wheel 4 - 4 wheel	3	
Kaudulla T2	2	7	
Kaudulla T6		9	
H_1 304	5	4	
H_2 306	5	3	1

Table M6. Mahaweli Maha 78/79 crop projected maturity and harvest summary.

Area	Issue Week										Out limit		7/9 inner limit		% mature when issue terms
	1 17	1 18	1 19	1 20	1 21	1 22	1 23	1 24	1 25	1 26	Weeks	Span	Weeks	Span	
	- - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - -														
Minneriya Mat[a] D13	-	6	-	-	67	89	100[b]	-		-	111-123	6	121-123	3	100
Minneriya Mat	-	6	-	-	16	22	55[b]	78	89	93	111-129	12	121-124	4	55
Kaudulla Mat T2	14	-	-	-7	53	55	88[b]	-	94	-	115-125	11	120-123	4	88
Kaudulla Mat T6	-	5	-6	22	33	-	61[b]	94	100	-	118-125	8	119-124	6	61
H_1 304 Mat	5	-	22	39	50[b]	61	67	88	100	-	116-125	10	119-124	6	50
H_2 Mat	-	-	-	-	22[b]	48	58	64	80	-	119-129	11	121-126	6	22

[a] Maturity as projected from seeding date based on Bg 11-11 as 4½ months (19 weeks) Bg 34-8 as 3½ months (14 weeks), Bg 90-2 as 4 month (17 weeks).

[b] Indicates week in which water issue was initially planned to terminate.

Table M7. Yield results for Mahaweli studies by soil type.

Area	RBE	IPD	LGH	T
	T/ha			
Minneriya				
D 13	3.8 ± 1.6 (9)*	4.2 ± 1.6 (6)	4.0 ± 1.0 (8)	4.0 ± 1.4 (23)
D 28	5.1 ± 1.1 (8)	5.1 ± 1.0 (8)	5.6 ± 1.3 (8)	5.2 ± 1.1 (24)
Kaudulla				
T2	4.8 ± 1.2 (9)	5.0 ± 1.0 (7)	4.0 ± 1.4 (6)	4.7 ± 1.2 (22)
T6	5.4 ± 0.8 (9)	4.3 ± 0.4 (6)	4.5 ± 0.2 (6)	4.8 ± 0.8 (21)
H_1 304	4.2 ± 0.8 (6)	4.3 ± 1.3 (3)	5.5 ± 1.1 (2)	4.5 ± 1.0 (11)
H_2 306	6.4 ± 1.6 (6)	5.6 ± 0.9 (2)	5.3 ± 1.2 (8)	5.8 ± 1.4 (16)

* Number in parenthesis is number of crop cuts in figure.

PARANTHAN

Descriptive Review: The Paranthan Cropping Systems program is conducted on the "Manawari" lands or rainfed lands forming a cap on the northern part of the island, just prior to the Jaffna Penninsula. The area is essentially a series of old sand dunes and clay lagoons in which the sand dunes have been almost completely eroded and deposited on the lagoons to form an area of sandy surface soils, underlain with sandy clay at varying depths. Being at the northern end of the island and thus furtherest away from the mountain hub in the south, the Manwari lands have the dryest climate in the country. The Maha rains from the North-east monsoons are about average for the country, but the Yala rains from the southwest monsoons are extremely low and unpredictable. This makes Yala cropping on extremely questionable operation.

Overall Evaluation

The Maha rains were favorable, but not outside the variability to be expected in the area. There was a light germinating shower in late September followed by "average" rains in October and November with nearly double the "average" in December (Table P1). January was the only Maha month of substantially less than average rains. Since there was no diesel shortage in the area this year, as there was the previous year, the land was all dry prepared prior to the onset of the rains. This was a direct result of the sandy surface soil in the area and can not be repeated elsewhere in the country. The pre onset land preparation allowed the farmer to take advantage of the late September shower to get their entire crop established. Eighty percent of the area was thus planted within the first 10 days following the initial rain (Table P2). This was the fastest overall crop establishment in the island. It would therefore, appear unnecessary to expedite this procedure with alternative technology such as pre-rain sowing and waiting for rains. The subesequent favorable rains made the crop exceptionally good for the area with an overall average yield of better than 3 t/ha using the generally low yielding but, stress the tolerant variety 62-355.

No rainfed Yala crop was grown except experimentally. The general Yala practiced is to graze the stable with animals brought down from the Jaffna peninsula for the purpose and concentrating some intensive vegetable cultivation whenever water is available from either streams, ponds or dug wells.

Experimental Trials

The field experiments during Maha concentrated or varietal evaluation and fertility. The variety evaluation consisted of a ten variety trial replicated on different land elements and a revolving replica trial on

12 farmer fields with each farmer growing two varieties strictly under farmer management. This was a good innovative approach but became difficult to analysis. In all the variety work was aimed at examing stability over the micro-environment. The results (Table P3) showed the mediam height varieties to be both higher yielding and more stable across micro-environments. The tall varieties didn't have the yield potential while the short varieties were less stable over micro-environment. The results of the variety trial were statistically consistant with the revolving replica farmer managed trials (Table P4). This again showed the tall varieties significantly low yield, and mediam statured varieties more stable. Unfortunately the favorable rainfall for Maha prohibits clear conclusions from being derived. This will have to wait until there is Maha rainfall as adverse as this was favorable. However, there is justification to concentration on mediam statured varieties. In the farmer managed variety work a weed interaction was picked up that showed an appreciable return to the farmer hand weeding effort. The regression developed was:

$$\text{Yield (kg/ha)} = 2481 + 6.27 \text{ (hours weeding)} \quad R^2 = 0.70$$

and

$$\text{Yield (kg/ha)} = 4422 - 601 \text{ (weed index)} \quad R^2 = 0.76$$

in which the weed index was a subjective rating between 1 and 5. The fertilizer trial was a time vs rate of N trial (Table P5). This trial showed significant difference only with control, so that time vs rate had no effect as levels between 60 and 70 kg/ha. Apparently there is no loss of N from heavy early application. This is probable because any leaching is stopped by the clay in the sub soil, and remains available to the rice.

