Analysis Report of the First Benchmark Survey of Mahaweli System C Upgrading Project

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Acknowledgements

This report is the outcome of a project initiated and funded by the Japan Bank for International Cooperation (JBIC) to carry out the analysis and interpretation of the datasets of the first benchmark survey on the Mahaweli system C upgrading project. IWMI acknowledges the machine readable datasets kindly provided by the consultants of Nippon-Koei who carried out the survey. IWMI is grateful to JBIC for the funds provided for this analysis and the constant support during the period of the consultancy.

Analysis Report of the First Benchmark Survey of Mahaweli System C Upgrading Project

Introduction

The major objectives of the Mahaweli System C upgrading project are:

1. to increase the productivity of the existing irrigations systems
2. to strengthen the capability of farmers' organization to enable them to manage and maintain the irrigation system, and
3. to rectify defects of existing irrigation system

The project includes major activities to:

1. Strengthen Farmer Organizations, including
   - Restoration of Distributary (D) and Field (F) Canals
   - Creation of post-harvest Storage Facilities
   - Provision of improved access to Credit Facilities
2. Agricultural Management Training
3. Rehabilitation of infrastructure, including:
   - Trans-basin canal
   - Main and Branch Canals

This report presents an analysis and geo-spatial presentation of the results of the Baseline Survey implemented by the main consultants, Nippon Koei during the period May to June 2001. Following data entry by the consultant's staff, IWMI received copies of the data in November 2001 on CD.

Location and background to MASL System C Upgrading project

System C is situated in the east-central part of Sri Lanka on the right bank of the Mahaweli Ganga, with a gross area of 66,700 ha of land of which 24,100 ha is supplied by gravity irrigation. There are approximately 25,500 settler families within the scheme command area engaged in agriculture, residing in villages of settlement areas varying from 20 to 30 homesteads. The command area lies between Mahaweli River and the main canal linking a series of large and medium size reservoirs along the canal. These reservoirs receive surface run-off from their own catchments, in addition to augmentation flows in the canal. This design, adopted in the original development of the irrigation system, enable the minor reservoirs to provide dual functions in receiving return flows and enhancing the flexibility of the water delivery in the canals.

System C crosses the boundary of the intermediate and dry climatic zones, with project area (Zones 3-6) located in the dry zone. The scheme is divided into six zones, numbered 1 to 6 sequentially, for the purposes of management and administration. The Zone 1 area is supplied by an existing irrigation system and is not included in the management of the Mahaweli Authority of Sri Lanka (MASL) operated System C.

The Accelerated Mahaweli Development Programme (AMDP) commenced in 1980 using GOSL funds with financial assistance from EC, IDA, OECF and Kuwait Funds. The development project was substantially completed by the end of year 1994. Water is diverted from Mahaweli Ganga through Minipe Right Bank Transbasin Canal to Ulhitiya – Rathkinda twin reservoirs. The Rathkinda main canal (length = 17.9 km; design discharge = 50 m^3/s) delivers irrigation to Zones 3 through 6, while Zone 2 irrigation is delivered through the Ulhitiya main canal (length = 10.9 km; design discharge = 11 m^3/s) The canal network of branch, minor branch, distributory and field canal totals about 1900 km to the developed areas of System C.

Problem Statement

The construction works of the project facilities in System C were substantially complete in 1994. System C made considerable positive impacts on the local and national economy, creating nearly 40,000 permanent jobs and increasing food supply by 140,000 tons of annual paddy production and other crops (Terms of Reference of Mahaweli Upgrading Project – MUP). The Upgrading Project was designed to address several aspects of the project not completed during the original development phase and to overcome deficiencies in the infrastructure and operations identified during commissioning. The MUP was designed to achieve project sustainability and operations including increased participation of farmers in management leading to improvements in the livelihoods of the local population.

In 1989, when approximately 75% of land and irrigation development originally planned was complete, the Model Unit Programme (MUP_1) was introduced to assist farmers to organize themselves for O&M of on-farm irrigation and agricultural activities. It was intended that this organization would be the base for increasing farm income by enhancement of productivity of paddy cultivation and crop diversification. MUP was conducted by MASL with the assistance of the Japanese Consultant financed by OECF (now JBIC) from April 1990 to July 1994. MUP_1 showed models for farmers' organizations in terms of F-canal rectification works and O & M of F- and D-canals, enhancement of paddy production, crop diversification, group purchase & marketing and group cultivation credit with technical guidance.

After all the works, under the OECF Loan for the System C development including the MUP_1 activities, were completed in December 1994, the project completion report was prepared by OECF summarizing the MUP_1 activities. The report identified concerns about the self sustainability of the farmers' community at System C. Consequently, a Special Assistance for Project Sustainability (SAPS) study was carried out to evaluate the sustainability of Farmer Organizations' activities in connection with the on-going Mahaweli Restructuring program.

The Mahaweli Upgrading Project (MUP) that, initiated in 2000, is being undertaken by MASL to implement the key recommendations made in the SAPS report, including the establishment of an effective Benefit Monitoring and Evaluation System (BME).

Benefit Monitoring and Evaluation (BME) at System C

The overall objective of BME is to monitor and evaluate the changes taking place due to implementation of the improvement project, and other interventions that occur subsequently, at Mahaweli System C. The changes will occur over time during the project implementation and in the post-project period. Any BME system must be able to capture both aspects of the expected improvements. Prior to implementation of the Benchmark Survey, reported by Nippon Koei (Nippon Koei, 2001) IWMI recommended that project implementation agencies monitor recurrent changes occurring during the project implementation period as, only then, could the project detect whether the impacts produced were heading towards the desired objectives. Correct and timely diagnosis of the impacts of interventions is a major factor in the attainment of the long term sustainability of project induced changes. The BME techniques proposed by IWMI to the Project Steering Committee were designed to provide detailed feedback on these aspects throughout the project period and to provide the basis for continued M&E in the post-project period.

Survey methods proposed

To implement an effective BME system for the System C Agricultural Improvement project IWMI proposed three types of survey (IWMI Proposal 2000). Firstly, to establish the baseline conditions, using traditional socio-economic and socio-technical surveys. These surveys will be the basis for evaluation of the medium to long-term impact of the project interventions. IWMI has recently developed and tested rapid survey techniques for monitoring changing perceptions in rural communities. These techniques are recommended to provide recurrent feedback to project implementation teams, funding and government agencies. Finally, recurrent socio-economic and socio-technical surveys are recommended at the project mid-term and at project closure. These surveys will follow-up the benchmark survey conducted at the start of project implementation, enabling evaluation of project impacts. These surveys could be repeated at a later stage to evaluate the longer-term impacts and sustainability.

The BME system, implemented by Nippon Koei the project consultants, incorporated only the traditional socio-economic and socio-technical survey components for the baseline and subsequent surveys. The survey tools utilized benefited from inputs by the IWMI team during the design and pilot testing phase leading to the collection of the project baseline survey discussed below.

The purpose of a baseline survey is to establish the pre-project conditions, thus enabling the evaluation of changes brought about by project activities. In addition, such surveys can help the project implementation team to fine tune interventions to address the specific conditions pertaining in different areas of the project. To achieve either objective it is important that the benchmark is established before too much activity has occurred in the field. It was recommended that an independent group should implement the benchmark survey, however the consultancy services included implementation of the BME system by the main consultant. Therefore, with design and testing assistance by IWMI, Nippon Koei recruited and trained local school teachers (N-K 2001 pg 4) as enumerators to interview the selected sample of farmers. Data processing and basic analysis was undertaken by the main consultant's staff. JBIC commissioned IWMI to analyze and interpret the data collected by Nippon Koei, which

is presented in this report. The report should be read in conjunction with the Nippon Koei Baseline Survey Report (Nippon Koei 2001).

- **Socio-Economic and Socio-Technical surveys**. A purpose designed questionnaire was administered to about 300 to 400 farmer households to establish a quantitative measure of the economic and technical status of the rural population in the project area. Samples of the rural communities were selected in six administrative blocks in System C, and the methods used to ensure representative samples of each community are discussed below.

Survey Methodology Adopted

The method selected for the baseline data collection was the administration of a purpose developed questionnaire of farmer households. The draft questionnaire was developed by Nippon Koei and reviewed by IWMI during December 2000. IWMI made specific suggestions for modifications to the questionnaire, which are reproduced as annex 1.

Samples of households in fifteen Units (the Unit is the lowest administrative boundary of Mahaweli management system) located in zones 3-6 were selected as representative of the characteristics of the MUP area. These units were selected to be representative of socioeconomic and physical variations in the intervention area. A random sample of 20 households was selected in each of the selected units for administration of the survey, giving a total sample size of 300 farmer households. The final Questionnaire Template used by the field enumerators is given in (Nippon Koei 2001).

The questionnaire was designed to capture farmer perceptions on the existing irrigation infrastructure, agriculture, socio-economic and local institutions supporting irrigation and agricultural activities. A pretest was done to fine tune the drafted questionnaire and data collection was undertaken with the revised questionnaire. To assist the consultants to test the questionnaire in the field IWMI mobilized a team of experienced enumerators to pilot test the questionnaire in early 2001. A brief commentary on the pilot test was prepared and is reproduced in annex 2.

Nippon Koei employed 30 school teachers, drawn from schools in the System C area to be trained as enumerators to conduct the field interviews. After trial interviews, the final version of the questionnaire was prepared and the survey was carried out during the period of latter part of May to end of June 2001; collecting respondents views on agriculture performance in Maha and Yala seasons in order to capture seasonal (temporal) and spatial variability of agricultural performance in System C.

The Nippon Koie completed data collection, encoding and quality controlling data entered to Excel spreadsheets, and the production of the Baseline Survey (2000 Yala and 2001/2001 Maha) report (Nippon Koei 2001). Copies of the processed data were made available to IWMI which form the basis for this report.

Nippon Koei (2001) presents a detailed description of the field study methodology, and thus only a brief overview of the sampling procedure, field methods and data entry is presented in this report.

The survey method selected by the consultant was interview by trained enumerators, recruited temporarily to undertake this survey. The work flow for the survey is illustrated in Figure 1.

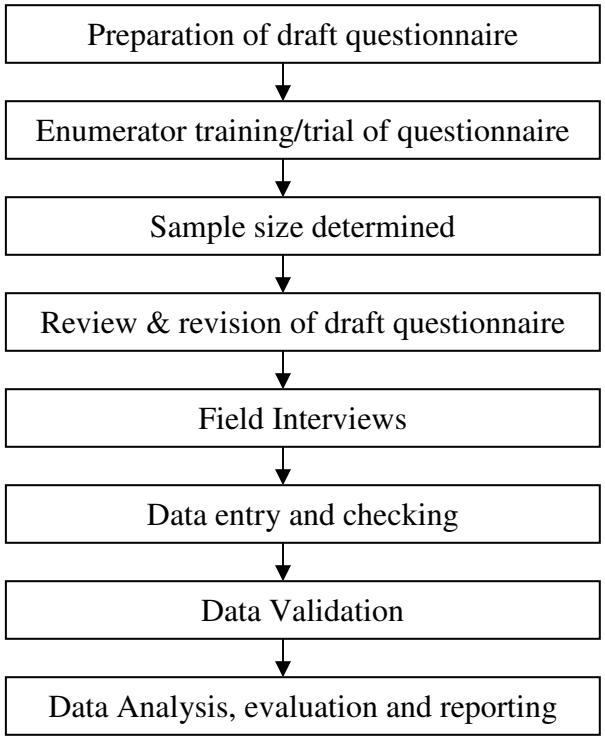


Figure 1 Survey and processing work-flow (after Nippon Koei 2001)

Units in these zones (3-6) were identified to provide adequate representation of all the units and the expected spatial variability (Table 1). Twenty sample farmers were randomly selected from each unit for interviews. Therefore 300 samples were interviewed to collect data on demographic, agricultural and financial aspects. In addition, data on existing irrigation systems and farmer organizations were collected to test the objectives of MUP mentioned above.

Table 1 Units selected for survey

Unit	Zone	Unit	Zone	Unit	Zone
Ihalagama (304)	3	Salpitigama (403)	4	Muwagammana (411)	4
Kelegama (305)	3	Bakmeedeniya (404)	4	Sooriyapokuna (501)	5
Henanigala South	3	Paludeniya (404A)	4	Nikawathalanda (503)	5
Bambarawana (401)	4	Damanewewa (405)	4	Veheragala (602)	6
Serupitiya (402)	4	Rankethgama (407)	4	Kanichchigala (602)	6

Administrative setting

Figure 2 shows the location of the System C and identifies the six management zones in the project area. Administratively the system is within the five administrative districts of Ampara, Badulla, Kandy, Matale and Polonnaruwa. The Mahaweli Ganga flows from south to north to the west of the command area.

Zone 1, System C is managed by Irrigation Department of Sri Lanka whilst the remaining five zones are managed by MASL. Zones 2 and 4 are subdivided into two and five management blocks respectively, giving a total of 11 management blocks in the scheme (Table 2) eight of which are in the area covered by the current survey.

Table 2 Sub-division of Units by management blocks

Zone	No. of blocks
1	1
2	2
3	1
4	5
5	1
6	1

Figure 3 shows the management blocks in each zone. Figure 4 illustrates the diverse land use in the project area. The project is largely classified as irrigable; however a considerable extent is classified as conservation forest. Plantation forests are found in all zones other than zone one. Small areas of grazing land are distributed throughout the system; however only zone 6 has substantial areas remaining for development. Cashew plantations are only found in zone six. Large scale agricultural enterprises are concentrated in zone one.

Figure 5 shows the general soil classification for zones two to six. Soil types are highly variable leading to different land covers and different crop selections.

Figure 6 shows the location of main tanks and canal infrastructure. Major tanks are mainly located in zone one, two and three; while minor tanks are concentrated in the downstream zones where the majority of the irrigated area is located.

Figure 7 shows the units selected for detailed survey in zones three to six.

