WORKING PAPER 69

Institutional Changes to Reduce Land Preparation Delay in the North Central Province of Sri Lanka

7 March 2003

Ronald Loeve, P.G. Somaratne, B.R. Ariyaratne, Markandu Anputhas and K. Jinapala

IWMI
International Water Management Institute

FUTURE HARVEST
IWMI is a Future Harvest Center supported by the CGIAR

Working Paper 69

Institutional Changes to Reduce Land Preparation Delay in the North Central Province of Sri Lanka

Ronald Loeve,
P.G. Somaratne,
B.R. Ariyaratne,
Markandu Anputhas
and K. Jinapala

International Water Management Institute

IWMI receives its principal funding from 58 governments, private foundations, and international and regional organizations known as the Consultative Group on International Agricultural Research (CGIAR). Support is also given by the Governments of Ghana, Pakistan, South Africa, Sri Lanka and Thailand.

The authors: Ronald Loeve is an Associate Expert, P.G. Somaratne and B.R. Ariyaratne are Senior Research Officers, Markandu Anputhas is a Research Officer, and K. Jinapala is a Research Associate, at the International Water Management Institute.

Loeve, R.; Somaratne, P.G.; Ariyaratne, B.R.; Anputhas, M.; Jinnapala, K. 2004. *Institutional changes to reduce land preparation delay in the North Central Province of Sri Lanka.* Working Paper 69. Colombo, Sri Lanka: International Water Management Institute.

/ institutional change / irrigation / land preparation / land preparation delay / water saving / Sri Lanka /

ISBN: 92-9090-549-2

Please direct inquiries and comments to: iwmi-research-news@cgiar.org

Cover photograph: *Ronald Loeve. Land preparation in Sri Lanka, June 2000.*

Contents

List of Figures iv
List of Tables iv
Appendix 1 Figures v
Appendix 2 Tables vi
Acronyms viii
Executive Summary ix
1. Introduction 1
    1.1. Objectives 2
    1.2. Institutional Arrangements in Major Irrigation Systems 2
    1.3. Institutional Arrangements to Improve Land Preparation Progress 3
2. Methodology 3
    2.1. Selection of Irrigation Systems 3
    2.2. Data Collection 4
    2.3. Study Area 5
        2.3.1. Climate in the North Central Province 5
        2.3.2. Physical System Characteristics 5
        2.3.3. Socio-economic Conditions of Selected Systems 6
3. Results 8
    3.1. Cultivation Meetings 8
        3.1.1. Water Situation at the Time of Cultivation Meetings 8
    3.2. Land Preparation Progress 11
        3.2.1. Pre-seasonal Maintenance 11
        3.2.2. Land Preparation Progress:
            Period between Water Issues and First Plowing 12
        3.2.3. Land Preparation Progress:
            Time between First Plowing and Second Plowing 13
        3.2.4. Land Preparation Progress:
            Time between Second Plowing and Third Plowing 14
        3.2.5. Land Preparation Progress:
            Time between Third Plowing and Sowing 14
        3.2.6. Overall Progress of Land Preparation 15
    3.3. Reasons for Deviation from the Agreed upon Cultivation Calendar 20
        3.3.1. Number of Days Delayed 20
        3.3.2. Period in which Land Preparation Delay Occurred 21
        3.3.3. Major Reasons for Delays 21
        3.3.4. Reasons for Water Problems 22
        3.3.5. Non – water Related Factors Affecting the Progressof Land Preparation 23
        3.3.5.1. Financial Problems 23
        3.3.5.2. Tractor Availability Problems 23
        3.3.5.3. Labor Problems 23
        3.3.5.4. Seed Paddy Problems 24
        3.3.5.5. Share/Leasing Arrangement Problems 24
        3.3.5.6. Delay Due to Political Environment 25
        3.3.5.7. Institutional Issues 25

3.4. Number of Farmers and Acreage with Land Preparation Delay 26
3.5. Impact of Land Preparation Delay on Variety Duration Selection and Crop Yield ... 27
3.6. Impact of Land Preparation Delay on Farmer Income 28
3.7. Impact of Land Tenure Status on Crop Yields 29
3.8. Contribution of Institutional Arrangements on Land Preparation Progress 30
4. Discussion 31
5. Conclusions and Recommendations 34
Literature Cited 37
Appendix 1 39
Appendix 2 47
Appendix 3 68