The conclusion from the Maha rice effort would appear, that the things to concentrate onwould be finding a more suitable variety for the area and developing better methods of weed control.

The Yala experiments run into severe difficulties. Five upland crop garden were established using sesame, green gram, cowpea and groundnuts. Each garden was subdivided with half dibbed into the straw and the other half planted after one land preparation with time tiller on a four-wheel tractor. The yala season started on exceptional note with a good heavy shower in early March that was twice "average" March rains (Table P1). Despite this good start only two of the five gardens provided a harvestable return. It was therefore, necessary to conclude that Yala potential in the Manawari lands was questionable because of too harsh an environment. It would only be the extreme exceptional Yala season that would have sufficient rains for a rainfed crop. The best land use would be to allow the animals to graze, as there gain or loss of weight would directly depend on the rainfall. Unfortunately the farmers get little return from the boarding animals. The other alternative would be to encourage the development of the irrigated vegetable patches surrounding streams, ponds or wells. This may require developing a credit scheme to cover the cost of building well and obtaining an appropriate size small lift pump.

Table P1. Paranthan rainfall distribution evaluation by crop year (m.m.) plus 1978/79.

Season month	Maha					Yala						
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.
$\bar{X}$ 22 years	55.6	227.0	359.3	329.1	82.6	65.1	32.9	83.0	68.6	13.1	28.5	39.3
Std. Dev.	51.3	108.7	195.1	231.6	99.4	97.6	31.7	48.8	51.1	20.8	43.3	56.9
Coef. Var.	92.2	47.9	54.3	70.4	120.3	149.8	96.4	53.4	74.4	158.7	152.0	144.7
1978-79	38	258	374	528	30	24	61	0*				

* Through April 20.

Table P2. Paranthan crop establishment for Maha 78/79.

Month	September						October			
Week	35	36	37	38	39	40	41	42	43	44
Week increment %	0.54	0	2.40	0.54	10.31	58.99	9.05	13.25	3.35	1.56
Accumulation %	0.54	0.54	2.94	3.48	13.79	72.78	81.85	95.08	98.43	100
Rainfall (mm)	0	0	0	0	15	0	0	166	84	297

Table P3. Paranthan variety trial results across land elements - Maha 78/79.

Variety	Land Elements			$\bar{X}$	SD	C.V.
	Sandy w/H_2O	Clay w/H_2O	Clay w/H_2O			
	kg/ha					
Tall Varieties						
62-355	2920	2500	1840	2420 a	544	22.5
Bg 75-148-1	1300	2640	1340	1760 a	762	43.3
H4	1080	2640	2120	1947 a	794	40.8
Karuppan	1900	2980	2480	2453 a	540	22.0
Medium Varieties						
Bg 76-7283	4040	3820	2760	3540 b	684	14.3
Bg 401-1	3800	5340	3040	4060 b	1172	28.9
Short Varieties						
Bg 33-2	3260	3780	2380	3140 b	708	22.5
Bg 94-1	2800	4860	2200	3287 b	1395	44.4
Bg 304-2	3040	4400	2480	3307 b	987	29.8
Bg 280-1	3120	5040	2780	3637 b	1219	33.4
$\bar{X}$	2726	3800	2342	2956		
SD	994	1077	497			
CV	36.5	28.3	21.2			

2 way analysis of variance

F value varieties = 5.59** df - 9/18
F value land element = 18.1** df = 2/18

LSD varieties 1586 kg/ha
a, b indicate significance from highest mean.

Table P4. Farmers managed revolving replica varietal investigations at paranthan Maha 78/79.

Farmer	Varieties					
	62-355	75-148-1	76-7283	280-1	401-1	94-1
	kg/ha					
1	-	2620	-	3400	-	-
2	2840	-	-	-	-	3380
3	-	2440	-	-	3790	-
4	-	-	3250	2580	-	-
5	2000	1000	-	-	-	-
6	-	-	-	-	4260	4480
7	-	560	4200	-	-	-
8	-	-	4210	-	-	4680
9	-	-	-	3420	-	3650
10	1900	-	-	-	2220	-
11	-	-	X	-	X	-
12	X	-	-	X	-	-
$\bar{X}$	2247 a	1655 a	3887 b	3133 b	3423 b	4048 b
SD	516	1029	551	479	1068	630

F value 5.5**

LSD 0.05 = 1267.1

a, b indicate significant as compared to the highest mean at 5% level.

Table P5. Fertility trial of time and rate of N at Paranthan Maha 78/79.

Treatment	R 1	R 2	R 3	$\bar{X}$
0-0-0-0	1490	828	1759	1359
V1-15-0-40	2877	3279	2732	3043
0-15-15-40	2561	3105	2422	2696
0-20-20-40	2939	2981	2111	2677
0-40-0-40	3560	2940	3208	3236
15-0-15-40	2277	3012	2546	2615
20-20-0-40	2442	3042	1821	2436
$\bar{X}$	2592	2777	2371	2580

Treatment represent N applied basal, 2,4,6 weeks after sowing.

F value 5.92**

LSD - 763

Control only one really significantly different.

Report on Cropping Systems Programme - 1978

Regional Agricultural Research Station

Bandarawela

Around the elevation 1300 m there is about 5000 ha of rice land in terraced mountain slopes and valleys. Of this about 500 ha is rainfed and the rest is irrigable through stream diversions, which could be year round or on an annual rotational basis.

The main rice growing season is January through June. However a small area, scattered through out the up Country Intermediate Zone, is planted to paddy around July, August.

Mostly raw milled red rice is preferred for consumption in the up country intermediate zone. So much so that 91% of the total rice lands is put under red rice, H4 being the most popular variety, since it is best suited for raw milling, and constitutes 87% of the total land area under paddy in the up country intermediate zone.