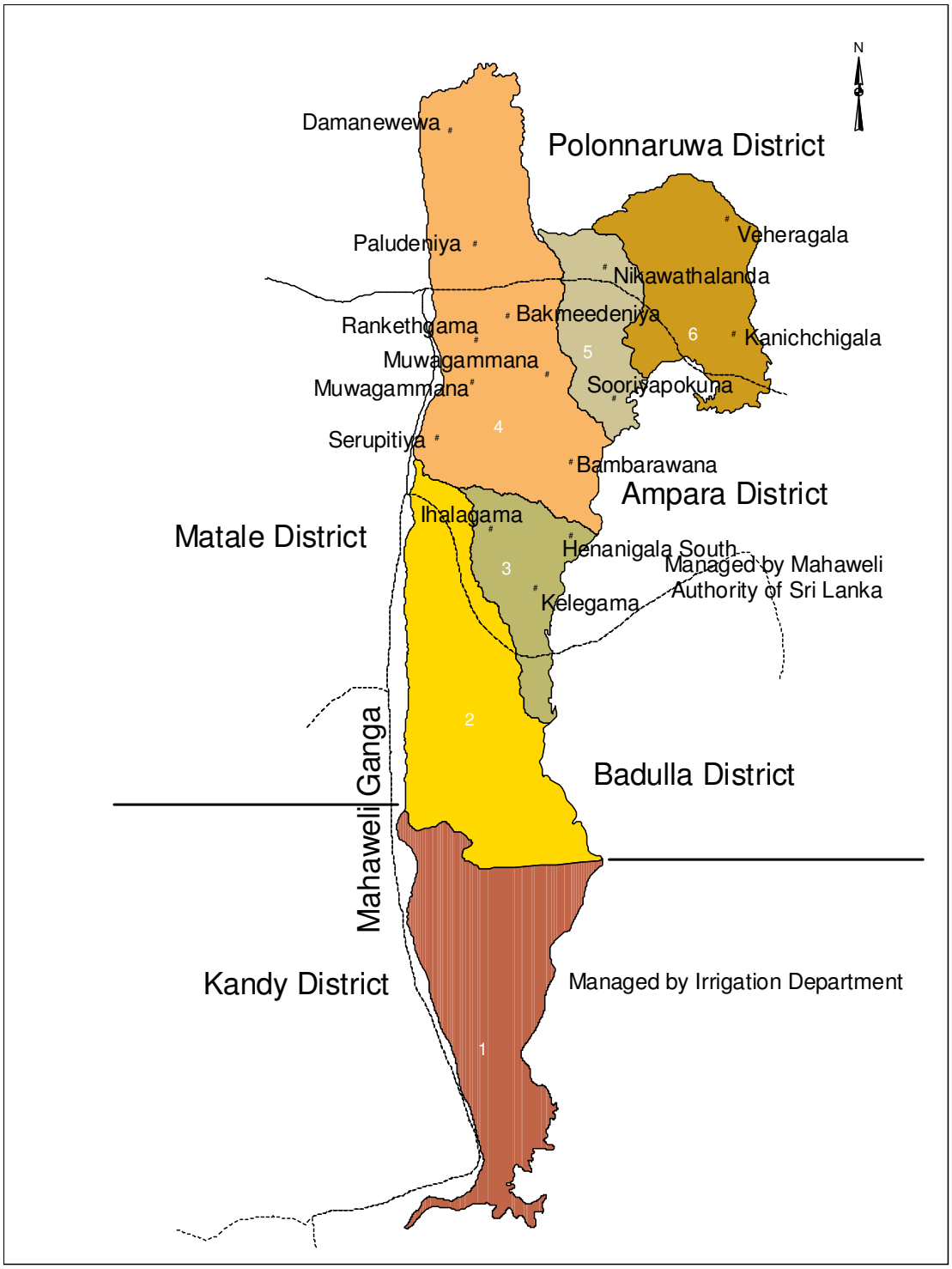


Figure 2 Location of Mahaweli System C

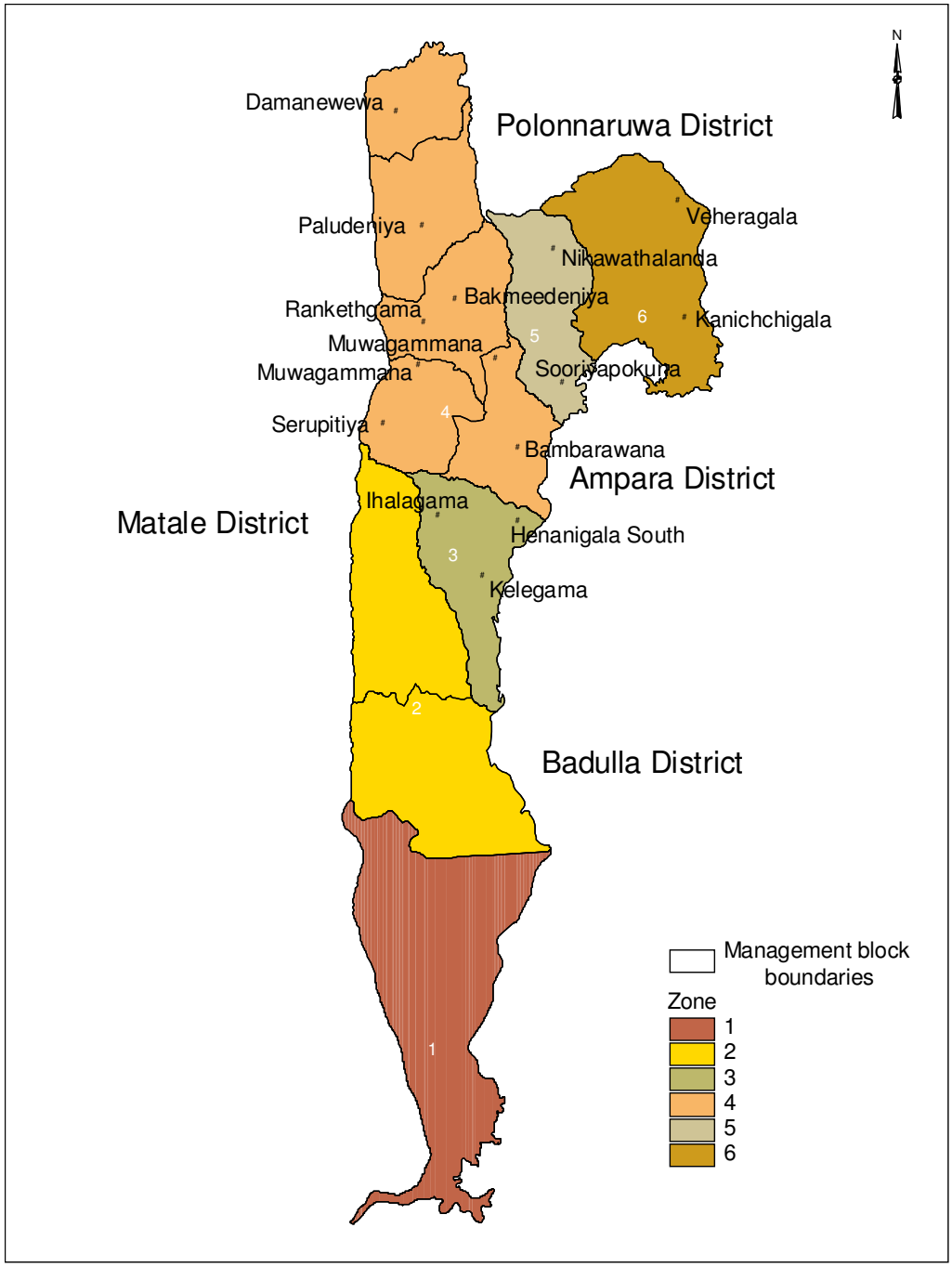


Figure 3 Location of Mahaweli System C

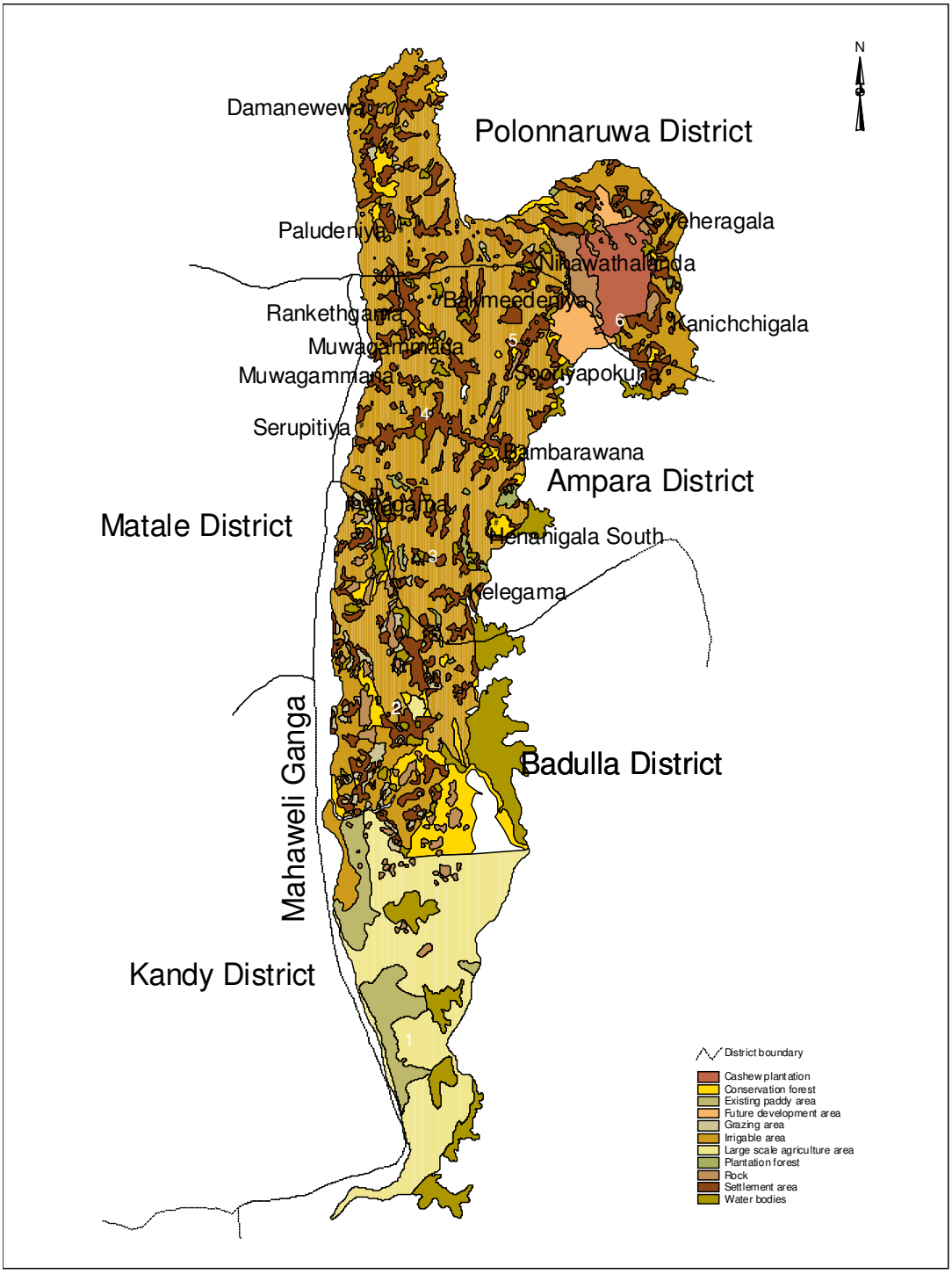


Figure 4 Land Use map – System C

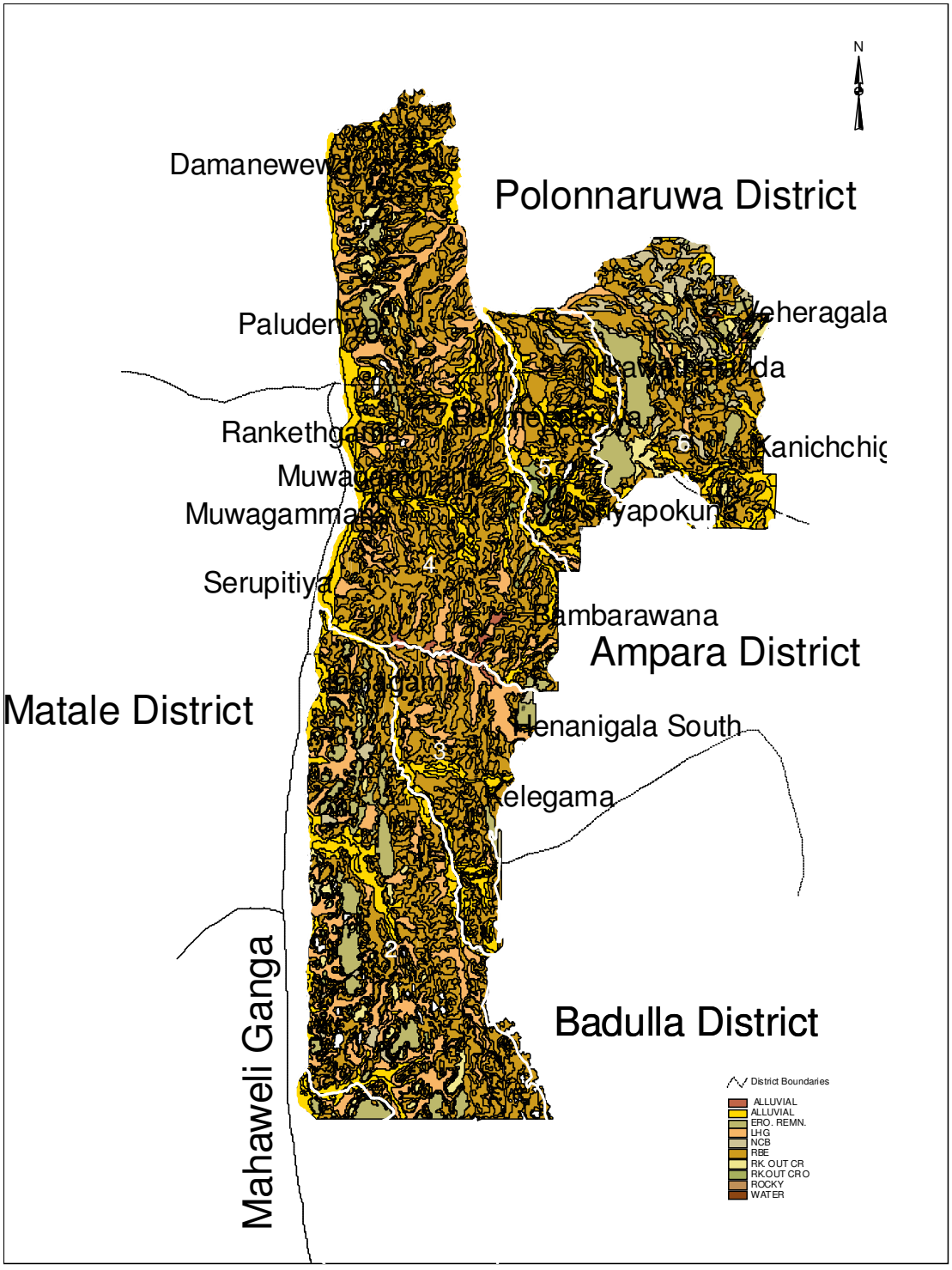


Figure 5 Soil Classification map – System C

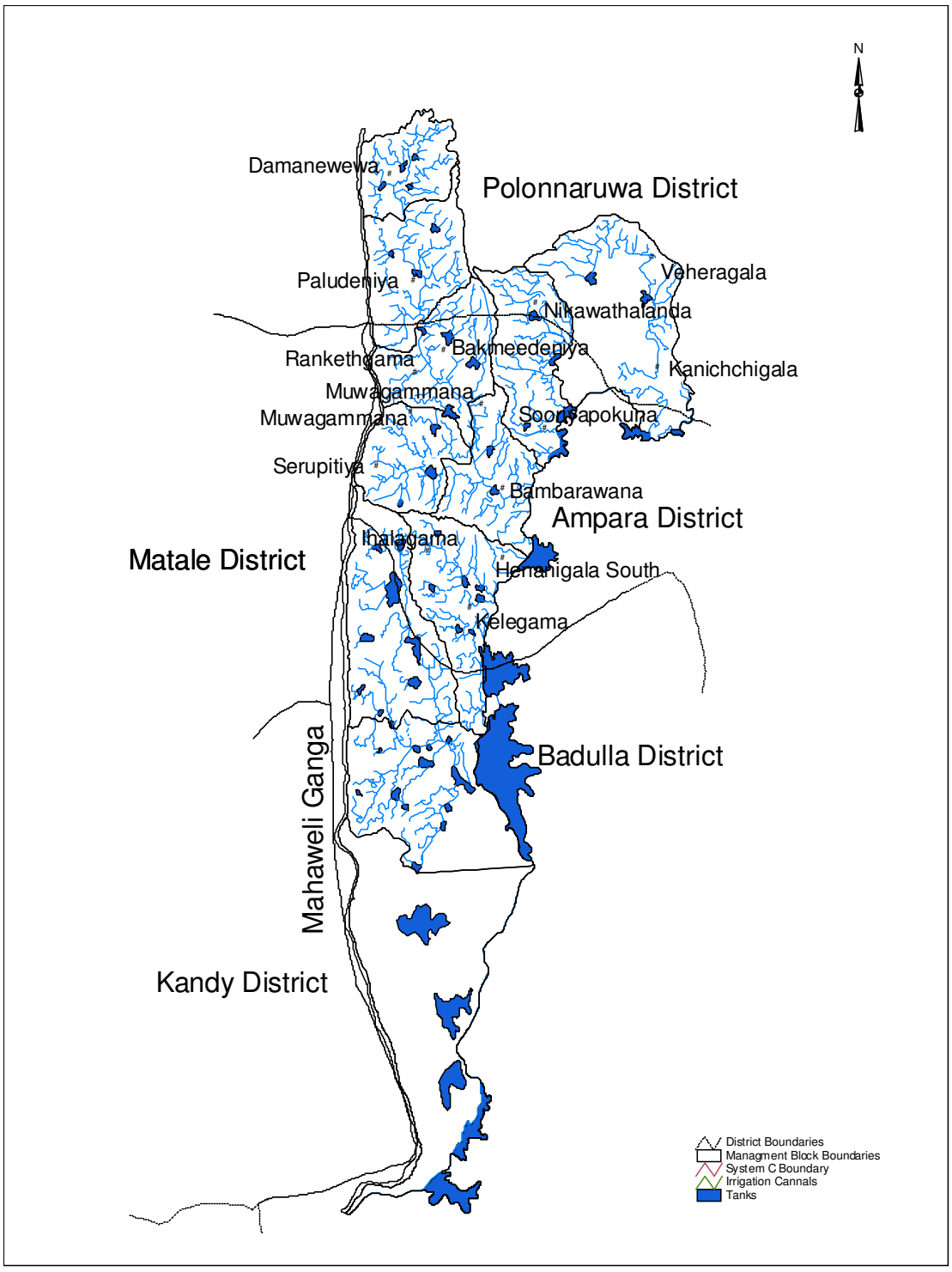


Figure 6 Main Canal and Water Infrastructure Features – System C

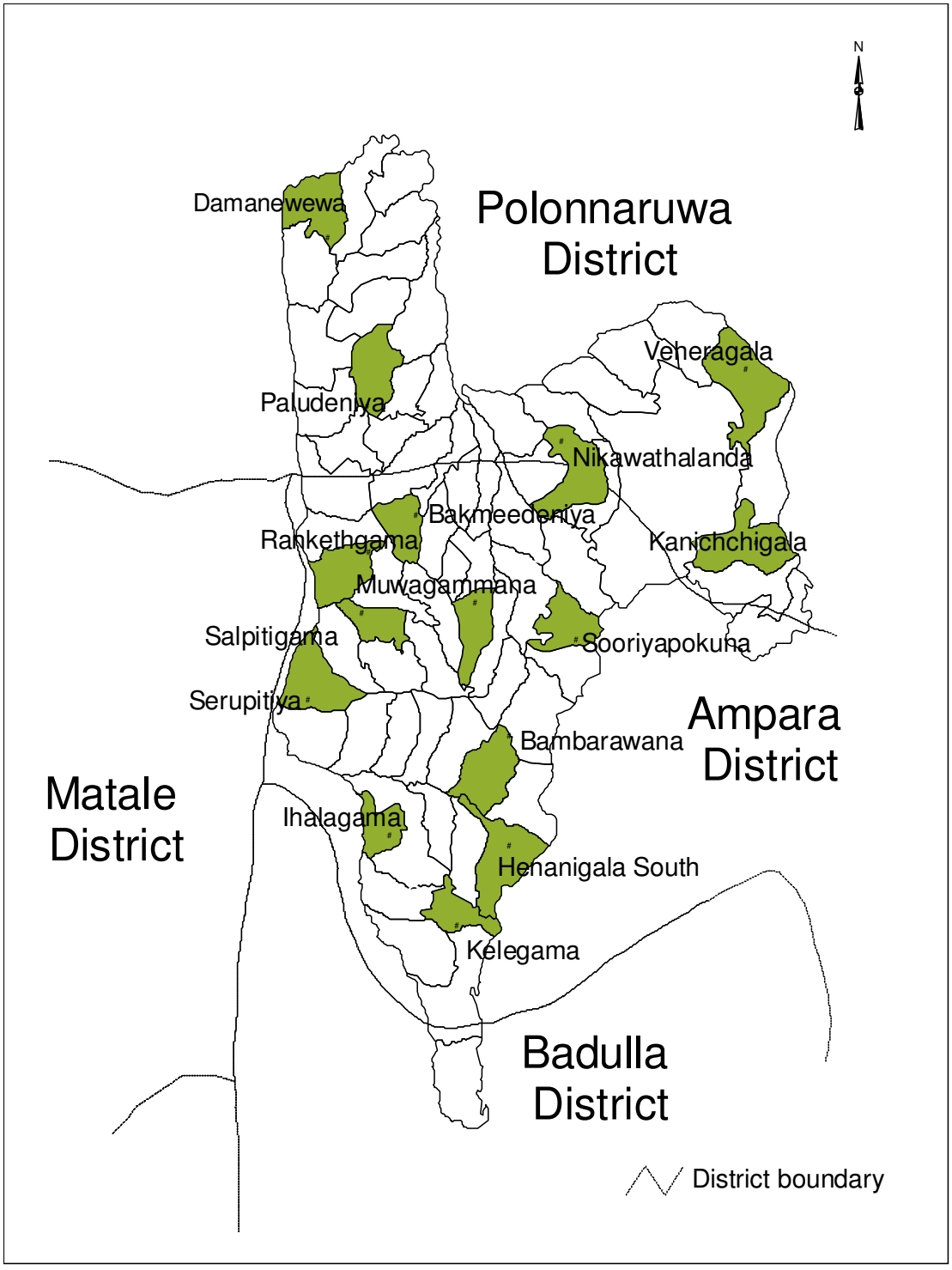


Figure 7 Location of MASL units selected for Baseline Survey – System C

Analysis and interpretation of Baseline Survey data

Nippon Koei (Nippon Koei, 2001) presents the analyzed survey data and basic interpretation of the baseline survey; including demographic analysis and initial farm and household budgets. The analysis and interpretations presented here provide an analytical basis for evaluation of progress of MUP towards the project development goals. In addition to the presentation of the statistical analysis of key variables a simple Geographic Information System (GIS) is used to illustrate the spatial variation of the observations.

The major objectives of the Mahaweli System C upgrading project are to:

1. increase the productivity of the existing system
2. strengthen the capability of farmers' organization to undertake system O&M
3. rectify defects of existing irrigation system

Our analysis utilizes the survey data provided to IWMI by Nippon Koei in November 2001.