Figures

Figure 1. Rainfall, tank storage variation and water issues, Rajangana scheme, 2001-2002 9
Figure 2. Rainfall, tank storage variation and water issues, Nuwarawewa scheme, 2001-2002 9
Figure 3. Rainfall, tank storage variation and water issues, Huruluwewa, 2001-2002 10
Figure 4. Rainfall, tank storage variation and water issues, Minneriya scheme, 2001-2002 10
Figure 5. Land preparation progress, Rajangana (total sample) 18
Figure 6. Land preparation progress, Nuwarawewa (total sample) 18
Figure 7. Land preparation progress, Huruluwewa (Dutuwewa area) 18
Figure 8. Land preparation progress, Minneriya-Raja Ela 19
Figure 9. Land preparation progress, Minneriya-Yoda Ela (Left Bank) (total sample) 19

Tables

Table 1. Proposed irrigation systems for study 4
Table 2. Sample size and location within the system 4
Table 3. Physical system characteristics 6
Table 4. Irrigation duty, cropping intensity and water utilization of selected systems 6
Table 5. Cultivation decisions in irrigation systems studied 8
Table 6. Percentage of farmers finishing land preparation within and after 21 days, and average number of days and standard deviation taken for land preparation 16

Table 7. Percentage of delayed farmers by number of days delayed 20
Table 8. Delayed farmers' perception of the period of delay 21
Table 9. Delayed farmers faced with water related problems (in rank order) 22
Table 10. Delayed and non-delayed farmer distribution 25
Table 11. Average cultivated area and percentage by non-delayed and delayed farmers 26

Table 12. Area (%) cultivated by non-delayed and delayed farmers with different varieties 27
Table 13. Average yield by non-delayed and delayed farmers 28
Table 14. Average yield of different varieties by non-delayed and delayed farmers 28
Table 15. Price of paddy per kilogram received by different farmer categories for different paddy variety durations 29
Table 16. Income received by non-delayed and delayed farmers for different paddy variety durations 29
Table 17. Impact of land tenure status on yield 29
Table 18. Impact of land tenure status on yield for delayed and non-delayed farmers 30

Appendix 1 Figures

Figure 1. Agro-ecological zones, North Central Province and location of selected systems, Sri Lanka (Agro-ecological zones adjusted from Panabokke, 1996) 39
Figure 2. Land preparation progress, Rajangana-Paluwewa-Tract 1 40
Figure 3. Land preparation progress, Rajangana-Ate Kanuwa-Tract 5 40
Figure 4. Land preparation progress, Rajangana-Weerapura-Tract 7 40
Figure 5. Land preparation progress, Nuwarawewa-Ambalawana 41
Figure 6. Land preparation progress, Nuwarawewa-DC123 41
Figure 7. Land preparation progress, Nuwarawewa-Paniyankadawala 41
Figure 8. Land preparation progress, Huruluwewa-Padikaramaduwa area 42
Figure 9. Land preparation progress, Huruluwewa-Nikawewa area 42
Figure 10. Land preparation progress, Minneriya-Kothalawalapura 42
Figure 11. Land preparation progress, Minneriya-Yoda Ela 43
Figure 12. Land preparation progress, Minneriya-Viharamawatha 43
Figure 13. Frequency analysis of land preparation duration, Rajangana 43
Figure 14. Frequency analysis of land preparation duration, Nuwarawewa 44
Figure 15. Frequency analysis of land preparation duration, Huruluwewa 44
Figure 16. Frequency analysis of land preparation duration, Minneriya-Raja Ela 44
Figure 17. Frequency analysis of land preparation duration, Minneriya-Yoda Ela 45