It is reported that 50% of the paddies are tilled manually using mammoties, 49% by buffalo and 1% using two wheel tractors. It is also reported that only 1% of the rice land is broadcast sown and the rest transplanted. Also it is said that only three fourths of the paddies are weeded. Of the rice fields weeded two thirds is performed manually and the rest using rotary weeders.

Soils and Landscape

The soils are predominently red yellow podzolics and the landscape could be broadly classified into the following categories.

1. Gently rolling subdued landscape with very gently rolling narrow valleys. It could be considered that the drainage would not be very good and water supply not assured.

2. Moderately broad gently sloping valleys with alluvial fill at the foot of the mountains. Uplands may be terraced with assured irrigation and good drainage.

3. Steep slopes with high relief. These areas may or may not be well drained especially when a perennial contour channel is situated above the land under consideration.

Existing Cropping Pattern

Farmers op . te in paddy fields, homesteads and highland "Hena", the latter is ..ainly under rainfed conditions. Field transplanting of rice is done mainly January through March as the low temperatures experienced from January to March causes sterility if rice is planted earlier than this. The maximum and minimum temperatures experienced in this region fluctuate at a critical level (Figure 1). Figure 1 illustrates the annual (1978) maximum and minimum temperatures and the cropping patterns adopted by the farmers in the prevailing environmental conditions. It is obvious that later planted (February, March) rice would yield higher if wind is not a problem as the other environmental factors are ideally suited for rice and flowering does not coincide with the yala rains (Figure 1). However in wind swept areas rice is always planted during early January and harvested around late May before the blowing sets in of during the initial stages of the blowing period (Figure 1).

Subsequently in the rice lands a crop of vegetable is cultivated, usually potato, bean or cabbage. In the wind affected areas since the vegetable is harvested early a second crop of vegetable would sometimes be grown, in the same land. Generally during October through December paddy fields are kept fallow due to intense rain and the restrictive cool temperatures experienced.

In the "Hena" during Maha vegetables (except potato) are cultivated with the onset of the monsoon. The farmers in this region do practice various types of mixed cropping in the belief that if one crop fails some other would succeed. Bean, corn, brinjal, cabbage, pumpkin etc. are grown in various combinations in the hena. It is a common feature to plant potato in hena around December, January and the harvested tubers (suitable sized) are used as seeds for paddy field planting during June/ July.

Present State of Socio-economic Conditions

Rice in the upcountry is mainly grown for consumption and vegetables furnish cash income. The most popular vegetables grown in this region are potato, bean and cabbage. These crops are cultivated amidst immense difficulties and problems such as recurrent low prices, overnight fluctuations of vegetable price, high costs and unavailability of inputs during the time of peak demand, unsatisfactory marketing avenues, exploitation by middlemen, poor accessibility from the villages to the main roads and nearest town, unsatisfactory modes of transport and perishability of produce. The following factors are the major determinants contributory to the economic set up in the up country intermediate zone.

1. Land Holdings:

Generally in the up country land holdings are very small as a result of fragmentation of limited land area. Farmers may operate one or more categories of the following types of land which may be cropped in various ways.

i. Paddy land
ii. Highland - "Hena"
iii. Homestead

2. Labor Use:

Most of the farm operations are performed manually as the use of machinery is restricted by the terrain and the size of land holdings. Family labor and exchange labor constitutes a major component in farm operations.

3. Farm Expenses:

Labor, materials, rent, hire charges, transport, commission etc are the primary components of farm expenses and this is in turn directly proportional to the cropping intennsities.

4. Farm Income:

Vegetables constitute major the share of farm income. Cash returns vary depending on the nature of the crops grown and the cropping intensities which is in turn governed mainly by the availability of irrigation water. It has to be noted that high gross returns may not furnish greater net income.

5. Credit and Indebtedness:

Even under high levels of management with good yields there is a high percentage of borrowing with the vegetable farmers due to various reasons. Credit providing organizations in the up country are:

i. Multi-Purpose Cooperatives
ii. Rural Banks
iii. National Banks
iv. Village Merchant - "Mudalali"
v. Commission Agents
vi. Neighbors and Relatives

It appears that there is a close link between the marketing agency and the source of credit as the cultivator is in need of regular credit which is obtained from the marketing agency and he is obliged to sell his produce through the same marketing agency.

6. Handling and Transport:

There is no properly organized mechanisms for the transport of vegetables produced in this region. Transporting is done mainly in lorries. The vegetables are packed in the most unscientific manner and transported to the primary outlet i.e. Colombo and these remain within the confinement of the lorry for about a day which enhances further deterioration resulting in heavy losses. As high quality do not obtain a premium price strict grading and proper handling and transport methods are not being adopted at present.

7. Marketing:

The vegetable farmer operates in an atmosphere of uncertainity as he does not really know as to how much he would get through the sales of his produce until the marketing agent informs him of his returns after disposal of the produce in Colombo. Also the farmer does not accrue maximum benefit as this has to go through several intermediaries who in turn make a profit. The following channels are available for vegetable marketing.

i. Commission Agent
ii. Multi-Purpose Cooperatives
iii. Marketing Department
iv. Marketing Federation
v. Village Fair
vi. Village Merchant - "Mudalali"

8. Price Fluctuation:

Due to the perishable nature of vegetables produced in the up country drastic price fluctuations are experienced. Prices fluctuate dramatically between months of the year, between days within a month and even hours of one day, (Figure 2).

Cropping Systems Programme - Up Country Intermediate Zone

The cropping systems programme in the up country intermediate zone is executed in a highly dynamic physical environment (Figure 1) and a very complex socio-economic environment. As we are dealing with highly perishable vegetable crops like cabbage, bean, potato etc. where there is no steady price (Figure 2), the alternate cropping patterns designed should be geared to maximise profitability within the fluctuating market.