The following sections present the results of the baseline survey with respect to the main project objectives and discussion of methods to evaluate the impact of the various project interventions in making progress towards the objectives of increasing productivity and improving the uniformity of access to the benefits of System C. In our analysis we consider not only the mean observations but also consider the distribution of observations. The objective is to identify where, although mean conditions appear acceptable, specific project interventions are not reaching the least well served.

Increasing Productivity

The major objective of the project is to increase the productivity of agriculture in the existing irrigation service area. Although some other field crops are cultivated in the irrigation system Paddy Rice cultivation dominates the cropping system in both seasons. Data generated through the baseline survey on land tenure, cultivated extents, paddy yield, input usage and problems faced during cultivation are used for analysis of agricultural performance at the Inception of the MUP interventions.

Land Holdings and Seasonal Use

The average land holding available for cultivation, amongst the sample population, is 1.03 ha (Table 3) with about 91% of respondents indicating they own land for cultivation. On average about 60% of the respondents are fully cultivating the land at their disposal while about 20% do not cultivate at all.

Attention is drawn to the five units (Bambarawana, Henanigala South, Kelegama, Muwagammana and Salpitigama) where less than 50% of the respondents indicated they were fully cultivating the land available to the household. Attention should also be given by the project towards the units of Henanigala South, Ihalagama, Kanichchigala and Kelegama where between 30 and 50 percent of the farmers were not cultivating the land available to them.

Table 3 Summary of Land Utilization

Unit Name	Average Holding (ha)	Percentage of Farmers		
		Land Owners	Cultivating All Land	Not Cultivating Land
Bakmeedeniya	.94	90	65	20
Bambarawana *	.94	85	**45**	10
Damanewewa	1.18	100	90	10
Henanigala South	1.10	100	**25**	**35**
Ihalagama	.94	85	50	**35**
Kanichchigala	1.10	90	55	**35**
Kelegama *	.99	85	**35**	**45**
Muwagammana	1.11	85	**45**	15
Nikawathalanda	1.01	90	65	15
Paludeniya	1.03	95	70	15
Rankethgama *	.97	100	85	15
Salpitigama	1.27	90	**25**	20
Serupitiya	.99	95	90	5
Sooriyapokuna *	1.01	90	70	10
Veheragala *	.94	90	85	5
Average	**1.03**	**91**	**60**	**19**

Agricultural Performance

Within the 300 respondents surveyed the average area cultivated during Yala and Maha 2000/2001 was 0.97 ha and 0.99 ha respectively (Table 4). The cultivated area remains fairly stable between the seasons, suggesting that personal preference rather than seasonal variations in water availability or other constraints influenced the cropping decisions. However the substantial variation in annual cropping intensity between units, from a minimum of 81% to a maximum 182%, gives rise to some question as to how representative the sample respondents are.

National average paddy yields in Maha and Yala 2000/2001 were 3.86 t/ha and 3.96 t/ha respectively (Abstract of the Statistical Handbook 2002). The average yields obtained in the sampled System C units were Maha 4.19 t/ha and Yala 4.14 t/ha, which although greater than the national average are lower than the benchmark yield (4.4 t/ha) used by the Department of Agriculture in estimates of model farm budgets.

There is no significant difference between the average yields obtained in the units and the overall mean annual yield (8.32 t/ha/yr) at the 5% probability level. However there are significant differences between the yields obtained at some units (least significant difference 1.32 t/ha/yr) where the project should consider additional interventions to establish the causal factors leading to the lower performance of the units. Veheragala appears as the best performing unit, amongst the sampled villages, whilst Henanigala South is the least well performing. Veheragala also has one of the lowest Inter Quartile Ratios (Abernethy,1989) as shown in Figure 8, whilst Henanigala South is the second highest, indicating a substantial disparity in the yields obtained amongst the sampled farmers in this unit. There is no significant difference, from the mean seasonal, in the yields obtained in a given unit between the seasons reported. However, at the village of Henanigala South, Damanewewa, Ihalagama

and Nikawathalanda the yields in the Yala and Maha seasons are significantly different at greater than the LSD of 0.182 t/ha.

Table 4 Summary ofAgricultural Performance (Yala and Maha 2000/2001)

Unit Name	Average Holding (ha)	Cropping Intensity (%)	Average Seasonal Performance (Paddy)			
			Yala		Maha	
			Planted area (ha)	Yield (t/ha)	Planted Area (ha)	Yield (t/ha)
Bakmeedeniya	.94	153	.88	4.20	.95	4.25
Bambarawana *	.94	178	.94	4.06	.94	4.06
Damanewewa	1.18	163	.97	4.11	.97	4.46
Henanigala South	1.10	81	.78	**3.85**	.78	**3.56**
Ihalagama	.94	142	.95	4.06	.95	4.28
Kanichchigala	1.10	128	1.14	**3.83**	1.12	3.92
Kelegama *	.99	99	.98	4.48	.98	4.23
Muwagammana	1.11	166	.95	3.96	.96	**3.77**
Nikawathalanda	1.01	173	.99	4.78	.97	4.48
Paludeniya	1.03	165	1.06	4.29	1.07	4.17
Rankethgama *	.97	174	.94	4.32	.94	4.44
Salpitigama	1.27	149	1.12	4.34	1.25	4.26
Serupitiya	.99	182	.98	4.14	.98	4.03
Sooriyapokuna *	1.01	166	1.00	**3.66**	.98	**3.83**
Veheragala *	.94	154	.91	4.78	.91	4.67
Average	**1.03**	**151**	**.97**	**4.14**	**.99**	**4.19**

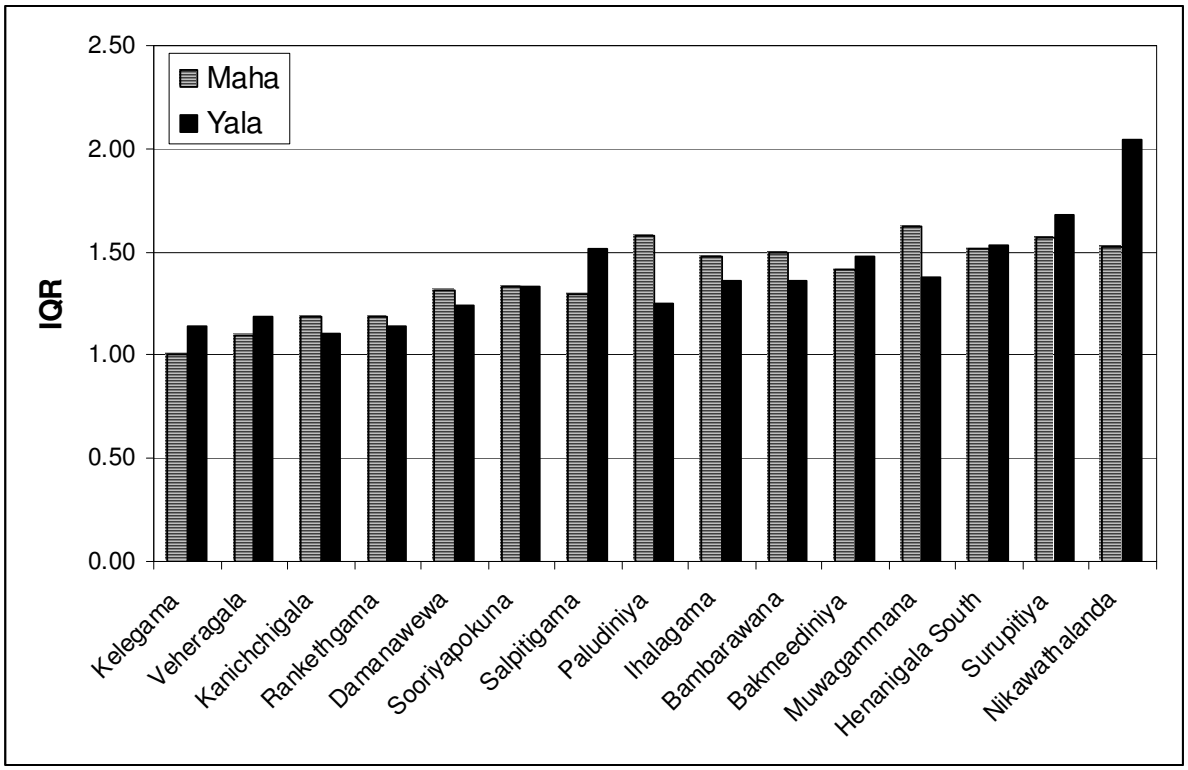


Figure 8 Within Unit variation in Yield (Interquartile Ratio)

Table 5 Mean Annual Yield by Unit (t/ha/yr)

Unit Name	Average Holding (ha)	Mean Annual Yield t/ha
Bakmeedeniya	.94	8.32
Bambarawana *	.94	8.48
Damanewewa	1.18	8.55
Henanigala South	1.10	7.13^{++}
Ihalagama	.94	8.43
Kanichchigala	1.10	7.97
Kelegama *	.99	8.57
Muwagammana	1.11	7.77^{++}
Nikawathalanda	1.01	8.67
Paludeniya	1.03	8.18
Rankethgama *	.97	8.73
Salpitigama	1.27	8.26
Serupitiya	.99	8.25
Sooriyapokuna *	1.01	7.59^{++}
Veheragala *	.94	9.27
Average	**1.03**	**8.32**

NB: $^{++}$ indicates units with mean annual yield significantly lower than Veheragala

Use of Agricultural Inputs

Analysis of agricultural production shows that the overall performance is relatively uniform with respect to the mean levels of production, more detailed analysis indicates some substantial differences in yields obtained in some sample units (Table 5). The following sections investigate variations in use of agricultural inputs in the sample units.

Rate of Seed Paddy Use

The Rice Research and Development Institute (RRDI) recommend a minimum seed paddy rate of 150 kg/ha. However the Department of Agriculture model farm budget calculations are based on a seed application rate of 110 Kg/ha which conflicts with the RRDI recommendations. Mean seed application rates in Maha and Yala, at about 112 Kg/ha, are close to DOA recommendations (Table 6).

Figure 9 illustrates a strong correlation between seed application rate and mean seasonal yield. Henanigala South (seed application rate 95 kg/ha) is amongst the lowest application rates whilst Veheragala is amongst the higher application rates at about 138 kg/ha.

Table 6 Seasonal Paddy Seeding Rate (kg/ha)

Unit Name	Maha (Kg / Ha)	Yala (Kg / Ha)
Bakmeedeniya.	136.00	124.93
Bambarawana	98.41	93.24
Damanewewa	106.40	105.92
Henanigala South	95.00	95.00
Ihalagama	101.42	92.69
Kanichchigala	115.80	112.02
Kelegama	110.60	110.20
Muwagammana.	111.06	117.97
Nikawathalanda	136.36	163.46
Paludeniya	104.93	107.03
Rankethgama	125.89	124.66
Salpitigama	99.06	100.51
Serupitiya	88.22	89.81
Sooriyapokuna	99.47	93.48
Veheragala	137.75	139.40
Average	**112.24**	**112.52**

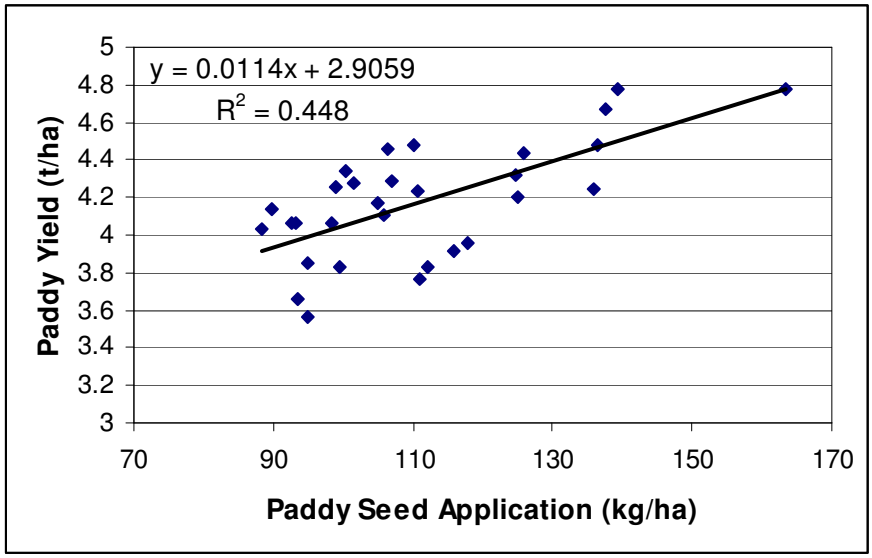


Figure 9 Yield response to seed application rate

Use of agro-chemicals and fertilizers

The RRDI recommended application rates for inorganic fertilizers for paddy cultivation are:

- Nitrogen (N) 100 kg/ha
- Phosphorous (P_2O_5) 30 kg/ha
- Potassium (K_2O) 20 kg/ha

Overall the average application rates of these fertilizers are above the recommended rates (Table 7). There is a positive response to the combined fertilizer (NPK) applied, however the

over application of Phosphorous shows a slight negative response, Figure 10. There is a strong positive response to Nitrogen applications.

Table 7 Fertilizer application rates (kg/ha)

Unit Name	Maha (Kg / Ha)			Yala (Kg / Ha)		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Bakmeedeniya.	83.79	21.79	16.71	115.67	29.93	32.06
Bambarawana	104.41	40.71	31.88	137.84	45.40	34.49
Damanewewa	123.45	20.35	34.40	124.71	17.44	35.66
Henanigala South	69.30	6.30	9.50	103.93	22.19	17.63
Ihalagama	107.17	26.83	29.92	119.85	31.63	36.08
Kanichchigala	116.23	0.00	12.23	115.43	29.88	25.21
Kelegama	75.56	23.44	22.67	83.94	23.33	24.89
Muwagammana.	118.89	36.22	21.67	118.34	36.50	23.27
Nikawathalanda	136.59	18.53	22.41	173.97	20.29	31.65
Paludeniya	82.88	36.75	16.06	82.83	29.25	13.33
Rankethgama	118.56	34.50	34.44	118.79	34.63	35.26
Salpitigama	103.81	39.69	35.44	99.42	42.33	34.26
Serupitiya	92.47	22.95	30.16	102.21	23.72	31.58
Sooriyapokuna	105.12	26.29	35.41	102.69	28.65	37.94
Veheragala	149.63	12.69	25.81	156.65	12.61	25.64
Average Application Rates	**105.86**	**24.47**	**25.25**	**117.08**	**28.52**	**29.26**

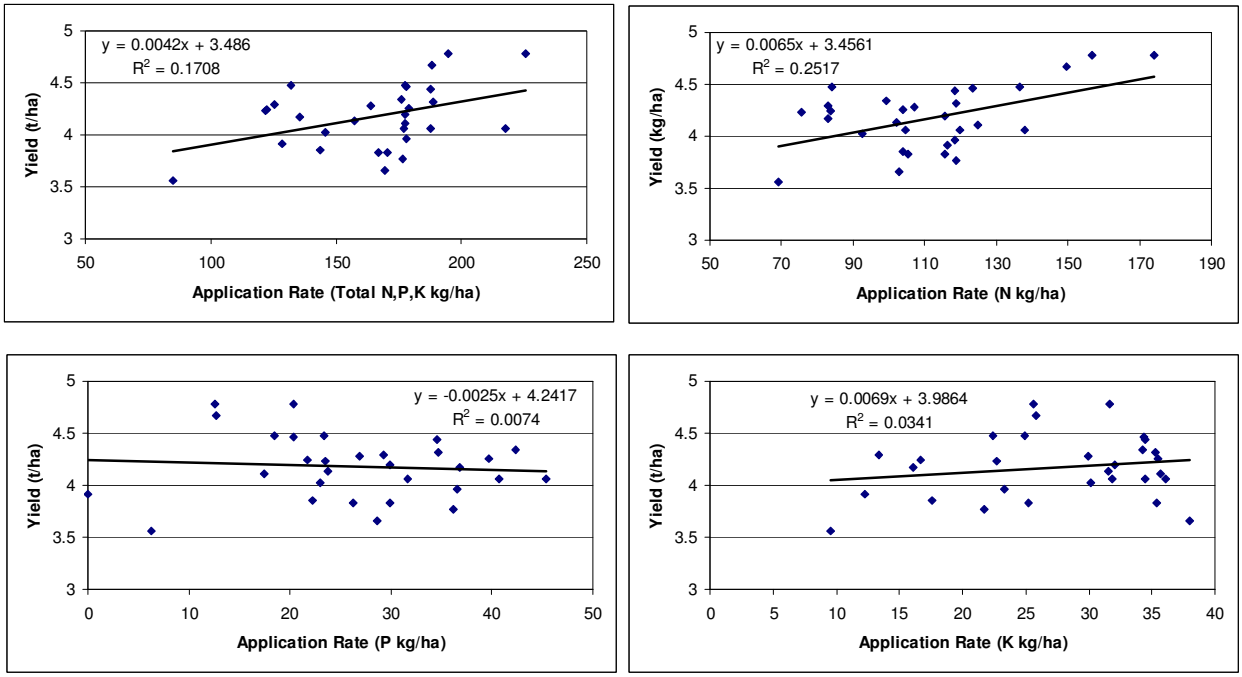


Figure 10 Yield response to fertilizer applications

Low seed paddy application rates at Henanigala South and Kelegama are associated with low average yields in these units. Veheragala application rates (total NPK of 188 and 194 kg/ha in Maha and Yala respectively) contributed to the reported high average yields.

Table 8 presents average expenditures on agrochemicals in the sample villages during the Maha and Yala seasons in 2000/2001. As can be seen from Figure 11 there is little relationship between the average investment in these products and average yield. However, investment in agrochemical inputs range from about 640 Rs/ha to over 4,700 Rs/ha. The village of Henanigala South is towards the lower end of the expenditures on these inputs in Maha (834 Rs/ha) and obtained the lowest mean yield. The farmers in Veheragala are relatively moderate in the application of these inputs, investing about 1,500 to 2,000 Rs/ha.

Table 8 Agro-chemical costs (Rs/ha)

Unit Name	Maha (Rs/ha)			Yala (Rs/ha)		
	Herbicides	**Insecticides**	**Fungicides**	**Herbicides**	**Insecticides**	**Fungicides**
Bakmeedeniya.	1535.00	784.70	512.50	1841.00	617.40	446.00
Bambarawana	2142.80	242.50	206.80	1680.00	260.00	159.80
Damanewewa	2311.30	246.80	320.00	2587.00	254.30	0
Henanigala South	230.00	308.20	295.70	1286.00	250.90	200.20
Ihalagama	218.30	190.20	233.80	391.00	259.30	190.10
Kanichchigala	2127.80	161.00	63.00	2200.00	139.30	88.90
Kelegama	4006.70	132.40	0	4683.00	26.00	0
Muwagammana.	2900.70	250.70	45.00	2265.00	195.20	515.00
Nikawathalanda	1849.50	362.40	178.00	1744.00	272.80	183.80
Paludeniya	4309.50	158.40	165.50	3985.00	354.30	0
Rankethgama	2312.70	196.70	400.40	2401.00	329.70	398.50
Salpitigama	1172.30	355.50	0	1824.00	270.50	0
Serupitiya	524.70	463.10	336.00	454.00	338.30	424.70
Sooriyapokuna	3741.80	160.70	60.00	4072.00	243.40	26.50
Veheragala	1123.40	346.40	99.50	1583.00	310.60	274.50
Average Application Costs	**2061.17**	**315.54**	**230.21**	**2203.66**	**274.80**	**261.41**

The wide variation in application rates and the apparent poor correlation between agrochemical investments and yields obtained indicate that improved extension advice is an urgent requirement to improve the economic performance of the farming community.