Appendix 2 Tables

Table 1. Period between water issues and first plowing (Rajangana) 47
Table 2. Period between water issues and first plowing (Nuwarawewa) 47
Table 3. Period between water issues and first plowing (Huruluwewa) 47
Table 4. Period between water issues and first plowing (Minneriya) 48
Table 5. Period between first plowing and second plowing (Rajangana) 48
Table 6. Period between first plowing and second plowing (Nuwarawewa) 48
Table 7. Period between first plowing and second plowing (Huruluwewa) 48
Table 8. Period between first plowing and second plowing (Minneriya) 49
Table 9. Period between second plowing and third plowing (Rajangana) 49
Table 10. Period between second plowing and third plowing (Nuwarawewa) 49
Table 11. Period between second plowing and third plowing (Huruluwewa) 49
Table 12. Period between second plowing and third plowing (Minneriya) 50
Table 13. Period between third plowing and sowing (Rajangana) 50
Table 14. Period between third plowing and sowing (Nuwarawewa) 50
Table 15. Period between third plowing and sowing (Huruluwewa) 51
Table 16. Period between third plowing and sowing (Minneriya) 51
Table 17. Length of land preparation period (Rajangana) 51
Table 18. Length of land preparation period (Nuwarawewa) 52
Table 19. Length of land preparation period (Huruluwewa) 52
Table 20. Length of land preparation period (Minneriya) 52
Table 21. Number of days delayed (In comparison with the date agreed upon at the cultivation meeting) (Rajangana) 53
Table 22. Number of days delayed (In comparison with the date agreed upon at the cultivation meeting) (Nuwarawewa) 53
Table 23. Number of days delayed (In comparison with the date agreed upon at the cultivation meeting) (Huruluwewa) 53
Table 24. Number of days delayed (In comparison with the date agreed upon at the cultivation meeting) (Minneriya) 54
Table 25. Reasons for water problems in MC—delayed farmers 54
Table 26. Reasons for water problems in DC—delayed farmers 54
Table 27. Reasons for water problems in FC—delayed farmers 55
Table 28. Soil problems—delayed farmers 55
Table 29. Shortage of rain during LP period—delayed farmers 55
Table 30. Uncertainty over water—delayed farmers 55
Table 31. Unspecified other problems—delayed farmers 56
Table 32. Delayed farmers faced with financial problems (in rank order) 56
Table 33. Delayed farmers faced with tractor availability problems(in rank order) 56
Table 34. Reasons for delays due to tractors—delayed farmers 57
Table 35. Delayed farmers faced with labor problems. 57
Table 36. Reasons for labor problems—delayed farmers 58
Table 37. Delayed farmers faced with seed paddy problems (in rank order) 58
Table 38. Reason for seed paddy problems—delayed farmers 58
Table 39. Delayed farmers faced with share/leasing arrangement problems (in rank order) 59
Table 40. Delay due to political environment—delayed farmers 59

Table 41. Land size distribution of delayed and non-delayed farmers (Rajangana) 59
Table 42. Land size distribution of delayed and non-delayed farmers (Nuwarawewa) 60
Table 43. Land size distribution of delayed and non-delayed farmers (Huruluwewa) 60
Table 44. Land size distribution of delayed and non-delayed farmers (Minneriya) 61
Table 45. Land tenure status of delayed and non-delayed farmers 61
Table 46. Land tenure status of delayed farmers 62
Table 47. Participation at cultivation meetings (delayed and non-delayed farmers) 62
Table 48. Awareness of the date of canal cleaning (delayed and non-delayed farmers) 63
Table 49. Awareness of the date of water release (delayed and non-delayed farmers) 63
Table 50. Knowledge about the age group variety of seed paddy to be sown (delayed and non delayed farmers) 64
Table 51. Awareness of the agreed date of sowing (delayed and non-delayed farmers) 64
Table 52. Different age group varieties cultivated by delayers and non-delayers 65
Table 53. Percentage of delayed and non-delayed farmers finishing land preparation within and after 21 days at head, middle, and tail-end of the system 66
Table 54. Average number of days taken for land preparation by delayed and non-delayed farmers at head, middle and tail-end of the system 67

Acronyms

FC	Field Channel
FO	Farmer Organization
DC	Distributary Canal
DCO	Distributary Canal Organizations (Farmer Organization)
ID	Irrigation Department
IE	Irrigation Engineer
IMD	Irrigation Management Division
INMAS	Integrated Management of Major Agricultural Schemes
IWMI	International Water Management Institute
LB	Left Bank
MC	Main Canal
OFC	Other Field Crop
P&RA	Production and Research Assistant, the grass root level officer of the Department of Agrarian Development
PC	Project Committee
PM	Project Manager
RB	Right Bank

Conversion

Sri Lankan rupees (Rs) 100	=	US$ 1.04 (April 2002)
US$ 1	=	Sri Lankan rupees (Rs.) 95.75 (April 2002)

Executive Summary

Many irrigation systems in the dry zone of Sri Lanka have water shortage problems. In spite of the fact that water shortage is a problem, water consumption is very high during land preparation which takes prolonged periods of time. This paper analyzes the impact of institutional interventions on efficient water management, especially during the land preparation period, based on research conducted in Huruluwewa, Rajangana, Nuwarawewa and Minneriya irrigation schemes in *maha* season (wet season which is from October to mid January) 2001/2002. It provides a comprehensive understanding of the factors behind prolonged periods of land preparation so that system managers and farmer communities can develop appropriate interventions to reduce water consumption during this period.