The main objective in this cropping systems programme at present is to introduce two crops of vegetables after the rice. Altogether three crops per year in the same land. This would be made possible by

introducing short aged cultivars of rice earliest planting (within the critical temperature regimes) and by cultural practices. There is a whole gammut of vegetable crops with varying age classes (Table 1) available which could easily fit into cropping patterns. Also a variety of high yielding short aged cultivars of rice suited for this region is available to supplement the cropping pattern testing.

Results of 1978

Socio-economic Baseline Survey

The study site is a village called Idama situated in the Uva Paranagama eloctorate and is about 30 km away from Bandarawela. This village is composed of 116 farm families. A bench mark socio-economic survey was conducted in July, 1978, where 105 farm families were interviewed. The results reported on vegetable cultivation is that of the previous Yala season (Yala 1977). Salient points of this study is discussed below.

1. Average Family Size:

   The average family size in this village was 5.35 (individuals over 12 years of age).

2. Land Holdings:

   The farmers in this village operate on one or more of the six categories of lands mentioned in Table 2. This table also shows the total extents of lands in the village operated by the farmers. It is observed that 93%, 92%, 93% and 43% of the farmers operate lowland irrigable paddies, three year puran, hena and homestead respectively. Only 8% and 9% of the farmers respectively operate lands outside the village and rainfed rice fields.

   A unique feature in the up country and also in this village is the small sizes of the land parcels. Even though some farmers own large extents (more than 1 ha) individual holdings varying in extents from 0.025 ha are scattered in different parts of the area. It is seen that there 82, 0.10 ha holdings and 37, 53 and 24 parcels of 0.05 ha, 0.20 ha and 0.30 ha, respectively. It was also observed that a single farmer operate more than one paddy field (Table 3) ranging from zero to 6 per farm family. The number of holdings operated by farm families is of importance especially as regards to the distribution of labor.

3. Labor Use:

In this village majority of the farm operations are performed by family labor and exchange labor. Only a very small amount of hired labor is used. It was seen that most of the hired labor used was for land preparation in paddy and potato and harvesting of paddy (Figures 3 and 4). The categories of labor used for various operations in paddy and potato production is also indicated in those figures.

4. Crop Area and Average Yield:

It was observed that in 1978 of the 48 ha of paddy land in the village 38 ha were planted to rice and 7 ha to vegetable crops. The vegetables were cultivated in the well drained lands. It should be noted that the three year puran lands were also planted to rice as 1978 was the year of water issue to these paddies. Table 4 shows the extent of land cultivated to various crops and their reported average yields.

5. Farm Income:

The total gross income, of the sample under investigation, earned through different crops is shown in Table 5. This shows that rice gave the highest gross income. However potato furnished the highest cash income to the farmers. The high figure of consumption (38%) in the hena potato is due the fact that a certain amount of the hena potato is retained as seed material for yala planting in the paddy fields.

Agronomic Investigations

The experiments conducted during this season was designed mainly to understand the problems in farmers' fields, and the two most popular vegetables, potato and bean were chosen for this purpose. Several varieties of potato and bean were tested in two drainage members of the soil since soil drainage was considered an important factor.

1. Varietal Performance of Potato as Influenced by Soil Drainage

This experiment was conducted to evaluate the performance of the varieties Coliban, Sequia, Desiree and Deleware in moderately well drained soils (gley layer found below 100 cm) and imperfectly drained soils (gley between 75 to 100 cm).

Results

Sprouting of Mother Tubers and Tuber Yield

The mean percentage sprouting of mother tubers planted was significantly superior in the imperfectly drained soils over that of the well drained soils, (1% significance) (Table 6). However there was no significant differences in the yield of marketable tubers between varieties or the soil drainage members despite the fact that there were significantly greater number of plants in the imperfectly drained soils. At this instance it must be noted that a large percentage of rotten tubers had to be discarded while estimating yields, and this component was negligible in the well drained soils. So it may be that a higher tuber yield could have been obtained in the imperfectly drained soils if rotting was minimal which could have been achieved by proper drainage. Further investigations are proceeding in this line.

Size of Seed Potato and Yield "Conversion"

"Conversion" in this text means the ratio of potato tubers produced per unit weight of mother tubers planted. This factor is considered important due to the very high cost of seed potato. The varieties used in this experiment had different sized tubers (Table 7) and indicates that the tubers of Coliban and Sequia weighed twice as that of Desiree and Deleware. The conversion factor of Desiree and Deleware are significantly superior to Coliban and Sequia showing that even with smaller seed tubers equally comparable tuber yields could be obtained.