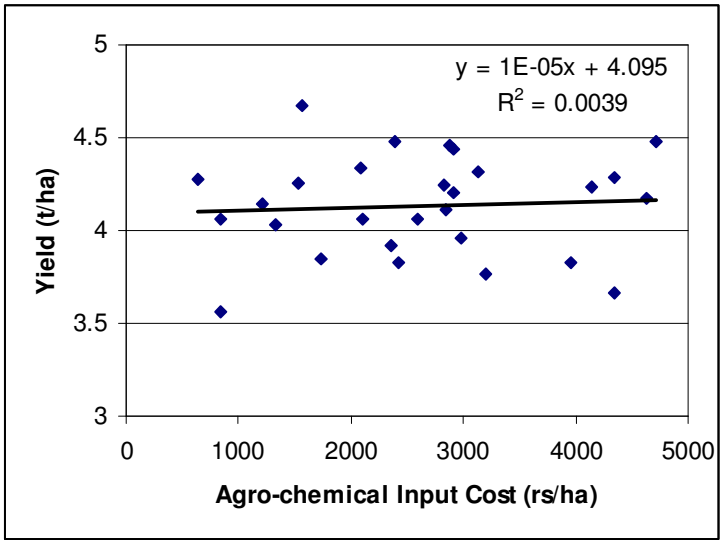


Figure 11 Yield response to total agro-chemical application (cost as analogue)

Labor inputs to paddy cultivation

Labor input for cultivation is generally a combination of family and external help. The external labor is often a combination of hired laborers and exchanged labor (Attham) whereby farmers exchange work in each others fields.

Table 9 Labor input for paddy cultivation (person days/ha)

Unit Name	Maha (person d/ha)	Yala (person d/ha)
Bakmeedeniya.	107	119
Bambarawana	123	123
Damanewewa	100	103
Henanigala South	70	80
Ihalagama	125	124
Kanichchigala	79	62
Kelegama	85	86
Muwagammana.	114	120
Nikawathalanda	92	98
Paludeniya	84	84
Rankethgama	105	107
Salpitigama	81	79
Serupitiya	85	78
Sooriyapokuna	108	110
Veheragala	84	80
Average Labor Use (d/ha)	**96.13**	**96.87**

The average number of person days utilized to cultivate during each season was a little over 96, only slightly in excess of the Department of Agriculture estimate of 90 person days/ha used in model farm budget calculations. Within the sample villages there is some variation in labor utilizations but we see no systematic trend between labor use and farm yields. (Figure 1

of Annex 3 shows the spatial variation of labor use in different units of the system for both Maha and Yala seasons.)

Impact of farmers experience on Agricultural Performance

Settlement of the System C area began during the development phase of the project. As a result there are now farming families with considerable experience, however the, so called, 2nd generation of farmers are obtaining lower yields than their 1st generation colleagues (Table 10). One component of the MUP is aimed at providing additional training for the 2nd generation farmers to assist them achieve better yields by provision of new training facilities and courses at Rathkinda Seed Farm (See figure 2 of Annex 3 for spatial distribution of second generation farmers in different units).

Table 10 Comparison of farmers experience and yields

	Farmer Generation					
Unit Name	**1st Generation Settlers**			**2nd Generation Settlers**		
	Maha t/ha	**Yala t/ha**	**% of farmers**	**Maha t/ha**	**Yala t/ha**	**% of farmers**
Bakmeedeniya	4.29	4.33	63.10	4.49	4.25	36.84
Bambarawana *	4.49	4.05	31.58	4.00	4.15	68.42
Damanewewa	4.57	4.08	73.68	3.91	3.96	26.32
Henanigala South	3.38	3.69	85.00	3.52	4.40	15.00
Ihalagama	3.81	3.49	68.42	5.72	5.90	31.58
Kanichchigala	3.93	3.86	57.89	4.14	3.99	42.11
Kelegama *	-	-	20.00	4.47	4.26	80.00
Muwagammana	3.75	3.71	68.42	3.84	4.53	31.58
Nikawathalanda	4.48	4.35	80.00	4.55	3.09	20.00
Paludeniya	4.26	4.06	80.00	3.27	4.56	20.00
Rankethgama *	-	-	-	4.41	4.29	100.00
Salpitigama	4.05	4.04	94.44	4.18	4.62	5.56
Serupitiya	4.20	4.32	94.44	2.50	2.50	5.56
Sooriyapokuna *	4.51	4.48	40.00	3.71	3.24	60.00
Veheragala *	4.61	4.50	21.05	4.65	4.81	78.95
Average	**4.34**	**4.34**	**62.48**	**4.09**	**4.17**	**41.46**

* Units where 2nd generation farmers form the majority group.

The role of the water user organizations and more experienced farmers should not be overlooked. Provision of effective and timely extension services to the farming population will help ensure that all farmers are better able to make best use of the resources available to them.

Farmers' views on Irrigation Services

Irrigation and paddy cultivation are inextricably connected in Sri Lanka and, although some other field crops (OFCs) are grown these are negligible in terms of water demand. However where OFCs are common the service requirements from the irrigation system are considerably more stringent than for paddy cultivation. In the sampled villages less than 0.5% of the irrigated area is used for crops other than paddy and the following observations by the survey respondents should be considered as relevant to paddy rice.

Irrigation costs and future demand projections

Irrigation service charges are a frequent issue of discussion. The baseline survey has captured the current levels (Table 11) of service fees levied at System C and also farmer opinions regarding appropriate levels of fees that may be charged in future (See figure 3 of Annex 3 for detailed irrigation services charges paid by farmers in the different units)

Irrigation fees are being levied by the WUA at System C and, as shown in Table 11, there is a substantial difference in the rates charged from about 100 Rs/ha/season to 370 Rs/ha/season. The baseline survey did not investigate the basis for these different charge rates or the principles by which rates where established by the organizations. Clearly the majority of the respondents felt the current level of irrigation service fees are acceptable, with over 80% reporting the fees as moderate and about 90% of respondents indicating they paid the levied fees.

Table 11 Summary of Irrigation Service Fee Levels

Unit Name	Respondents view of current irrigation fees			
	Amount Paid (Rs /ha/season)	Moderate %	Expensive %	Very Expensive %
Bakmeedeniya	297	31.25	56.25	12.50
Bambarawana	272	80.00	6.67	0.00
Damanewewa	371	81.82	9.09	0.00
Henanigala South	371	66.67	22.22	11.11
Ihalagama	321	89.47	10.53	0.00
Kanichchigala	99	95.00	0.00	0.00
Kelegama	173	92.86	7.14	0.00
Muwagammana	346	68.75	25.00	6.25
Nikawathalanda	124	83.33	11.11	5.56
Paludeniya	198	73.68	26.32	0.00
Rankethgama	148	94.44	5.56	0.00
Salpitigama	371	92.86	0.00	0.00
Serupitiya	99	69.23	15.38	7.69
Sooriyapokuna	297	100.00	0.00	0.00
Veheragala	321	100.00	0.00	0.00
TOTAL	253.87	81.29	13.02	2.87

When asked about future water requirements the majority of farmers (73%) indicated they were expecting supplies to be increased, with about 75% proposing a small increase and about 25% suggesting supplies should be doubled (Table 12).

Although the farmers clearly indicated there preference for increased water supplies few (less than 10%) indicated a willingness to pay irrigation fees in excess of 500 Rs/ha/season, and the majority (about 90%) indicating they were reluctant to pay as much as 500 Rs/ha/season (Table 13). Clearly farmers are interested to minimize the costs of farm production, however for the WUA and the O&M of the system to become self sustaining the level of internal revenue generation will probably need to be increased. Formulation of clear guidelines for establishing irrigation fees will need to be developed to arrive at equitable fee rates in place of the apparently arbitrary rates currently set by the WUA.

Table 12 Farmers' opinion on future water requirements

Unit Name	% of Response		
	No Increase	Double Supply	Increased a Little
Bakmeedeniya	20.00	25.0	75.0
Bambarawana	22.22	7.1	92.9
Damanewewa	10.53	76.5	23.5
Henanigala South	0.00	37.5	62.5
Ihalagama	6.67	30.0	70.0
Kanichchigala	73.68	-	100.0
Kelegama	30.77	20.0	80.0
Muwagammana	30.77	12.5	87.5
Nikawathalanda	0.00	50.0	50.0
Paludeniya	68.75	-	100.0
Rankethgama	60.00	12.5	87.5
Salpitigama	11.11	23.1	76.9
Serupitiya	25.00	10.0	90.0
Sooriyapokuna	29.41	-	100.0
Veheragala	17.65	25.0	75.0
Average	**27.10**	**25.00**	**78.05**

Table 13 Summary of rates of ISF acceptable to farmers

Unit Name	Willingness to pay (% of cultivating Farmers)		
	No Payment	<500 Rs/ha	500 – 1000 Rs/ha
Bakmeedeniya	-	100	-
Bambarawana	11	82	6
Damanewewa	-	100	-
Henanigala South	-	73	-
Ihalagama	-	100	-
Kanichchigala	-	92	-
Kelegama	6	89	-
Muwagammana	-	88	-
Nikawathalanda	-	88	6
Paludeniya	-	100	-
Rankethgama	-	100	-
Salpitigama	-	100	-
Serupitiya	-	100	-
Sooriyapokuna	-	76	-
Veheragala	-	69	6
Average	**0.67**	**90.47**	**6**

Irrigation Service and Agricultural Problems

Farmer's perception of the problem issues that impact on the agricultural operation and their livelihoods are a critical guide to what the project must address, either directly through project interventions or indirectly by influencing the intervention of other line agencies. Table 14 summarizes the percentage of the survey respondents that identified selected issues as directly impacting on the productivity of their agricultural enterprises. (Figure 4 of annex 3 gives the spatial variation of agricultural and irrigation constraints faced by farmers in the different units.)

Grouping the issues into three main categories (Land and Water; Agricultural Inputs; and Local Environment) indicates that the access to and cost of Agricultural Inputs adversely impacts about 46% of the respondents. Further about 41% consider constraints imposed by the general environment to affect their productivity and livelihood, and about 32% indicated that land and water issues constrain there operations. Within this broad view there are considerable differences between the villages and within the individual villages, however it does indicate that in order to increase productivity and to support sustainable livelihoods in the System C area the farming population will require inputs beyond physical rehabilitation of the irrigation infrastructure and formation of water user groups.

Agricultural Inputs

The high cost of agricultural inputs was identified as a constraint by about 67% of the respondents with use of low yielding varieties being the second most serious issue (60%). These issues may be considered as two sides of the same problem – seed costs are considered to be high so farmers do not invest in the high yielding varieties. Access to suitable seed material (48%) and problems obtaining sufficient labor at critical times (42%) were also noted. Finally, the availability of Animal and Machine Draught Power (27%) and access to Agro-chemical and Fertilizer inputs (40%) were identified by the farmers as having negative impacts on productivity.

The survey has revealed considerable variations in the benefits obtained by the respondents from the use of fertilizers and agro-chemicals as well as considerable differences in the reported application of rates of seeds, fertilizers and other inputs. These results further stress the need for an effective and comprehensive extension service and the need for additional training opportunities for the farming community.

Local Environment

Pest & Diseases (66%) and Weeds (53%) were identified as substantial problems in the area of System C. The farms in the area are also subject to damage by wild animals (42%), specifically wild boar. This problem is particularly acute in Damanewewa, Paludeniya and Kanichchigala where over 80% of farms are adversely affected by animal damage. Farmers also identified the absence of farm roads (23%) as detrimental to farm production. Droughts (20%) were noted as problems in four villages (Damanewewa, Henanigala South, Nikawathalanda and Salpitigama) which also recorded water shortages as an issue of concern.

Land and Water

Problems of water shortage (34% overall) were identified as significant in four villages (Damanewewa, Henanigala South, Nikawathalanda and Salpitigama), where over 60% of farmers identified this as a major constraint. A problem with adequacy of drainage (36%) was reported by farmers at Damanewewa, Serupitiya, Nikawathalanda and Ihalagama. Over 90% of farmers at Damanewewa indicated that land leveling was also a problem, although only about 22% of other farmers considered this an issue.

Table 14 Reported Agricultural and Irrigation Constraints

Unit Name	% of farmers reporting problem							
	Water Shortages	**Drought**	**Pests & Diseases**	**Low Yielding Varieties**	**Land Leveling**	**Weeds**	**Damage by wild Animals**	**Drainage**
Bakmeedeniya	25	0	57	50	0	29	14	40
Bambarawana	30	5	100	75	30	88	6	30
Damanewewa	85	90	95	100	95	95	100	90
Henanigala South	60	65	100	75	30	82	27	40
Ihalagama	35	5	67	35	30	58	42	55
Kanichchigala	10	5	75	40	35	83	83	35
Kelegama	15	0	56	50	10	0	56	15
Muwagammana	15	5	41	45	20	47	18	5
Nikawathalanda	80	55	88	85	30	76	47	55
Paludeniya	10	0	81	30	20	69	100	10
Rankethgama	25	0	72	50	35	44	6	15
Salpitigama	65	65	31	75	40	25	6	45
Serupitiya	20	5	44	90	0	67	33	60
Sooriyapokuna	10	0	12	45	10	0	18	15
Veheragala	30	5	69	60	15	38	69	25
Average	**34.33**	**20.33**	**65.87**	**60.33**	**26.67**	**53.4**	**41.67**	**35.67**

Unit Name	% of farmers reporting problem						
	Animal & Machine	**Labor**	**Seeds**	**Agro-chemicals**	**Fertilizer**	**High Farm Input Costs**	**Lack of Farm Roads**
Bakmeedeniya	0	14	21	7	07	14	7
Bambarawana	47	47	88	88	88	94	29
Damanewewa	95	100	85	95	95	100	80
Henanigala South	45	45	100	91	73	91	55
Ihalagama	17	92	67	42	42	100	33
Kanichchigala	33	17	42	67	67	92	8
Kelegama	0	33	33	67	22	22	11
Muwagammana	18	35	41	29	29	53	6
Nikawathalanda	41	71	53	76	76	88	41
Paludeniya	31	25	19	13	19	81	25
Rankethgama	11	22	33	28	22	44	6
Salpitigama	6	44	13	19	13	63	6
Serupitiya	11	17	28	89	11	61	11
Sooriyapokuna	41	12	41	47	24	29	12
Veheragala	13	63	56	25	19	75	13
TOTAL	**27.27**	**42.47**	**48.00**	**52.20**	**40.47**	**67.13**	**22.87**

Extension Services

The disparity in application rates of major agricultural inputs of seeds, fertilizers and agro-chemicals indicates an inadequate farmer training and extension service. This is further confirmed by the numbers of farmers reporting they had consulted (average 2.3 times) with the extension officers in the previous 12 months. Of the 43% (Table 15) over 70% indicated they found the advice to be of marginal or poor quality or of little use. The spatial distribution of the access to extension advice is striking (Table 15) with Henanigala South and Damanewewa having the poorest access. Henanigala South achieved the lowest yields and amongst the poorest use of agro-inputs. Farmers in this Damanewewa appear to be most

pessimistic about the problems faced by the farming community (Table 14, above) although the yields are above the sample average and the use of agro-inputs do not seem unreasonable.

Table 15 Access to Agricultural Extension Advice in previous 12 months

Unit Name	Farmers %	Consultations #
Bakmeedeniya	36	2.1
Bambarawana	12	3.0
Damanewewa	5	2.0
Henanigala South	9	0
Ihalagama	58	2.1
Kanichchigala	25	1.3
Kelegama	22	2.0
Muwagammana	47	2.5
Nikawathalanda	76	3.5
Paludeniya	100	6.5
Rankethgama	28	1.6
Salpitigama	50	2.0
Serupitiya	56	2.1
Sooriyapokuna	71	1.2
Veheragala	38	2.3
TOTAL	**43**	**2.3**

The variation in the frequency of consultations between villages and farmers suggests the Extension Services are not reaching the main target audience effectively. The high level of dissatisfaction with the usefulness of the information provided by the service also indicates that further attention must be given to improving this service.

Post-harvest and Marketing Issues

Overall only about 34% of respondents indicated that they were active in selling agricultural products in the local market/pola. Of these the majority had a number of observations regarding problems associated with the market and post-harvest activities (Tables 16 & 17). Before considering the detail of these tables a number of apparent inconsistencies should be noted. In table 17, three villages Bakmeedeniya, Kelegama and Paludeniya, reported average transport charges of over 200 Rs/bag. However, less than 10% of the respondents in these villages indicated that the High cost of transport is a constraint on marketing of produce and yet over 50% of farmers at Bakmeedeniya and Kelegama noted that Low Prices are a problem.

There appears to be no relationship between the distance from the village to the market and the average transport charge. This suggests the data on transport costs are, at least in part, erroneous. Further research is required to establish realistic transport costs for each location.

It is notable that a number of respondents (15% of the total) indicated that marketing problems are related to low quality production, particularly at Henanigala South, Salpitigama and Sooriyapokuna (figure 5 of annex 3 for details).

Table 16 Post-harvest problems related to market sales

Unit Name	% of farmers					
	Low Prices	Poor transport	High Cost Transport	Poor Storage	Low quality products	Lack of packaging
Bakmeedeniya	50	7	7	7	36	-
Bambarawana	18	29	24	-	-	-
Damanewewa	30	30	15	15	15	10
Henanigala South	64	55	36	18	55	18
Ihalagama	58	67	67	42	25	42
Kanichchigala	-	-	-	-	-	-
Kelegama	89	11	-	11	-	11
Muwagammana	-	-	-	-	-	-
Nikawathalanda	6	6	6	6	6	6
Paludeniya	13	6	6	13	-	6
Rankethgama	-	-	-	-	-	-
Salpitigama	75	-	-	6	56	-
Serupitiya	22	28	28	-	-	-
Sooriyapokuna	71	6	59	47	47	-
Veheragala	31	13	25	-	-	-
Average	**32**	**16**	**18**	**10**	**15**	**5**

Table 17 Distance to market, transport costs and Paddy Prices

Unit Name	Distance to Market (Km)	Transport costs (Rs / Bag)	Price of paddy – Rs / Kg	
			Maha	Yala
Bakmeedeniya	2.3	300.0	9.57	9.73
Bambarawana	4.5	45.0	10.33	9.94
Damanewewa	2.1	9.7	10.00	10.00
Henanigala South	5.5	23.0	10.11	9.98
Ihalagama	5.3	45.2	10.94	10.63
Kanichchigala	16.6	10.3	10.50	10.81
Kelegama	1.4	164.0	11.11	11.42
Muwagammana	2.4	10.3	9.77	10.33
Nikawathalanda	0.0	0.0	10.76	10.12
Paludeniya	5.5	227.0	10.27	10.08
Rankethgama	3.1	16.8	10.25	9.03
Salpitigama	3.4	6.6	10.56	9.84
Serupitiya	5.8	7.6	10.06	11.09
Sooriyapokuna	11.2	0.0	10.36	10.23
Veheragala	7.5	79.2	9.30	9.55
Average	**5.1**	**63.0**	**10.3**	**10.2**

Use of Credit

Access to credit is an important constraint in many agricultural communities. In the sampled area about 62% of the respondents indicated they had current credit arrangements and a total of about 68% were seeking further credit facilities at the time of the survey. Farmers indicated that about 70% of credit was provided by the formal Bank and Cooperative sector; family and friends fund approximately 20% of local loans; with local traders and merchants providing 10%. For the 2002/2003 season farmers were looking towards banks providing nearly 47% of the credit requirements; family and friends a further 33% and the traders and merchants about 20%. While these results indicate relatively positive view of the operation of the credit market at System C it should be noted that there are considerable differences in use of these different credit sources between the sample villages, as some groups reported no credit from the formal and family sectors.