To capture the impact of institutional interventions, three systems with intervention and one system without intervention were selected. First, a survey was conducted on all farmers in the pilot areas. This was followed by a more detailed survey on delayed farmers, carried out after the completion of the land preparation period. Finally, data on crop yield were collected from all farmers to see whether there is any significant difference between the yields of delayed and non-delayed farmers.

In Rajangana and Nuwarawewa schemes the majority of farmers have a land preparation delay. The length of delay is also longer than in the other two schemes studied. In Minneriya Yoda Ela and Huruluwewa, the majority of farmers finished land preparation on time. In most cases land preparation delay occurs in the period between the first water issue and the commencement of land preparation. In general, farmers complete land preparation within the time agreed at the cultivation meeting, but not by the due date. This is mainly due to the fact that they do not start land preparation activities on time, immediately after the issue of water for the season.

Both water related and non-water related factors have an impact on land preparation progress. Water related factors play an important role only in Nuwarawewa and Minneriya while non-water related factors are important in Rajangana and Huruluwewa. Main water related factors are maintenance problems and canal deterioration at the main and distributary canal levels, operation of the distributary canal, and maintenance and water sharing problems at the field canal level. Non-water related factors are a major reason for land preparation delay, especially in Rajangana. Delayed farmers mentioned non-water related factors such as non-availability of tractors, labor shortage and problems related to the procurement of paddy seed as reasons for the land preparation delay. Tenure status, such as leased-in and mortgaged-in or share cropping, did not have a negative impact on land preparation progress, and the majority of delayed farmers, except in Nuwarawewa, are owner-operators.

Delayed farmers have a tendency to shift to a shorter duration variety, which gives comparatively low yield. The highest yield penalty was found in the 3 month duration variety, which is cultivated mostly by delayed farmers. Irrespective of the paddy variety cultivated, per hectare income of delayed farmers is lower than that of the non-delayed farmers. The highest income loss is found with farmers cultivating a three-month duration variety.

Farmer attendance at cultivation meetings is extremely low, even though the cultivation meeting is the most effective way to disseminate information on cultivation decisions to farmers. Farmer organizations (FOs) could contribute enormously in improving communication between farmers and government officials, in disseminating decisions made during cultivation meetings and in finding solutions to non-water related problems. However, for implementing cultivation meeting decisions, farmer organizations need to be strong.

With the understanding that existing institutions cannot improve land preparation progress, a new institutional arrangement-the Jala Meheum Committee (Water Management Committee), was initiated by the Irrigation Management Division (IMD) to monitor land preparation progress and to solve water related problems at field level that delay land preparation. A scheme level committee was proposed to supervise and guide the Jala Meheum Committees. However, the proposed Jala Meheum Committees cannot perform their water management activities effectively with totally defunct or weak farmer organizations and without the active involvement of grass roots level officers and turnout attendants. The impact of Jala Meheum Committees on land preparation progress is not observed, since these committees were in operation only to some extent in Huruluwewa, mainly due to the heavy involvement of the Project Manager (IMD) in the program. In none of our sample systems, the proposed scheme level committee was established. The water situation at the commencement of the season and the political environment just before the 2001 general elections had serious negative impact on the initiation and functioning of the newly introduced institutions.

The Jala Meheum Committee has its focus only on solving water related factors, but this research clearly indicates that besides water related factors, non-water related factors have serious negative impact on land preparation progress. Therefore even a perfect working Jala Meheum Committee will not be able to solve land preparation delays in systems where non-water related problems are the main reason for land preparation delay.

Interventions like Jala Meheum Committees cannot successfully function within one or two seasons. They should be pilot tested several seasons prior to replication in other irrigation schemes. The research highlights that active involvement of grass roots level officers can help Jala Meheum Committees to function even when FOs are weak.

To further strengthen the proposed institutional changes, it is necessary to establish scheme level committees to supervise the Jala Meheum Committees and provide guidance and assistance to improve land preparation progress. The commitment of the Production and Research Assistants to plan and implement the activities of the Jala Meheum Committees is also needed and these committees should monitor land preparation progress and provide feed back to FOs and agencies concerned for another two to three seasons until FOs develop their capacity to handle these activities independently. FOs should be further strengthened to participate effectively in planning and implementing agricultural programs with special attention on the management of limited water resources and to take the responsibility of O&M of the tertiary system. Irrigation agencies need to maintain and operate the main system to avoid land preparation delays resulting from problems associated with main system management.

1. Introduction

Many irrigation systems in the dry zone of Sri Lanka (figure 1, appendix 1) are faced with water shortage problems. Some systems face water shortage even during *Maha* season, especially towards the end. Water shortage has negative impacts on cropping intensity and yields and finally on the income of families living in these irrigation schemes.