2. Varietal Evaluation of Bean Influenced by Soil Type

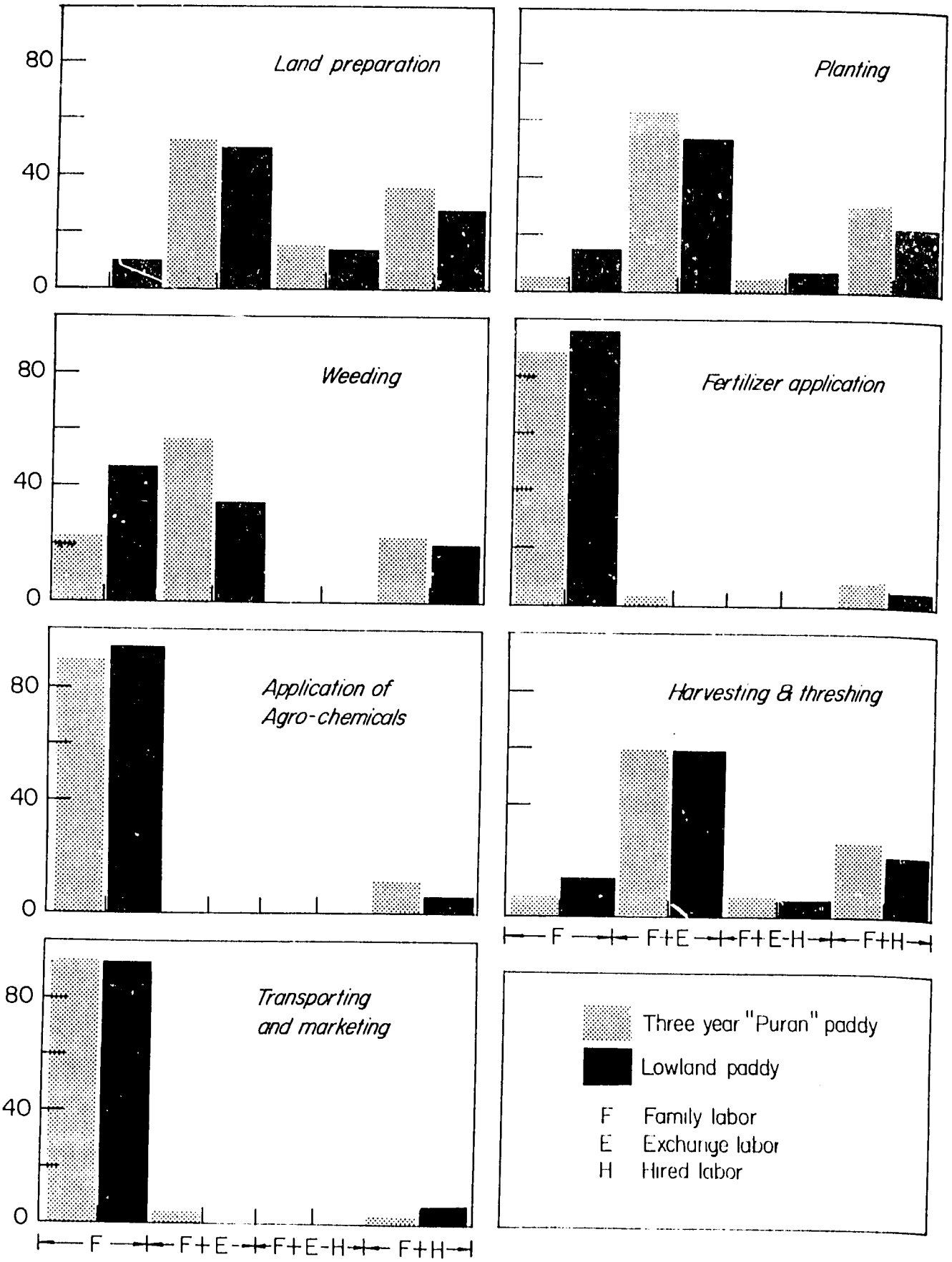
Four varieties of bush beans Top crop, Wade, Canadian wonder and Contender were tested in moderately well drained soils and imperfectly drained soils. In the imperfectly drained soils the crop suffered severely due to root and collar diseases, especially in soils where the gley layer was found around 60 cm, resulting in high yield depressions. Consequently a two to four fold yield increase was obtained in the moderately well drained soils (Table 8).

Angunukolapelessa

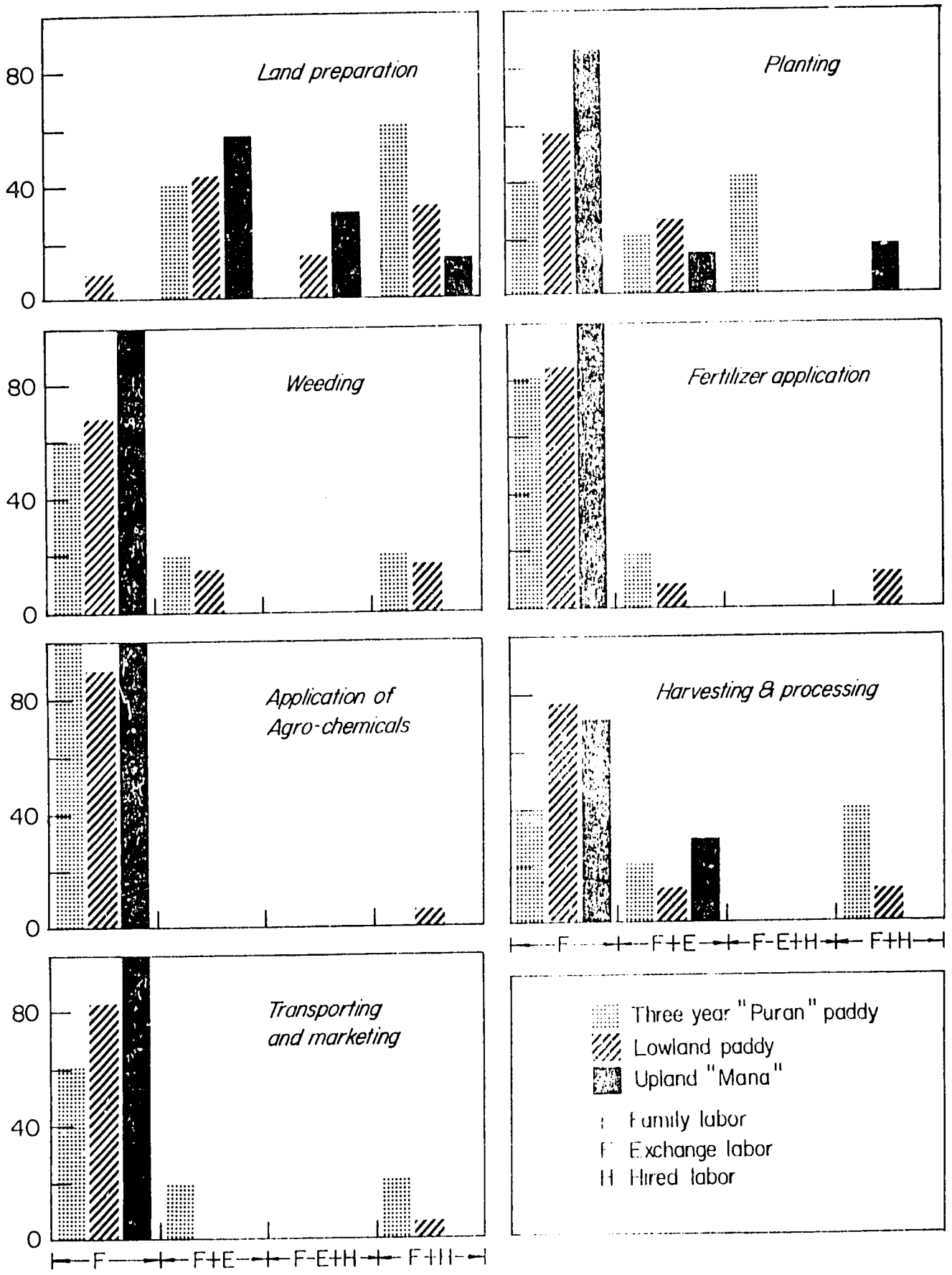
Our Cropping Systems Program at Angunukolapelessa covers the Udawalawe Development Scheme which shall develop 500,000 acres of land for irrigated agriculture at its completion. The research officer attached to Regional Research Station has acquainted himself with the environment having completed the baseline survey. The program is still at initial stage of development. Few trials were conducted within the research station during the last Maha season (1978/79). They were mostly varietal screening with respect to paddy, and also cotton varietal experiments too were conducted in addition to green gram and few other introductory crops. During the coming Maha season this program is expected to mature into a cropping systems program with farmer participation.