Table 18 Summary of access to and use of agricultural credit

	% respondents		% of production
Unit Name	**Used credit**	**Require credit**	**to tenant**
Bakmeedeniya	70	85	58.20
Bambarawana	50	75	47.75
Damanewewa	85	50	60.00
Henanigala South	50	80	67.15
Ihalagama	47	70	58.67
Kanichchigala	70	80	56.14
Kelegama	30	25	67.00
Muwagammana	85	65	66.00
Nikawathalanda	65	95	-
Paludeniya	45	55	72.50
Rankethgama	70	90	-
Salpitigama	50	75	63.40
Serupitiya	50	35	60.00
Sooriyapokuna	80	80	-
Veheragala	75	65	60.00
TOTAL	62	68	62.84

A further dimension of the credit market is the use of leased land where the lessee pays rent through a share of the total production. Again considerable variations in the average proportions of the crop required by the land owner are evident (Table 18). At Bambarawana over half of the total crop is given to the land owner.

Strengthening the Capacity of Farmers and Farmer Organizations

A major feature of irrigation system operations in Sri Lanka is the active participation of farmers in operations and maintenance (O&M) activities. This involvement is deeply rooted in traditional small scale irrigation and is recognized as essential in the successful operation of the more modern, large scale schemes, such as System C. However, although the tradition of collective action (Shramadana) is well established, there remains concerns about the extent and impact of participatory management in the recently developed and rehabilitated schemes, where modern irrigation practices and the extensive role of line agencies has tended to instill a culture of dependency on government agencies.

The System C Upgrading Project includes activities with specific focus on the development and strengthening of a more extensive participation by farmers in local level organizations, namely farmer organizations (FO), with the objective of improving system performance and enabling the MASL to reduce operational costs.

Farmer Organization Membership

Farmer organizations were established during the original development and operation of the System C settlement, with farmers being responsible for operation of the on-farm irrigation systems. As a result membership of FOs is relatively high with over 90% of respondents reporting they were members of the local organization (Table 19). In the villages surveyed the overwhelming majority of respondents claimed membership indicating the potential for effective participatory irrigation system O&M is in place.

Table 19 Membership rates and knowledge of membership objectives

Unit Name	% of Farmers	
	FO Membership	Knowledge of FO Objectives
Bakmeedeniya	80.00	30.00
Bambarawana	87.50	87.50
Damanewewa	94.44	93.75
Henanigala South	90.00	57.89
Ihalagama	100.00	78.95
Kanichchigala	100.00	100.00
Kelegama	80.00	80.00
Muwagammana	94.44	93.75
Nikawathalanda	95.00	95.00
Paludeniya	100.00	95.00
Rankethgama	95.00	95.00
Salpitigama	100.00	100.00
Serupitiya	100.00	100.00
Sooriyapokuna	88.24	71.43
Veheragala	85.00	85.00
	92.64	84.22

While the rate of membership is relatively homogeneous across the sampled areas, the level of knowledge of the members about the objectives and activities of the organizations is less

uniform. This confirms the importance of the FO strengthening and training components of the System C Upgrading Project.

Operation and Maintenance

Overall about 95% of the people surveyed indicated they recognized that the farmer organizations should have a substantial role in the maintenance of the irrigation infrastructure. Nearly 60% of the respondents suggested that the FO should be totally responsible for the system maintenance activities (Table 20). However nearly 6% of farmers indicated they continue to expect MASL to maintain the irrigation facilities with no participation by the farmer organization member or the local community.

Table 20 Respondents proposals for system maintenance responsibility

Unit Name	% of respondents				
	MASL	FO	MASL + FO	FO + Village Community	MASL + FO + Village Community
Bakmeedeniya	0	62.50	0	37.50	0
Bambarawana	0	50.00	50.00	0	0
Damanewewa	0	93.75	6.25	0	0
Henanigala South	21.05	47.37	31.58	0	0
Ihalagama	0	50.00	0	15.00	25.00
Kanichchigala	0	100.00	0	0	0
Kelegama	7.14	85.71	0	0	0
Muwagammana	5.56	11.11	77.78	0	5.56
Nikawathalanda	0	100	0	0	0
Paludeniya	0	5	95	0	0
Rankethgama	0	94.74	0	0	0
Salpitigama	5.56	77.78	5.56	11.11	0
Serupitiya	0	10.53	89.47	0	0
Sooriyapokuna	52.94	0	47.06	0	0
Veheragala	0	100	0	0	0
Average	**5.93**	**58.89**	**27.41**	**4.07**	**2.22**

An interesting observation is that farmers indicating they should not have partial responsibility for system maintenance generally obtain a higher mean yield than those indicating acceptance of maintenance responsibilities (Table 21). Why this should be is not clear.

However the widespread acceptance of the desirability of shared responsibilities for operation and maintenance indicates a sound basis for further development of participatory management. From the variation in the knowledge about the objectives of the FO then need to focus on capacity development amongst the leaders and members of the organizations.

Table 21 Reported yields grouped by opinion about maintenance responsibility

Unit Name	Farmers Accepting Maintenance Responsibility %	Maha Yield (t/ha)		Yala Yield (t/ha)	
		Yes	No	Yes	No
Bakmeedeniya	50	3.81	4.70	3.78	4.59
Bambarawana	65	3.93	5.17	3.87	5.30
Damanewewa	35	4.20	4.70	3.77	4.36
Henanigala South	73	3.51	3.14	3.85	3.76
Ihalagama	92	4.18	5.50	3.96	5.50
Kanichchigala	100	3.95		3.84	
Kelegama	33	5.21	4.26	5.31	3.71
Muwagammana	47	3.79	3.84	3.73	4.19
Nikawathalanda	94	4.66		4.24	
Paludeniya	38	4.26	3.86	4.29	4.13
Rankethgama	33	4.29	4.48	4.34	4.27
Salpitigama	63	3.99	4.39	3.45	5.55
Serupitiya	11	4.25	3.99	5.43	3.96
Sooriyapokuna	76	3.98	3.26	3.66	3.86
Veheragala	88	4.66		4.52	
Average	**56.1**	**4.18**	**4.27**	**4.14**	**4.43**

Farmer respondents indicated that improving irrigation facilities was the highest priority issue to resolve regarding land and water management issues (Table 22). However it is striking that more respondents in this survey focused on agricultural support services, with 80% of respondents indicating use of improved seed remains a major issue, and 65% reporting pest and disease management as a major constraint. These results confirm the importance of balancing hardware and software interventions in the MASL System C upgrading program. Resolving water distribution problems alone, without ensuring adequate agricultural support and post-harvest processing services are available, would be unlikely to lead to substantial improvements in agricultural output or improved rural livelihoods.

Role and development of Farmer Organizations

Strengthening the capacity of the water user organizations to improve operations and maintenance of the lower order water distribution infrastructure is intended to address the need to ensure reliable and equitable water distribution, while relieving the government agencies of the burden of management at the tertiary and field canal levels. The role of the farmer organizations in provision of agricultural support services should be considered as a viable mechanism to address the concerns farmer respondents have raised regarding extension and post-harvest services.

Although farmer organizations can be effective in strengthening the capacity of farming communities, respondents in this survey noted a range of problems in the existing organizations in the System C area that the upgrading project should seek to address (Table 23). Farmer respondents noted that little farmer interest and poor participation are the major constraints on the activities of the organizations at System C. However, a lack of willingness to participate may be due to a lack of confidence in the leadership of the organization and inadequate consultation between the leadership and general membership. Nearly 30% of the respondents cited these two issues as constraining the activities of the organizations.

Table 22 Respondents priority for improving water and farm management issues

		Whole Sample	Bakmeedeniya	Bambarawana	Damanewewa	Henanigala S.	Ihalagama	Kanichchigala	Kelegama	Muwagammana	Nikawathalanda	Paludeniya	Rankethgama	Salpitigama	Serupitiya	Sooriyapokuna	Veheragala
Land & Water Management																	
Improved irrigation facilities	(%)	61.7	35.7	64.7	95.0	100.0	91.7	50.0	88.9	35.3	82.4	25.0	55.6	81.3	77.8	17.6	43.8
Increased irrigation water	(%)	48.3	42.9	52.9	90.0	54.5	58.3	8.3	55.6	41.2	82.4	12.5	38.9	62.5	50.0	5.9	56.3
Improved drainage	(%)	34.8	0.0	41.2	90.0	27.3	41.7	33.3	0.0	23.5	70.6	12.5	16.7	68.8	27.8	5.9	31.3
Agricultural Management																	
Prevent pests and diseases	(%)	65.2	57.1	64.7	100.0	100.0	41.7	75.0	44.4	58.8	82.4	62.5	83.3	31.3	61.1	35.3	68.8
Increased mechanization	(%)	52.6	35.7	82.4	95.0	27.3	100.0	50.0	22.2	29.4	82.4	37.5	38.9	37.5	44.4	23.5	62.5
Prevent weed damage	(%)	51.7	21.4	52.9	100.0	72.7	41.7	75.0	0.0	58.8	64.7	68.8	61.1	12.5	55.6	11.8	50.0
Improve farming practices	(%)	50.0	35.7	64.7	95.0	63.6	58.3	58.3	11.1	41.2	64.7	56.3	44.4	18.8	61.1	29.4	25.0
Prevent wild animal damage	(%)	47.0	0.0	11.8	100.0	54.5	50.0	83.3	88.9	23.5	52.9	100.0	0.0	12.5	72.2	11.8	62.5

Table 23 Respondents priorities for improved agricultural support services and post harvest issues

		Whole Sample	Bakmeedeniya	Bambarawana	Damanewewa	Henanigala S.	Ihalagama	Kanichchigala	Kelegama	Muwagammana	Nikawathalanda	Paludeniya	Rankethgama	Salpitigama	Serupitiya	Sooriyapokuna	Veheragala
Agricultural Input and support services																	
Use improved seed/plant varieties	(%)	80.4	57.1	94.1	95.0	90.9	100.0	91.7	77.8	70.6	88.2	81.3	83.3	56.3	77.8	70.6	75.0
Improve farm input supply system	(%)	62.6	28.6	82.4	100.0	90.9	58.3	83.3	33.3	41.2	82.4	50.0	44.4	25.0	66.7	64.7	75.0
Strengthen agricultural extension services	(%)	56.1	21.4	64.7	100.0	72.7	75.0	75.0	0.0	41.2	88.2	31.3	55.6	43.8	66.7	17.6	62.5
Improved agricultural credit services	(%)	55.7	21.4	52.9	100.0	72.7	75.0	66.7	22.2	29.4	70.6	43.8	50.0	18.8	72.2	58.8	62.5
Improved product transport	(%)	50.0	0.0	82.4	100.0	72.7	66.7	91.7	22.2	35.3	64.7	6.3	33.3	18.8	66.7	29.4	50.0
Improved farm roads	(%)	40.0	14.3	41.2	85.0	54.5	66.7	16.7	11.1	47.1	70.6	18.8	38.9	25.0	55.6	17.6	12.5
Post-harvest facilities																	
Construct storage facilities	(%)	57.4	7.1	76.5	95.0	27.3	100.0	75.0	11.1	52.9	88.2	43.8	38.9	18.8	88.9	41.2	62.5
Construct drying floor	(%)	36.5	0.0	58.8	95.0	18.2	83.3	58.3	0.0	29.4	76.5	12.5	11.1	0.0	27.8	0.0	56.3
Construct processing facilities	(%)	27.8	0.0	35.3	90.0	18.2	33.3	50.0	0.0	17.6	64.7	18.8	11.1	0.0	11.1	5.9	37.5

A serious constraint is the perception that the regulations that guide the activities of the FO were considered by the 37% of the respondents to be inadequate. However the regulations for each organization are based on a standard template of regulations under the Agrarian Services Act 1979. There is growing opinion (Abernethy 2004 personal communication) that standardized boilerplate regulations are not well suited to participatory management organizations as such groups need to be able to devise operational norms and procedures that reflect the perceived needs in the specific locations. More importantly the group needs to emerge with a shared perception of the benefits to be obtained in exchange for the commitments the organization demands of its membership. It is likely that the needs of a community near the head of the canal system will be different from those at the tail and therefore a slightly different set of organizational objectives will emerge.

The identification of inadequate regulatory framework and restricted participation by potential members is perhaps indicative that the communities in System C do not perceive the proposed organizations as dealing with issues they consider as major priorities. This is further supported by the respondents' identification of problems in agricultural support services and post harvest issues as being of higher impact than water management (Table 22). Therefore, interventions aimed at strengthening the organizations should, in addition to focusing on membership and leadership development, assist the organizations develop the capacity to evaluate and respond to the local requirements of the membership. Having the capacity to identify specific local constraints and developing the regulations to enable the FO to address those would provide a compelling reason for potential members to join the organization.

Table 24 Opinions of problems adversely impacting Farmer Organizations activities

Unit Name	% of farmers reporting						
	Insufficient Operational Activity	Little Farmer Interest	Restricted Operations Funds	Inadequate regulations	Poor farmer participation	Poor consultation	Poor Leadership
Bakmeedeniya	35	10	5	30	10	15	20
Bambarawana	5	0	10	45	15	15	-
Damanewewa	58	63	58	63	63	63	63
Henanigala South	70	70	40	60	30	55	55
Ihalagama	47	60	40	27	60	33	40
Kanichchigala	5	10	10	15	10	5	5
Kelegama	40	60	25	30	45	25	15
Muwagammana	25	20	25	40	30	55	45
Nikawathalanda	90	95	85	85	95	75	100
Paludeniya	5	10	10	-	30	10	15
Rankethgama	15	40	25	10	45	15	10
Salpitigama	20	35	15	45	50	60	45
Serupitiya	10	20	10	40	30	5	-
Sooriyapokuna	13	33	7	27	40	13	13
Veheragala	5	45	45	35	45	10	15
Average	**29**	**38**	**27**	**37**	**39**	**30**	**29**

Farmer opinions on upgrading infrastructure

The physical rehabilitation component of the System C project includes upgrading Field and D channels in addition to repair of the Trans-basin main and branch canals. The objectives of these interventions are to resolve problems that have emerged since completion of the construction phase resulting from inadequate maintenance as well as deliberate "damage" caused by individual or groups of farmers to obtain local improvements to irrigation supplies.

This section reports the opinions expressed by the survey respondents on the needs and objectives of the physical interventions of the upgrading project related to the expected impacts of the intended improvements to the infrastructure. Farmers views on specific outcomes including:

- improved irrigation services, including reduction of water shortages during the cultivation period, incidence of drought, role of government agencies and farmer organizations in water distribution and system O&M, reduction of illegal water tapping by farmers and control of water distribution by specific farmer groups
- improving system operations, including reduction of system losses due to leakage from the irrigation system, damaged irrigation system, including broken or dysfunctional gates in the system, inadequate intake facilities/pump diversion structure and other damaged or broken structures,
- improved system maintenance and reduction of the prevalence of weeds, soil and inert matter blocking canals,

Requirement for rehabilitation

Table 25 Farmers view of rehabilitation requirement vs. achieved yields

Unit Name	Rehabilitation required % respondents	Maha Yield t/ha		Yala Yield t/ha	
		Yes	No	Yes	No
Bakmeedeniya	75	4.35	3.68	4.37	3.45
Bambarawana	100	4.22	4.00	4.23	4.00
Damanewewa	85	4.56	3.89	4.18	3.59
Henanigala South	100	3.44	2.97	3.82	2.97
Ihalagama	100	4.29	-	4.09	-
Kanichchigala	65	4.02	3.83	3.84	3.84
Kelegama	75	4.27	4.73	3.69	4.98
Muwagammana	94	3.78	4.26	3.94	4.15
Nikawathalanda	100	4.66	1.80	4.24	2.25
Paludeniya	65	4.34	3.28	4.21	4.13
Rankethgama	79	4.56	4.38	4.32	4.12
Salpitigama	100	4.14	-	4.24	-
Serupitiya	65	3.87	4.28	3.96	2.92
Sooriyapokuna	89	4.01	3.22	3.88	5.73
Veheragala	100	4.64	4.67	4.48	
Average	**86**	**4.22**	**4.10**	**4.13**	**4.05**

A clear majority of respondents, 86% (Table 25), indicated that physical rehabilitation was necessary. However this group of farmers generally obtained higher mean yields than those suggesting that such investments were not required. This perhaps reflects the importance given to physical rehabilitation by farmers whose livelihoods are more dependent on farming, i.e. those who are better farmers are more concerned that the system operates effectively than those with alternate sources of incomes.

Improving Irrigation Services

Physical rehabilitation of infrastructure is expected to have direct impacts on the quality and quantity of irrigation services received by farmers at System C. In order to be able to quantify these impacts farmers were requested to provide their views on the quality of these services under the conditions prior to the project interventions. Of critical importance to farmers is the reliability and quantity of irrigation deliveries. These are adversely impacted by excessive system losses upstream either due to unauthorized abstractions or poor maintenance.

Reliability of Irrigation Deliveries

A slight majority of farmers, 55.77% (Table 26) indicated that irrigation supplies generally arrived in a timely fashion. However, the reported levels of satisfactory performance varied markedly between the units surveyed. Specifically the village units of Bakmeedeniya (21%), Damanewewa (11%), Henanigala South (29%) and Nikawathalanda (26%) appear to be particularly poorly served.

The reported yields appear to support the farmer perception that timeliness of supply is crucial to satisfactory agricultural performance with farmers in Bakmeedeniya, Henanigala South and Nikawathalanda that reported timely water delivery generally obtaining higher yields than those not satisfied with irrigation reliability.

Table 26 Timeliness of water supply vs. yields

Unit Name	Farmers reporting timely supply %	Maha yields t/ha		Yala yields t/ha	
		Yes	No	Yes	No
Bakmeedeniya	21.05	4.29	4.25	4.31	4.19
Bambarawana	82.35	4.24	3.90	4.20	3.90
Damanewewa	10.53	3.80	4.44	3.74	4.05
Henanigala South	28.57	3.89	3.24	4.00	3.72
Ihalagama	53.33	4.73	3.89	4.34	3.81
Kanichchigala	78.95	3.99	3.74	4.01	3.35
Kelegama	53.85	4.71	4.00	4.79	3.32
Muwagammana	56.25	3.63	3.88	4.13	3.90
Nikawathalanda	26.32	4.71	4.64	4.64	4.11
Paludeniya	94.12	4.07	2.88	4.38	1.63
Rankethgama	85.00	4.45	4.23	4.23	4.59
Salpitigama	65.00	4.13	4.15	4.08	4.60
Serupitiya	60.00	4.35	3.56	4.47	3.57
Sooriyapokuna	55.56	3.61	4.26	3.43	4.16
Veheragala	64.29	4.50	4.85	4.36	4.69

Adequacy of irrigation deliveries

A slightly larger majority, 60.46% (Table 27), of farmers expressed general satisfaction with the quantity of irrigation deliveries. However, the farmers of Bakmeedeniya, Damanewewa, Henanigala South, Ihalagama and Nikawathalanda were dissatisfied with the quantities of water received during the cultivation.

It is notable that in selected villages, for example Bambarawana, Muwagammana and Paludeniya, the average yields of farmers expressing dissatisfaction with the volumes of irrigation were higher than those satisfied with the irrigation service. Although not conclusive this may indicate that farmers are aware of the relative levels of supply to their immediate neighbors and neighboring villages. Where the neighbors supply is perceived to be greater than the supply provided to the individual this results in dissatisfaction with the supply provided, even if the supply is clearly adequate for successful cultivation.

Conversely, in the Ihalagama, unit farmers expressing satisfaction with volumes of supply were able to achieve yields averaging more than 1.2 tons/ha greater than the less well served farmers during each season.

Table 27 Satisfaction with quantity of irrigation deliveries vs yields

Unit Name	% of farmers Satisfied	Maha		Yala	
		Yes	No	Yes	No
Bakmeedeniya	40.00	4.13	4.32	4.09	4.29
Bambarawana	75.00	4.24	4.40	4.20	4.56
Damanewewa	10.53	4.46	4.36	4.40	3.97
Henanigala South	46.67	3.86	3.01	3.88	3.78
Ihalagama	43.75	5.01	3.57	4.65	3.53
Kanichchigala	85.00	3.95	3.95	3.92	3.43
Kelegama	53.85	4.71	4.00	4.79	3.22
Muwagammana	87.50	3.82	4.25	4.07	4.25
Nikawathalanda	27.78	3.60	5.14	4.19	4.27
Paludeniya	83.33	3.90	4.48	4.14	4.40
Rankethgama	84.21	4.43	4.47	4.40	4.15
Salpitigama	55.00	4.53	3.36	4.57	3.81
Serupitiya	50.00	4.54	3.55	4.90	3.34
Sooriyapokuna	85.89	3.87	4.25	3.38	3.30
Veheragala	80.00	4.65	4.60	4.54	4.30
Average	**60.46**	**4.25**	**4.11**	**4.27**	**3.91**

While problems with equity, adequacy and reliability of irrigation supplies are clearly perceived problems by the farmer communities, the causes of these problems often occur at a location remote from the village. Failures of canal structures, inappropriate, unscheduled or unauthorized diversions in upstream locations are all operational problems that result in failures to deliver the expected level of service at farm level.

Improving system operations

Responses to the survey indicate the farmers are well aware of the issues and causes of less satisfactory levels of irrigation service performance. The questionnaire pro-forma guided the

respondents to identify key issues including water losses from the irrigation system due to leakages and unauthorized diversions; problems with damaged canal and other structures; damaged or non-operational gates; and inadequate management of water distribution indicated by a lack of monitoring equipment.

System water losses

Farmers are acutely aware of water leakages from the irrigation system, with nearly 50% of the respondents indicating that leakages impacted on their cultivation. However, it should be noted that water leakage is not synonymous with water wastage; as water escaping from an upstream location in the canal is often utilized productively by other farmers or may return to the canal system at a lower point downstream. But these informal distribution systems can often lead to a sense of a lack of control by the responsible authorities leading to other disruptive actions such as canal damage which was reported by nearly 58% of the survey respondents, reaching 80% of respondents in Damanewewa, Nikawathalanda, Rankethgama and Serupitiya villages. Nearly 27% of farmers reported that broken or damaged gates impacted agriculture in their villages to a greater or lesser extent.

Some 27% of farmers reported that the lack of instruments for water monitoring adversely impacted their operations. While this may be taken to indicate a desire to have greater regulation of water distribution decision to implement an extensive network of gauging posts should be taken with caution, many such systems are costly to operate and maintain. Frequently the gauges are installed and no systematic use is made of the observations and the data obtained is often of little value. A well designed network of gauging instruments at key locations that is well maintained and monitored regularly as part of daily operations may be a more effective response than simply installing a gauge post at every regulator and farm ditch outlet.

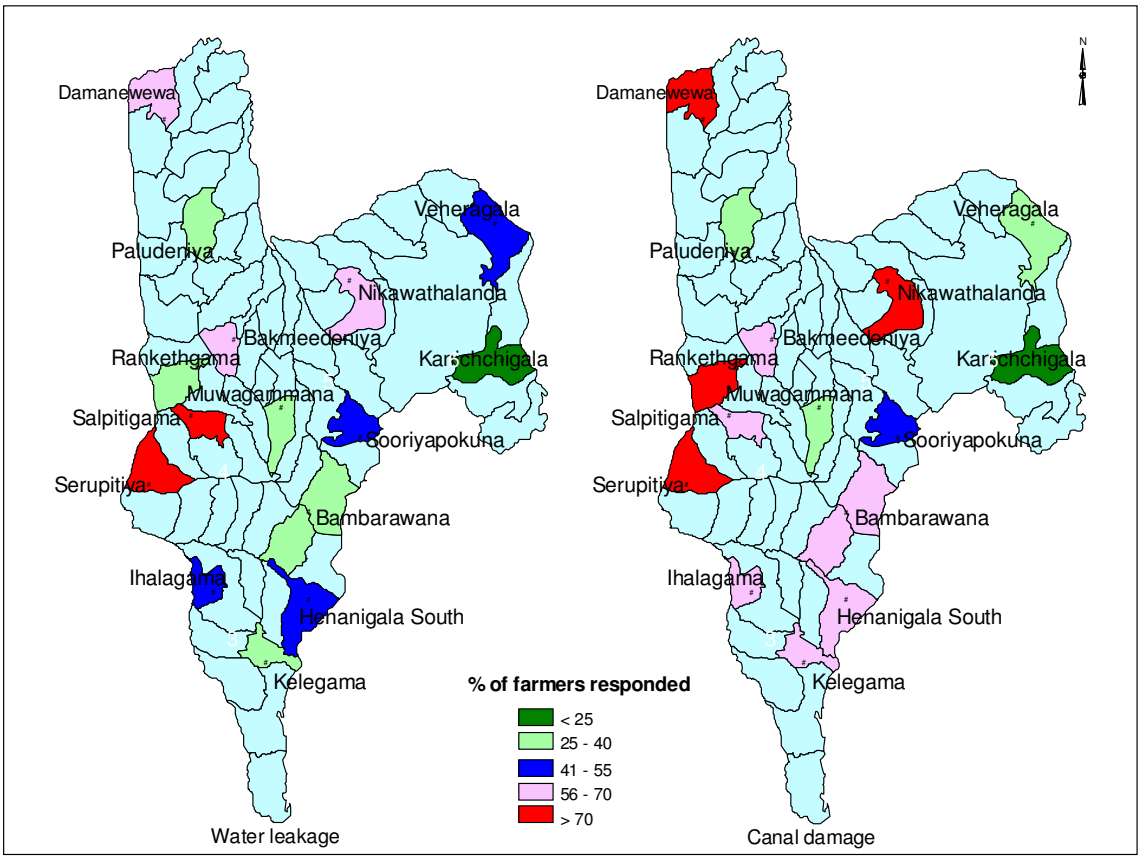
Control of water distribution by influential groups of farmers is an important problem reported by 30% of all respondents. In Kanichchigala up to 80% of farmers reported that this is a problem in the village. Inequity of water distribution is a major issue that tends to create conflict within the farmer community and therefore the project must take appropriate action to identify the causes of such behavior and seek acceptable solutions in order to reduce the conflict among the farmer community.

However, although control of water distribution by influential farmers was recognized as a problem by the majority of respondents, only 8% of farmers indicated they were adversely impacted by the authorized authorities not maintaining full control over water distribution at System C.

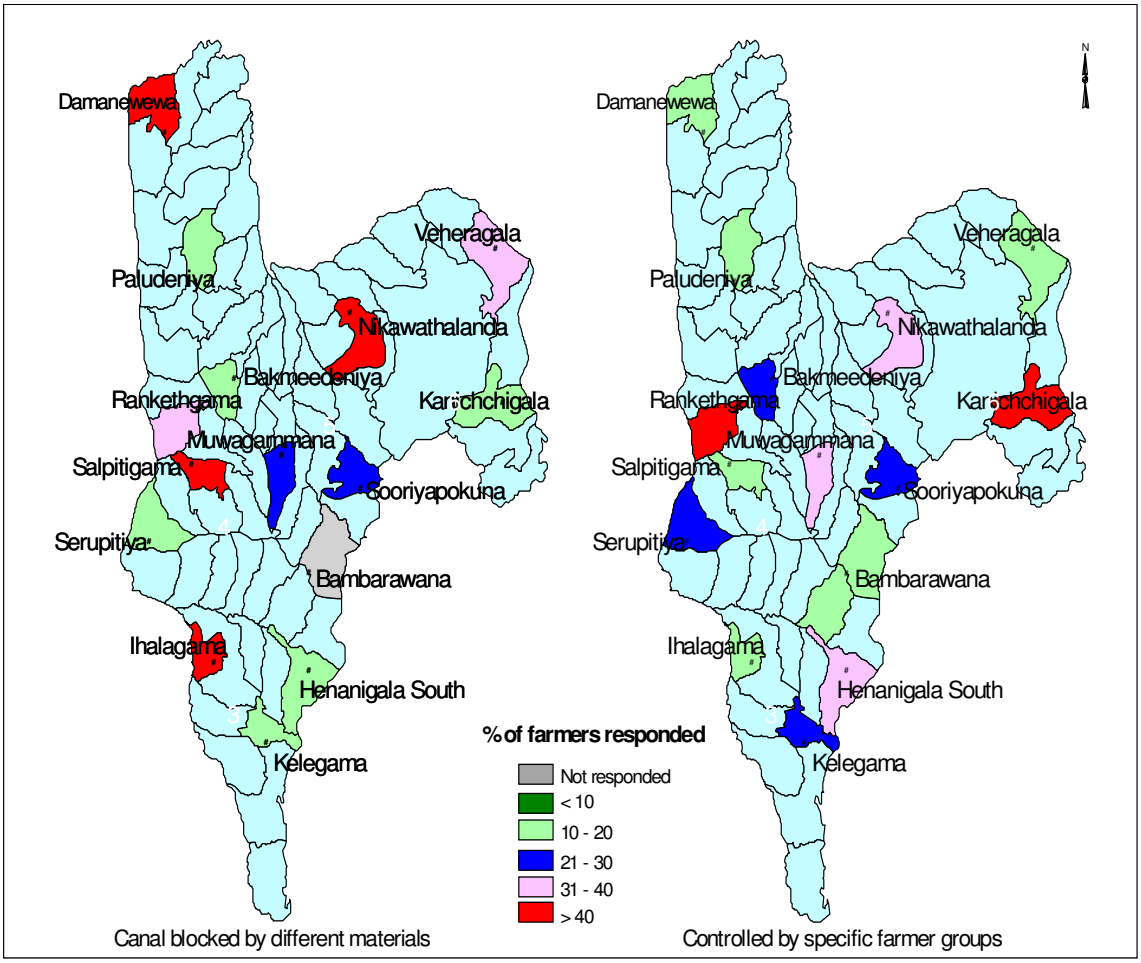
System Maintenance

About one third of respondents (32%) reported poor system maintenance was perceived as a problem, with this group indicating the presence of weeds, sediments and other inert materials in the canals disrupted smooth operation of the distribution system. Approximately 10% of farmers indicated that problems with intake structures and pump units adversely affected water supplies, while nearly 20% indicated that illegal tapping of water from the canal system was problematic.

Among the problems related to irrigation system in different units, canal damage (57.67%), leakage (48.33%), canal blocked by different materials (32%) and controlled by specific farmer groups (30%) were reported in most of the units. While these problems and their impacts are unit specific they were clearly perceived to adversely impact cultivation practices and finally on yield. The relative prevalence of these problems is presented in GIS maps Figure 12 (a) to 12 (b).



(a)



(b)

Figure 12 Major problems related to irrigation system in different units

Cultivation in canal reservations was not considered to be a severe problem and was identified by only about 10% of farmers overall.

Comments on survey procedures and post-collection processing, storage and presentation

A key objective of the baseline and follow-on surveys is to enable system management; central agencies; and funding organizations track and evaluate the impact of the project interventions on the livelihoods of members of the rural communities within the project area. This presupposes the ability and wish to make before and after comparisons between data sets obtained through surveys.

Survey Procedure

The survey instrument designed by the main consultants, Nippon Koei, and revised following a review by IWMI is an effective tool to identify the major characteristics of rural households and the major constraints imposed by the support systems serving the communities in areas such as System C. IWMI indicated some concern over the recruitment of local school staff as enumerators for the baseline survey, the survey does overall appear to have been conducted efficiently and effectively. However it has not been possible to undertake an analysis of the results obtained by specific enumerators in order to evaluate the reported data for systematic bias introduced by the enumerators, either by accident or deliberately. In future surveys it is proposed that independent enumerators are employed to collect a sub-sample across the survey area in order to allow identification of any systematic variations introduced by the enumerators. Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI) should be considered as a key resource for quality control of such surveys.

Data storage and analysis

Nippon Koei selected MS Excel spreadsheets as the storage and processing medium for the data obtained by this survey. While this is a pragmatic solution for the collection of a discrete set of survey results with professional staff available to develop and test the data storage and processing system this solution is not recommended for general use. MS Excel is a powerful and widely used data analysis tool. However it is not well suited to the development and management of large relational databases such as would be required to enable comparisons of subsequent surveys or to enable comparison of performance across irrigation systems. Furthermore data quality control in spreadsheets is notoriously difficult, and with large data sets the performance of the data entry systems degrades as the size of the data set increases. While this can be resolved in the short term by use of powerful computers with large memory allocations, this is not a practical solution in the longer term.

Furthermore the use of spreadsheets as the storage mechanism tends to encourage the co-mingling of data storage with intermediate data processing stages. In the case of System C the analysis of farm incomes and other factors is distributed across the individual spreadsheet files used for each village unit. While the consultants have made a very good job in ensuring the analysis applied in each sheet is consistent across the entire set of data sheets, maintaining such consistency into the future is a major task. A simple typing error in a single cell will propagate an error throughout the analysis system that would prove difficult to identify.

MASL and the Sri Lanka Irrigation Department (ID) will increasingly be faced with demands from government and donor agencies to demonstrate the impact and benefits obtained by investments in irrigation hardware and related software. There is a clear need for these departments to establish standardized approaches to benefit monitoring and evaluation that can be applied in baseline and project impact analyses. However, in the absence of a standardized system owned by these authorities, project consultants and system operators will be faced with developing and applying simple standalone systems, such as at System C, that do not contribute to establishing the necessary capacities within the agencies to undertake routine performance and impact assessments.

It is strongly suggested that MASL and the Irrigation Department collaborate to establish a standardized project monitoring and evaluation system using similar, if not identical, survey instruments for use at all systems and by consultants and departmental evaluation sections. A relational database with appropriate data entry templates and error trapping routines should be developed and made available at all system offices and for use by consultants when working at a given scheme. For simplicity and compatibility with the most commonly used office software the MS Access database system is suggested as a suitable tool for this purpose.

Data presentation
The data collected and analyzed in the course of baseline and subsequent follow-on surveys are typically presented in tables and simple graphical formats. However, while these formats are well suited to enabling representation of temporal changes in conditions they are less well suited to illustration of the spatial variability of important characteristics. It is recommended that in addition to the use of tables, graphs and written commentary the use of GIS software linked to the proposed database and analysis systems be implemented and staff trained to utilize these relatively new tools. Both MASL and ID have GIS units that are staffed with capable personnel; however this staff is often only marginally involved in project related work.

The spatial representations of data presented in this report are simple maps derived using key survey data and base maps prepared by the MASL Forestry group at Polgolla. Considerably more detailed information could be derived form the survey data and presented through these systems with a fairly modest investment on the part of the agency in terms of additional staff training, software and hardware.

Observations and recommendations

Standardized Benefit Monitoring and Evaluation
Nippon-Koei have developed and implemented a detailed socio-economic and agricultural performance survey. It is understood that a similar survey template has been implemented elsewhere in Sri Lanka by the consultant with a considerable degree of confidence in the results obtained. It is suggested that the key line agencies, research groups and leading funding agencies, active in the Irrigation and Drainage sector in Sri Lanka, organize a review of these instruments and design a standardized baseline and monitoring survey tool for future use. Careful design of the basic tool will enable widespread use, enabling site specific data requirements to be addressed by the addition of further sections, remembering the need to recognize the value of the time of the respondent.

The development of a standardized survey tool will enable the development of a standardized storage and analysis tools, in addition to the generation of a cadre of skilled and experienced field enumerators able to implement such surveys. These investments will lead to considerable savings in survey costs and improvements in survey accuracy.

Survey procedures
Nippon-Koei employed local school staff to implement the survey at System C. IWMI raised some questions about the use of well-known local persons to implement a survey that probed

the socio-economic status and household incomes. Further investigation of the precision of the responses obtained and the consistency of results between different enumerators is recommended.

In future baseline and follow-on surveys it is proposed that independent enumerators are deployed to collect a sub-sample across the survey area in order to allow identification of any systematic variations introduced by the enumerators. The ARTI should be considered as a key resource for quality control of such surveys.

Data management

HARTI and organizations such as IWMI and the national ICT training institutes should be engaged to develop and support a general database management capacity in the leading irrigation and agricultural agencies. Donor agencies should ensure that future project consultancies are required to utilize a standardized survey and database management system, extending the system when additional information or site specific features need to be captured.

The use of spreadsheets as the primary data storage and analysis medium is not recommended. These tools are highly effective for selected purposes; however they are not well suited to the maintenance of large relational data sets. Furthermore the ease with which errors in processing can be introduced makes these tools not suited to general application in routine use for this purpose. It is strongly recommended that MASL and other agencies develop and adopt a standardized tool kit of data management and analysis software based on relational database systems, statistical analysis software and GIS applications.