Mannar

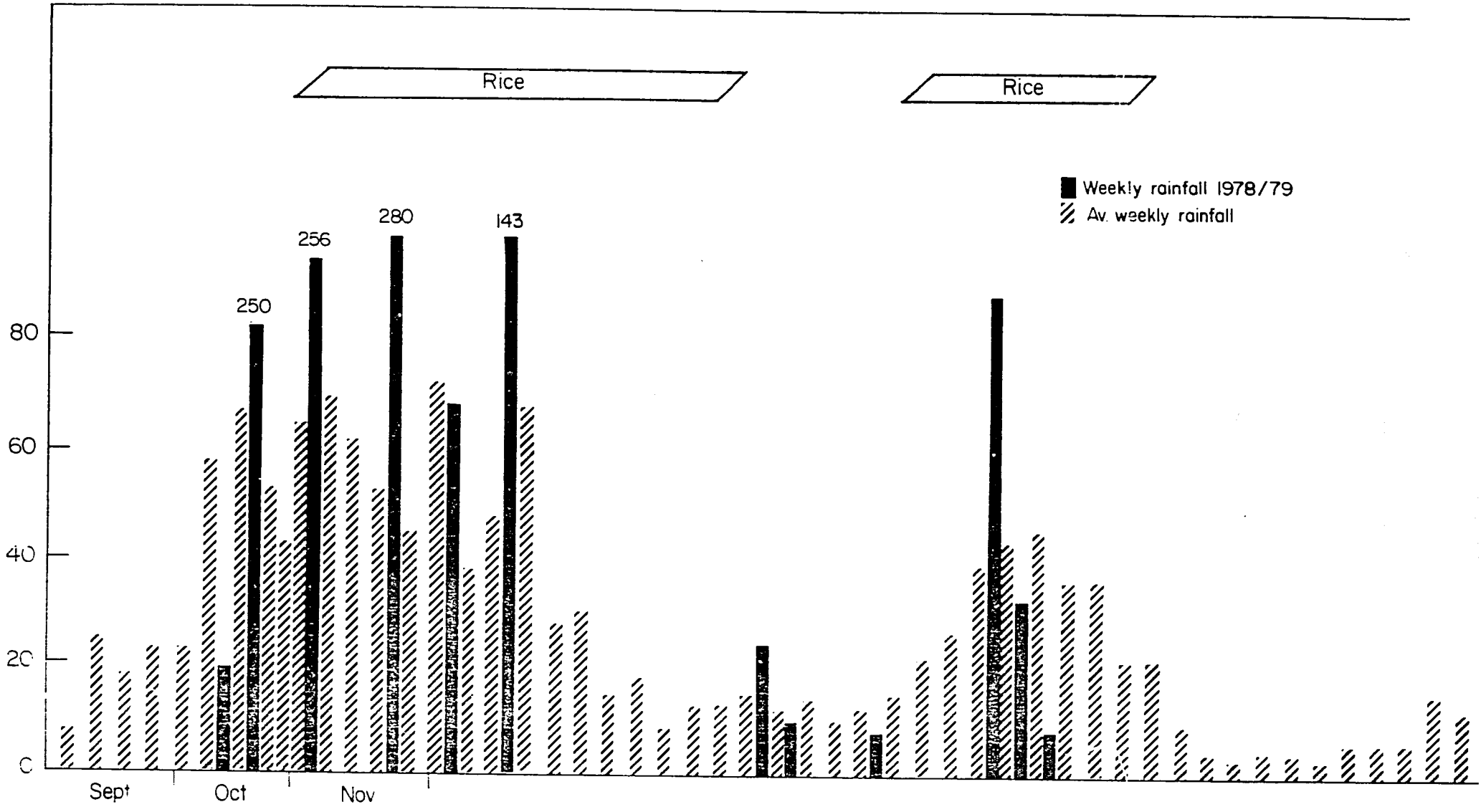
This is still in an infant stage, isolated in a major rice growing area. The rainfall distribution is much similar to Paranthan. However, the rainfall is supplemented by a large network of tanks. The general cropping pattern for the area is rice in Maha followed by another crop of rice in Yala. But the Maha rice crop is grown below the tank whereas the Yala crop is grown in the tank bed itself. There is also a considerable amount of deep water utilization using tube wells. Most of these tube wells are a problem during the dry spell as the salinity level of water goes up during this time of the year. Our program at this location is geared towards economising tank water by advancing the date of planting in Maha so that the rainfall is tapped to the maximum. Also well salinity monitoring program is being undertaken in order to study and understand the danger involved since this is an alarming rate of expansion of drilling tube wells. During the last Maha season varietal testing program with paddy cultivars was conducted in the nearby government farm. Highland crops program is in the field during the Yala season. Farmer Cooperator program will start in the oncoming Maha season.