Adoption of these practices will lead to savings in cost of surveys, avoid repeat surveys that are incompatible with earlier surveys and also enable development of a better overall picture of the status of the irrigation and drainage sector in Sri Lanka.

Data Presentation

It is recommended that in addition to the use of tables, graphs and written commentary the use of GIS software linked to the proposed database and analysis systems be implemented and staff trained to utilize these relatively new tools. Furthermore, the presentation of results as simple averages is less informative than showing distributions of, for example, yields. Also the use of Inter quartile ratios (Figure 7) allows the comparison of the relative performance of groups in different locations and across time steps.

Results of 2000 Baseline survey, System C

Notwithstanding the comments regarding the survey process and data management systems employed to implement the baseline survey at System C, the consultants have accomplished the objective of capturing a baseline data set against which the impacts of the upgrading project may be assessed over time. The tools and techniques employed to achieve this should be studied and where appropriate adopted in similar development activities in Sri Lanka, subject to the constraints noted above.

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Annex 1: IWMI's Comments to fine-tune the draft questionnaire

MAHAWELI SYSTEM C UPGRADING PROJECT

Baseline Survey Questionnaire

General Comments

The questionnaire is relatively well structured and designed for data entry to computerized database systems. With appropriate geo-coding it will be possible to produce, both, spatial and temporal differentiated information by linking the data with the existing GIS systems prepared by MASL Forestry Division, Pologolla.

Although the questionnaire is well structured we recommend that the section that focuses on cost of production (COP) information should be removed from the questionnaire applied generally. It is not necessary to survey 400+ respondents to establish cost of production data as we would expect their to be little variation across the system. By removing Question 3 from the general questionnaire the time required per respondent would be reduced considerably, making it possible to expand the sections relating to systems operation and also farmer organizations. Both these sections are considered to be inadequate to enable the formation of a viable baseline on which to base impact evaluations during and after the interventions.

We would expect the questionnaire as currently presented to require over two hours to adequately capture the necessary information. It may be considered that the enumerator will become experienced and will be able to increase the speed of later interviews, however it must be cautioned that for the farmers answering the questions it will be a first for everyone and they will require time to think of their answers. Hurrying the respondents through the questions will exacerbate the tendency for farmers not to give accurate responses to the later questions.

The Cost of Production data (Question 3) can be recast as a stand alone questionnaire by adding general family information to the head and implementing a separate interview series for this section. A total sample of between 40 and 60 respondents, selected by stratified random sample, will be adequate to provide the required information. The sample can be stratified, firstly, by location and, if desired, by farmers background.

When the Question 3 section is recast as a stand-alone questionnaire, we would recommend reformatting the response sheet to landscape, consolidating all crops on the same page. Include crop and season headings on each page. This will simplify the task of the enumerator by saving the necessity to flick from page to page to check which column is which.

Specific recommendations

Question 1 – Household background

Q1.4,2 – Village history

Recommend removing this question and ask the Block inspector instead.

Q1.4,3 – Experience

Recommend rephrasing as:
How many years have you been operating a farm either here or elsewhere.

Q1.7 Home Durable

Recommend moving Q1.7 before Q1.6.

Q1.8 Section 2 – Land Tenure

We recommend the addition of two additional forms of land tenure. Namely:

i) Taken on Mortgage/Loan;
ii) Official Allocation.

Q1.8 Section 3 – Breakdown of land-holding

Make this question specific to a season – eg Maha 2000-2001. Land-holdings change from season to season.

Q1.8 Section 5 – Land Buying and Selling

We assume that the block manager would be able to provide this information, without the necessity to repeat the question to every respondent. It seems a little redundant here.

Question 2 – Hiring Cost of Farm Power

Q2.1— Inventory of Farm Machinery and equipment

We recommend moving Q2.1 to become Q1.10. This information is about numbers of items, rather than costs. It sits more naturally with the information in Question 1.

Question 3 – Crop Production and Farming Practices (In last one year)

We recommend removing this entire group of questions to make a separate questionnaire focused on establishing cost of production. This survey instrument can be used more frequently than the full Baseline questionnaire if required, and can be enumerated for a smaller sample than the full baseline survey.

Q3.9,g – Sold - to whom did you sell and its quantity.

We suspect that farmers will generally have sold and disposed of their crops through multiple events during the post-harvest period. We think it unlikely they will be able to recall the size or timing of individual sales and thus the total quantities disposed of to each category. Perhaps replace the question with something like:

What percentage of your crop did you dispose of immediately post-harvest?

Who to

Q3.4 – Total Quantity and unit-price of chemicals sprayed

Recommend adding an additional column for Application No. Plus ask farmers to give the trade names of chemicals used in each application.

Question 4 – Income from Home garden, livestock etc…

We recommend simplifying this question as farmers unlikely to have this information in System C.

Question 5 – Non-farm income

OK

Question 6 – Living Expenses

We recommend that farmers be asked to recall their expenditure on consumables on the basis of a week, rather than a month. These are questions 6.1, 6.2, 6.3, 6.5, 6.6, 6.12 & 6.14. The other items of expenditure are more logically asked as an annual figure.

Question 7 – Present Farming Situation

OK

Question 8 – Extension Services

OK – but be careful in laying out the questionnaire to avoid confusion for the enumerator when skipping sections as indicated.

Question 9 – Agricultural Credits

OK

Question 10 – Marketing

OK

Question 11— O&M of Existing irrigation system

See Question 19, 20, 21, 22 & 23 of Sample RBE questionnaire.

Question 12 – Irrigation Service Charge

Q12 is OK as it stands. But check what current MASL policy is regarding current and future Irrigation Service Charges. If there are no charges, cut the irrelevant sections.

Question 13 – Existing Farmer Organizations

Add additional questions to establish the functionality and viability of existing organizations. See Annex A – Indicators used for assessment of farmer organization performance.

Question 15 – Gender

OK

Question 16 – General Affaire of People in the Community

OK

Annex 2: IWMI's comments after pilot test of the questionnaire

Experience in Administering the Benchmark Questionnaire in System C

These observations and recommendations are based on the reports from the IWMI enumerators who pilot tested the N-K draft questionnaire at System C.

- Most boxes in the questionnaire consist of numbers. When we mark "✓" inside the boxes it may not be clear enough.

- **1.3 (5) Occupation Column** – Farming is the occupation of the householder. Since this is described in detail later, it is not necessary to mention it in this column. If the householder's occupation is not farming, then it is important to record it. When filling in the monthly income (next column) according to the occupation, it is difficult to state the monthly income from farming. It may not be correct if calculated, because the income of 2 seasons is spent during the whole year. When compared, income and expenditure are the same. Expenditure incurred during a non-income month being the same as future income. This may be a major problem.

- **1.4 – 1.4.1** – Questions regarding the period of residence in the area. But, there are farmers who have been there from their birth. There is no box to mention this.

- 1.4.3. Comes after 1.4.1. **1.4.2** is missing.

- **1.8** – Extent of land owned out of the total land and extent cultivated out of the land owned should be incorporated into this question.
  - Under **1.8.1**, for land tenure answers should be obtained referring to a specific year/season.
  - In **1.8.3**, a column titled "Other" should be included in the table (Payment in Cash) for 50% of the yield, i.e. to show the extent of land partially cultivated.

- **Q. 2.** – Hiring of Farm Machinery is the main title. Question 2.1 should be amended to read as "What are the farm machinery owned by you?"

- **2.2** – Table is named as Hiring Charges. Current hiring charges in the area should be indicated first. And then methods used by this householder should be identified. A column to be added to indicate use of owns tractors/animals. The table should be simplified to show activities such as first ploughing, second ploughing, and leveling, threshing etc.

- Table 2.3 should also be simplified to suit the agricultural patterns of the area. Accurate answers could be obtained if questions are simplified including separate activities such as clearing of field bunds, repairing of field bunds, sowing, transplantation, weeding,

fertilizer application, application of agro-chemicals, Harvesting etc. Currently Table 2.3 does not include any details of sowing.

- **Labor** – Hired, mutual sharing (Attam) and family labor should be sub-divided as male, female, children etc.

- Q. 3 – Overly Complicated. Should be simplified to obtain details of previous maha and yala separately. In the present form of this question it is difficult to obtain accurate answers from farmers. It is also a tiring task for the farmer. Data collector is also faced with difficulties. When obtaining details from farmers' memories, details of activities from the beginning to the end of a cultivation season can be obtained. As such, questionnaire should be simplified to obtain data on crops of one season first, and then the other season. If so answers will be more accurate.

- **3.4** – Insufficient space to write names of chemicals. Number of rows to be increased. A column to be included to name the unit and quantity in each unit.
E.g.

Name	Units price
Endosalfan	01 Bottle
Surcorper	01 Can

Add a column

Qty. in each unit
Bottle = 400 ml
Can = 3 lt.

- **3.5 Seeds** – Add a column for Use of their own Seeds

- **3.6** – Labor should be subdivided explain manpower. Accurate details could be obtained by including to show family labor (male, female, and children), contract (male, female and children) and hired labor (male, female, and children).
  - Format of table **3.6** has been spread unnecessarily. Agricultural activities can be taken into a table in the order they are carried out in the area. Details should be obtained separately for each season. The table can consist of details of activities from first activity (clearing of field bunds) to end seasonal activity (threshing) for example a table as follows may be suggested.

Activity	Family labor			Contract			Hired labor			Use of Machinery
	No. of days			No. of days			No. of days			
	M	F	C	M	F	C	M	F	C	
1. Clearing of field bunds										
2. Ploughing										
3. Supply of water										
4. threshing										
(?)										
(?)										

- It is easy for the data collector as well as the farmer to have one table for both labor and use of machinery. If so accurate answers can be obtained.
- In the questionnaire given to us, a column is not available to include answers for repairing of field bunds. Instead it is combined into the column for land clearing. Using one table per crop/season can minimize these deficiencies.

- **Q. 10** – 10.1 deals with sale of produce. Q.3 also mention sale of produce. As such, this question is irrelevant, or else should be changed. In no area paddy yield is taken to the fare to sell. It is sold in the field itself. The question should be changed to read as "How are crops, other than paddy, sold?"

- **15.4 Drinking Water** – No opportunity to mention about wells in the home garden.

- **15.6 Sleeping Facility** – Include under Q.1

- 17.2 – There is nothing that an individual can do alone to improve the social condition. As such, their answers will be about social activities that should be undertaken. Question should be amended to find out the most essential social improvements needed.

General Comments

1. Household questions should be asked separately. All connected questions should be in the same section. E.g. sleeping arrangements, drinking water, etc.
2. 4-wheel tractor should be included under use of machinery.
3. Remove income from the table on household information. It is better to discuss expenditure before inquiring about income.
4. Tables are complicated. Tables should be formatted in such a way that it can be easily filled. Can be in the order that activities are performed in the agricultural sector.
5. Participation in gender, agriculture, housework and social activities should be taken separately.
6. Although there is no box in the questionnaire to mention about the time taken to administer it with a farmer we have calculated that at least 1.5 hours is needed to fill one questionnaire by an enumerator trained for this purpose.
7. We had extreme difficulties to keep a farmer for a long period. Well-trained field assistants can better manage this, but casual staff hired as enumerators for a one-off survey assignment may not be able to retain the respondents' attention.

Annex 3: Spatial representation of the indicators

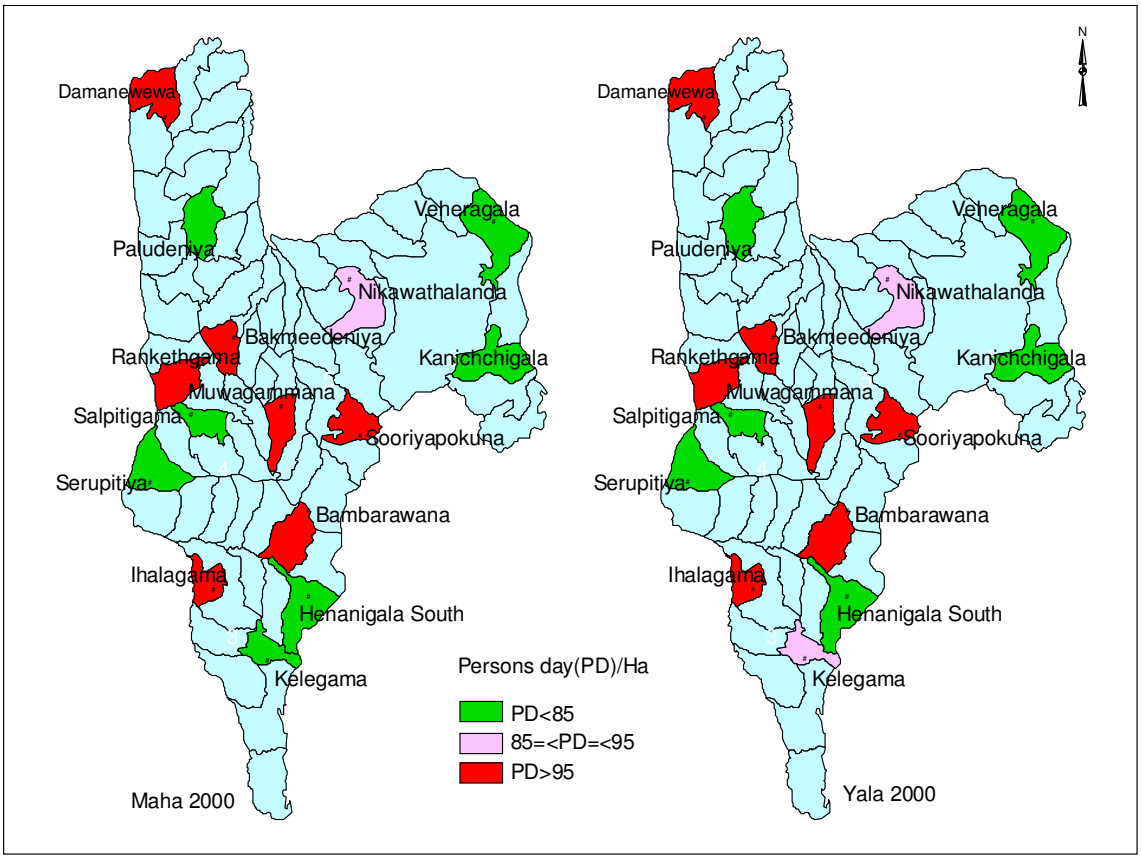


Figure 1: Average number of labor used in different units of the system

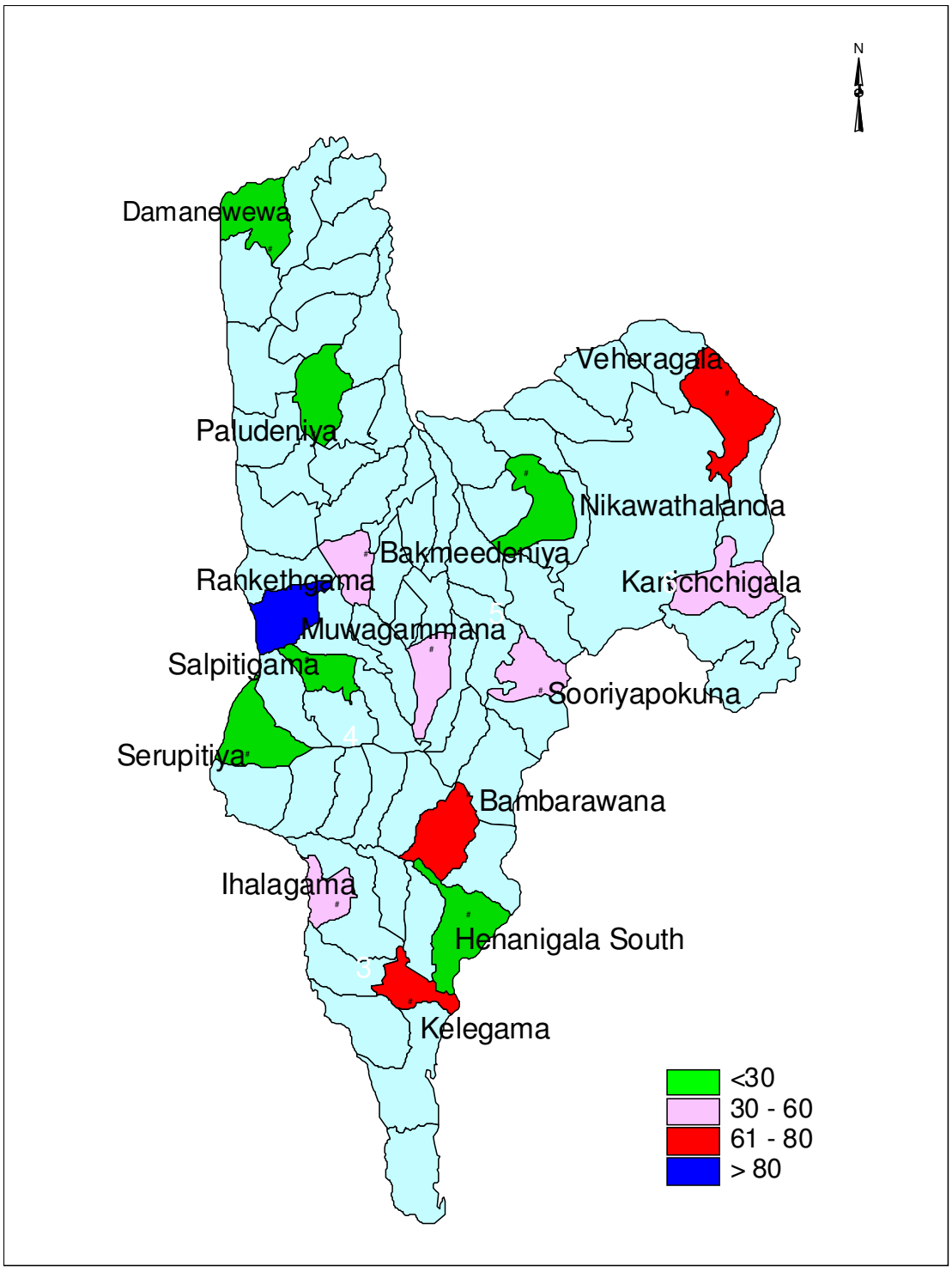


Figure 2: Distribution of percentage of second generation farmers in different units

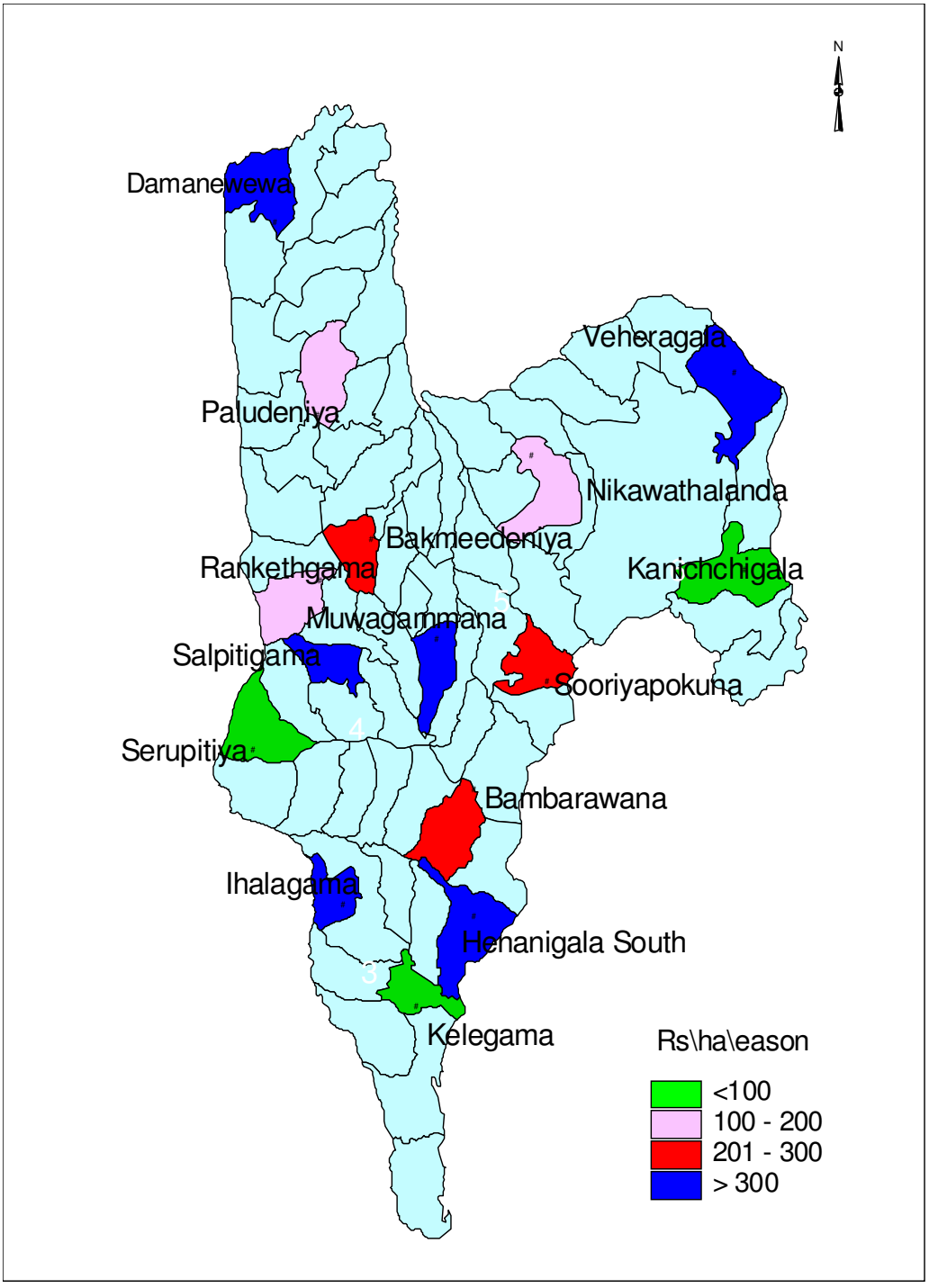
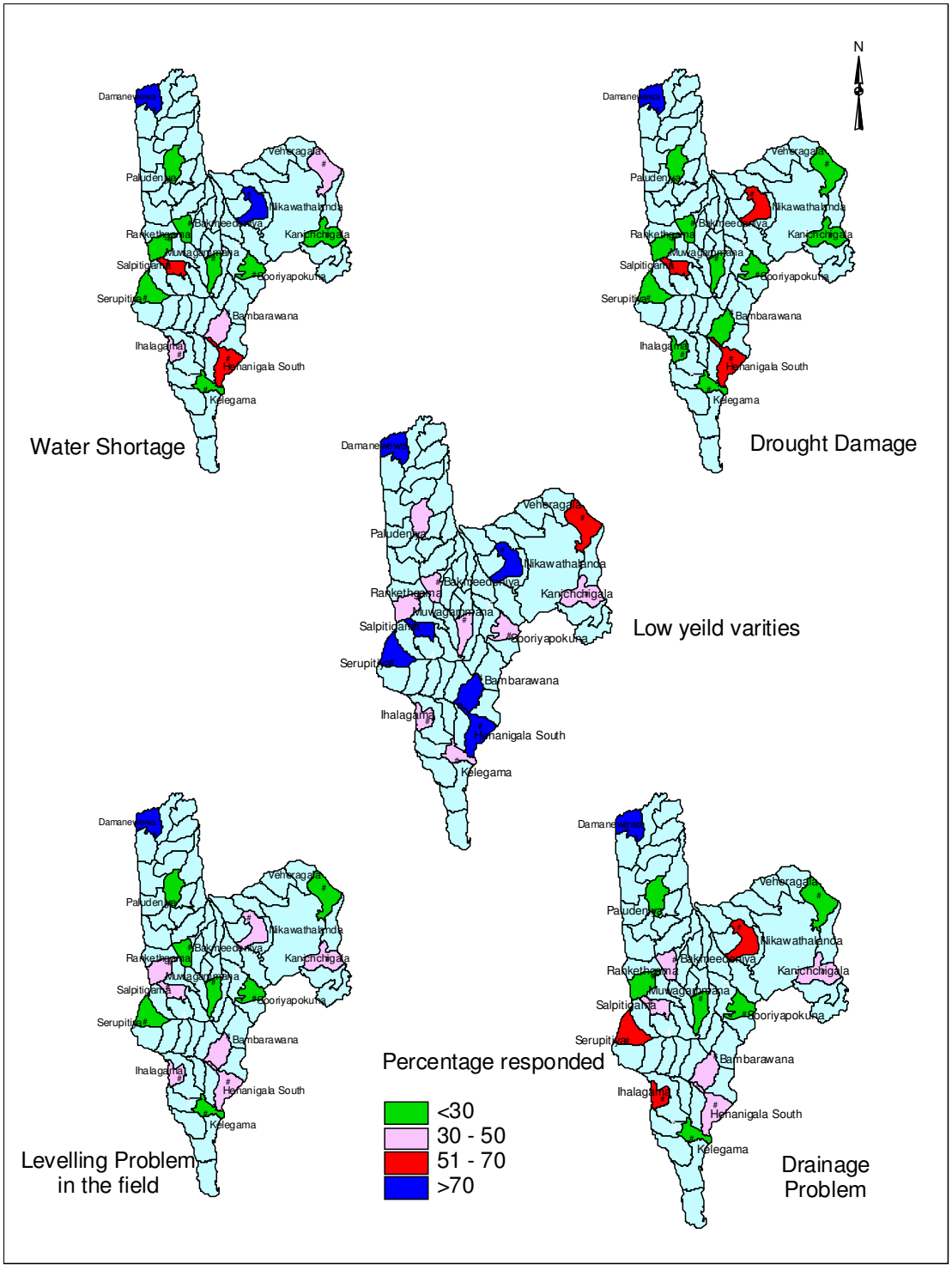
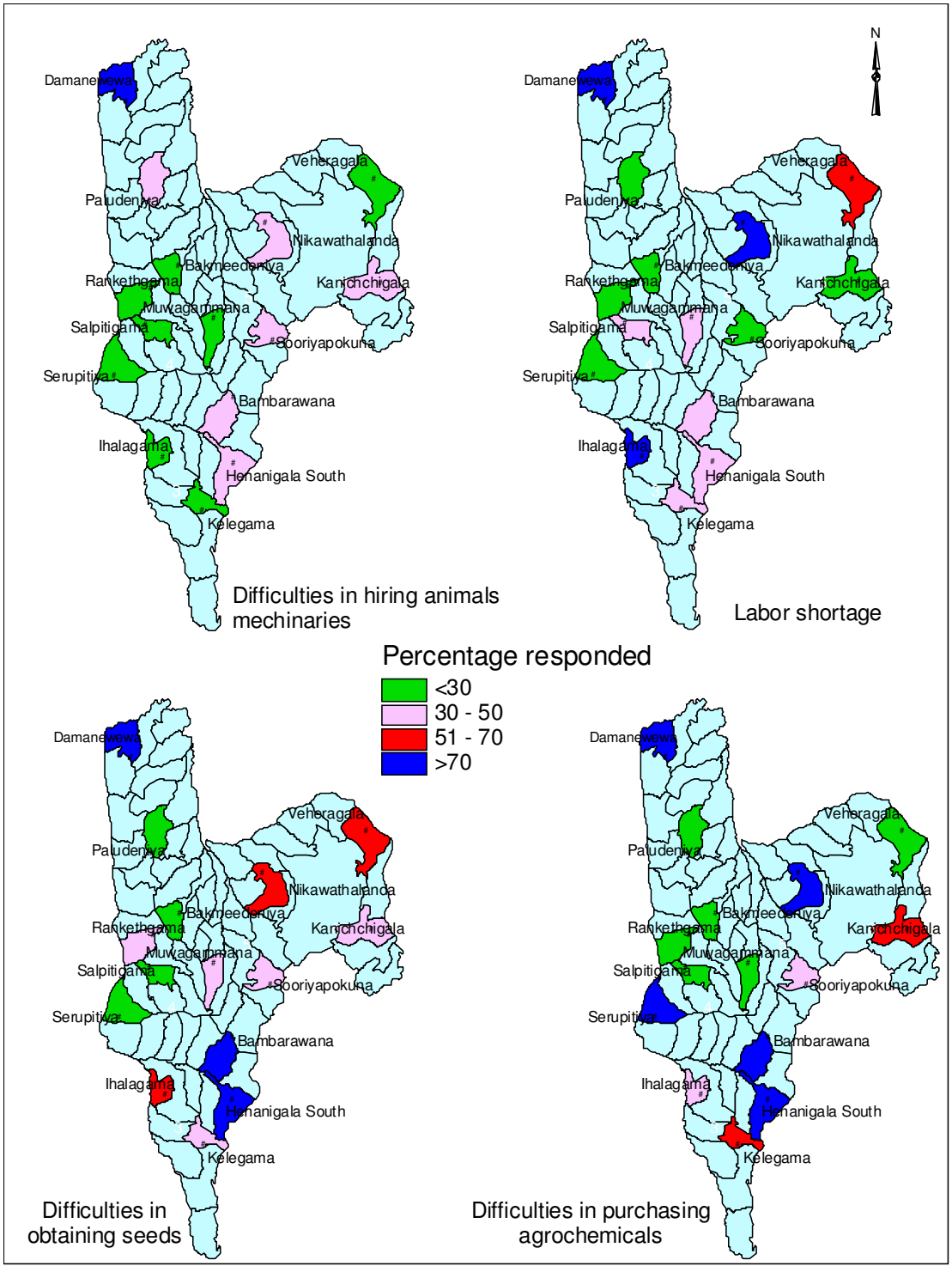


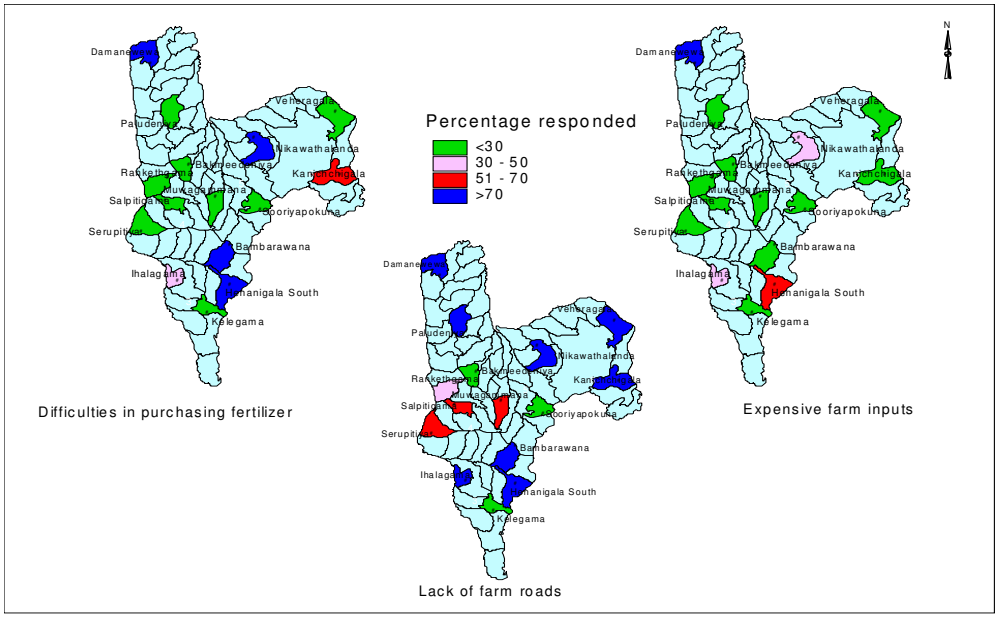
Figure 3: Amount of irrigation services fee paid by farmers in different units


N
Water Shortage
Drought Damage
Low yeild varities
Levelling Problem in the field
Drainage Problem
Percentage responded
<30
30 - 50
51 - 70
>70
Damanewewa
Veheragala
Paludeniya
Nikawathalanda
Bakmeedeniya
Ranketheyna
Kanchchigala
Muwagammana
Salpitigama
Kooriyapokuna
Serupitiya
Bambarawana
Ihalagama
Henanigala South
Kelegama

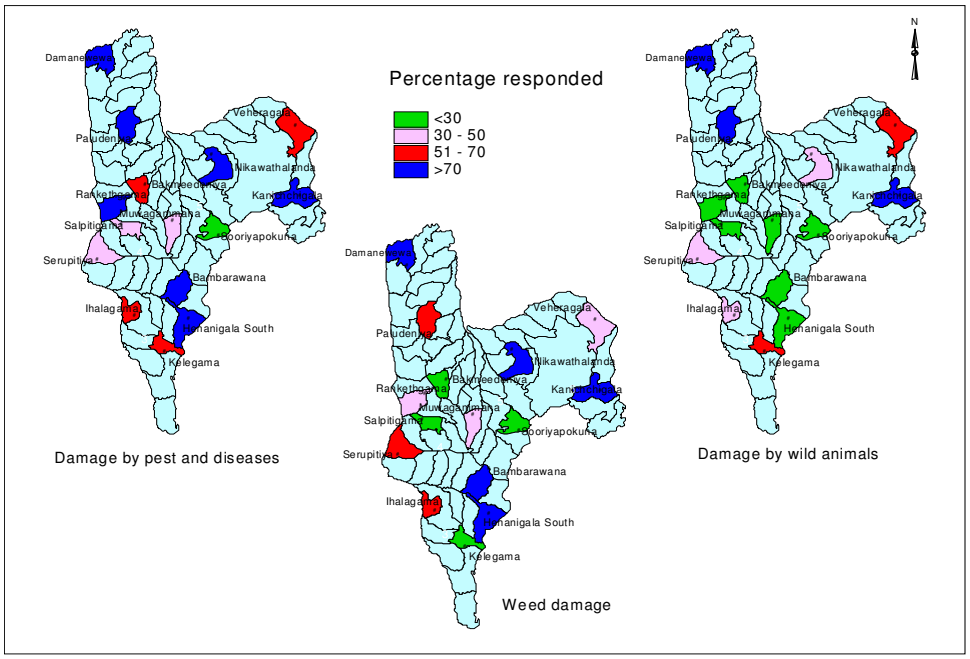
(a)


N
Damanewewa
Veheragala
Paludeniya
Nikawathalanda
Bakmeedeniya
Rankethagama
Kanichchigala
Muwagammana
Salpitigama
Sooriyapokuna
Serupitiya
Bambarawana
Ihalagama
Henanigala South
Kelegama
Difficulties in hiring animals mechinaries
Labor shortage
Percentage responded
<30
30 - 50
51 - 70
>70
Difficulties in obtaining seeds
Difficulties in purchasing agrochemicals

(b)



(c)



(d)

Figure 4: Agricultural and irrigation constraints faced by farmers in the different units (a to d)

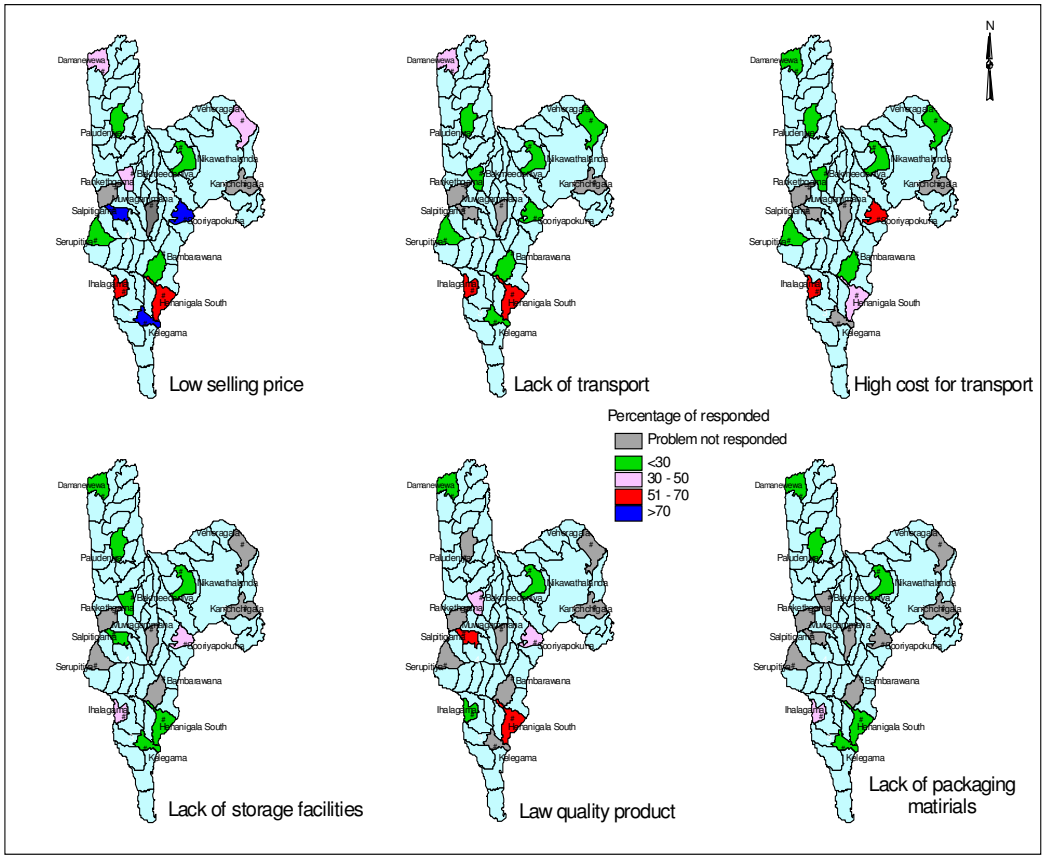


Figure 5: Post harvest problems faced by farmers in different units of the system