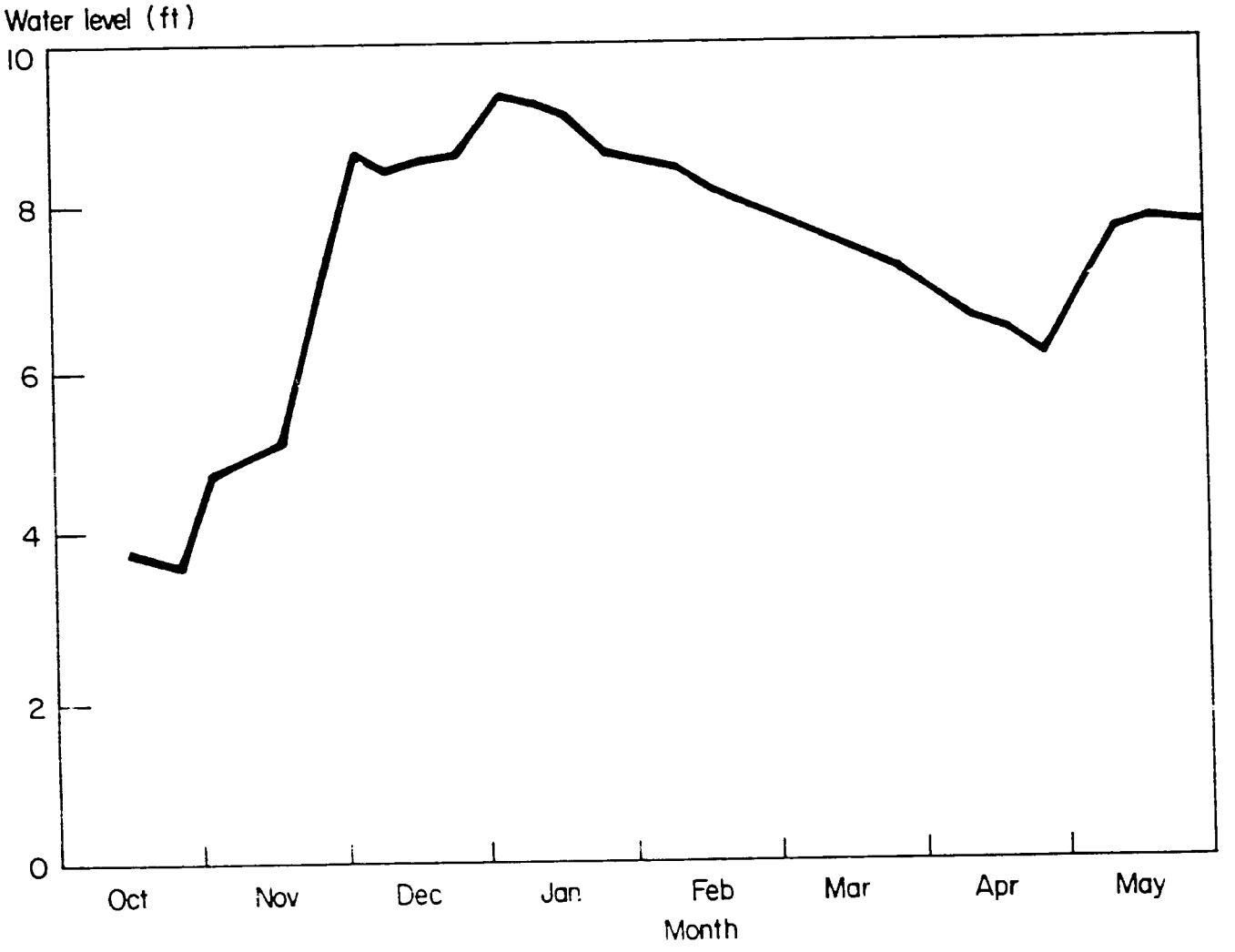
Categories of labor use by operation in Puran and lowland paddies (percentage of farmers) for paddy cultivation.



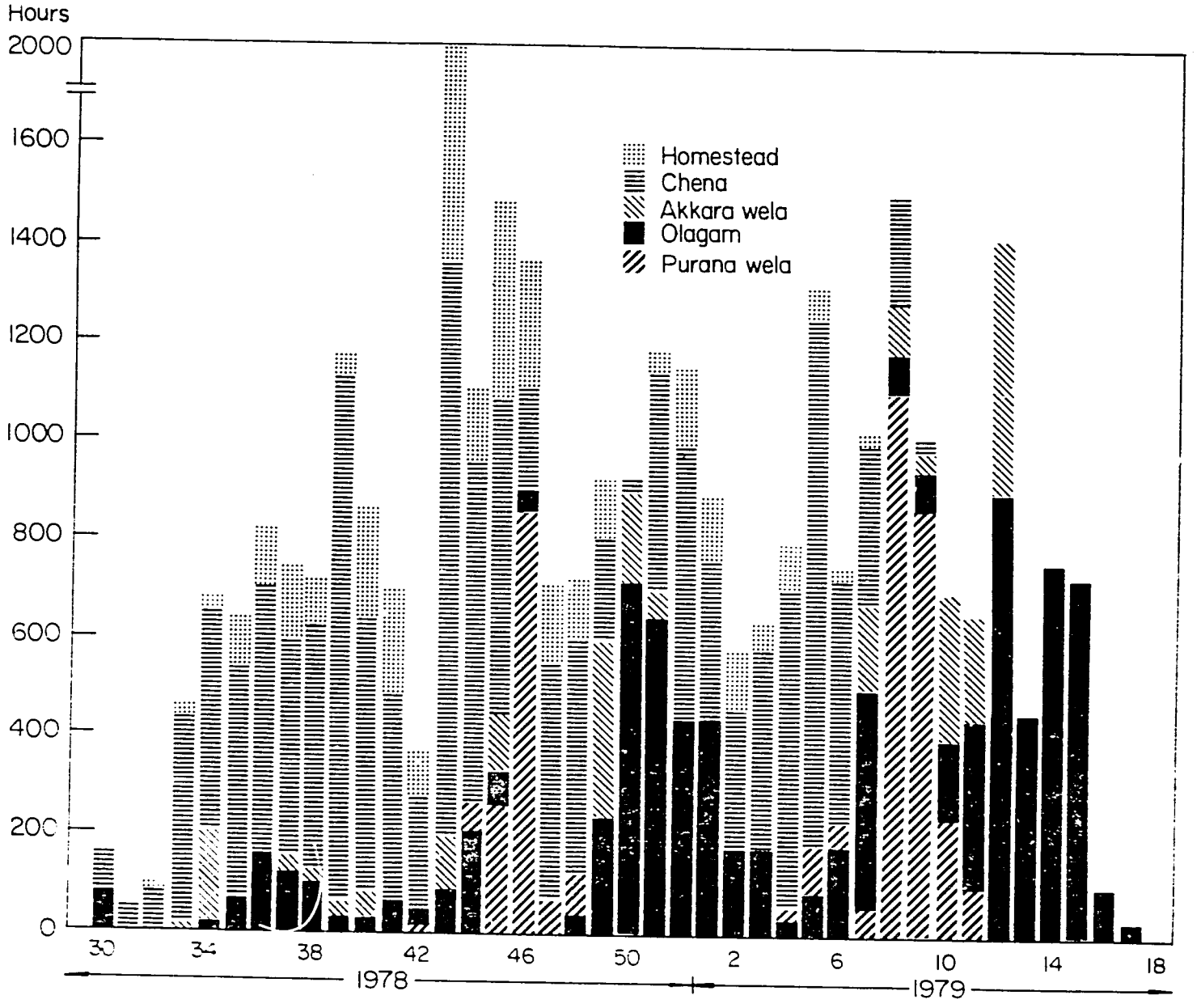
Categories of labor use by operation in Puran paddy, lowland paddy and upland "Hena" for potato cultivation (percentage of farmers).



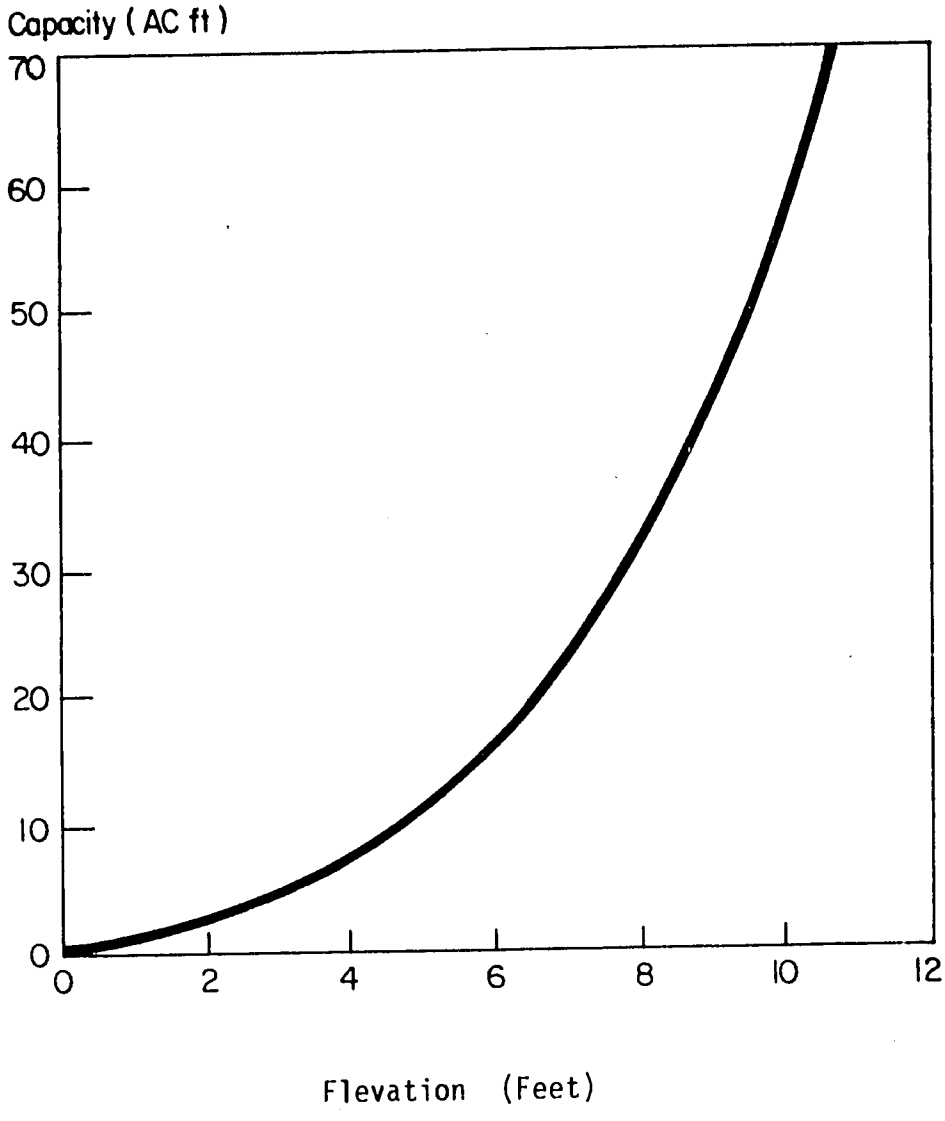
Cropping pattern tested at Walagambahuwa 1978/79 year.



Water level of Walagambahuwa Tank, 1978/79.



Weekly labour use Maha 78/79 Walagambahuwa, 20 families.


Capacity (AC ft)
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
Flevation (Feet)