Though water shortage is a problem in the irrigation systems, research on irrigated paddy farming indicates that water consumption is very high for land preparation that takes prolonged periods of time. The water requirement for land preparation is theoretically 150-200 mm, but can be as high as 650-900 mm when its duration is long, i.e. 24-48 days (De Datta 1981; Bhuiyan et al. 1995). Field water input during crop growth may vary from 500-800 mm (De Datta et al. 1973) to more than 3000 mm (Hukkeri and Sharma 1980). Research on irrigation management and crop diversification conducted in Kirindi Oya and Uda Walawe systems by IWMI from 1986 – 1994 indicates that water used for land preparation varied between 680-1180 mm. Field water input during the crop growth varied between 1169-1784 mm for *maha* season and 1662-2405 mm for *yala* season (dry season, from mid March to June), meaning that out of the total water used for paddy cultivation during a cultivation season, up to one-third is used during the period of land preparation period (IIMI 1990). Research further highlights that time taken for land preparation is as long as 35 days out of the total crop period of 105 days (IIMI 1989; IIMI 1990). Reasons for such higher water consumption and prolonged periods of land preparations include water management problems at main and tertiary system levels, irrigation behavior and attitudes of farmer communities, institutional problems at the farmer level and socio-economic conditions of the irrigation communities in the irrigation schemes. The irrigation agencies managing these systems have realized that water shortage and water related problems could be significantly reduced through improved performance during land preparation. The Irrigation Management Division (IMD) of the Ministry of Irrigation and Water Management is a multi-disciplinary unit to coordinate the activities of the line agencies (in the fields of agriculture, agronomy, sociology economics, management, engineering) serving the irrigated agricultural sector (USAID 1985). IMD has initiated some institutional interventions for improved water management during the land preparation period in several irrigation systems in the dry zone of Sri Lanka in *maha* season (2001/2002). These interventions aimed at addressing water scarcity problems generally encountered in these systems towards the end of the season in order to reduce serious socio-economic problems faced by farmers due to crop failures and poor yields. It is assumed that the appropriate interventions during the land preparation period would drastically reduce water consumption and irrigation water related problems in these systems.

Based on the results of *maha* season 2001/2002, the agencies expect to replicate the institutional interventions in other dry zone irrigation schemes faced with similar water scarcity problems.

This paper analyzes the impact of the institutional interventions on efficient water management, especially during the land preparation period, based on research conducted in several major irrigation schemes in the dry zone of Sri Lanka in *maha* season 2001/2002. The study was conducted by IWMI in response to a request by IMD that seeks to have a comprehensive understanding of the factors behind the high water consumption and prolonged periods taken for land preparation, in order to formulate strategies to reduce water consumption during this period. Based on the available literature (Alwis et al.1983; Somarasekra et al.1987; IIMI 1988; IIMI 1990) both water related and non-water related factors could have negative impacts on the progress of land preparation and are considered in this research. The research hypothesizes that proper intervention for managing the process of land preparation will help considerably reduce water consumption during the land preparation period.

1.1. Objectives

The major objective of this paper is to contribute to the existing body of knowledge on irrigation system management during the land preparation period so that system managers and farmer communities can develop appropriate institutional and other interventions for efficient water management. The other objectives (that are set around this major objective) are,

- to provide feed back to the Irrigation Department (ID) and IMD on the performance of land preparation activities and the institutions concerned,
- to explain socio-economic and institutional factors that facilitate or hinder the performance, and
- to make recommendations to overcome socio-economic and institutional constraints for improved performances.

1.2. Institutional arrangements in major irrigation systems

The major irrigation systems in Sri Lanka (other than Mahaweli systems) are managed under the program for Integrated Management of Major Agricultural Schemes (INMAS) of the Ministry of Irrigation and Water Management. ID and IMD of the Ministry jointly manage the INMAS program with the active involvement of farmers and other agencies like the Department of Agriculture and the Department of Agrarian Development. At irrigation system level the staff consists of the Project Manager (PM) representing IMD and the Irrigation Engineer (IE) representing ID.

INMAS system operates on a three-tier system comprising Field Channel (FC) groups at the bottom, Distributary Canal Organizations (DCOs) in the middle and the Project Committee (PC) at the apex.

1. FC groups are informal with a representative selected by the farmers.
2. DCOs are formal organizations comprising FC group representatives to represent each field channel under a given distributary canal. The farmer representatives select DCO office bearers. FC groups and DCOs have responsibilities over operation and maintenance as well as water management at the respective levels through the involvement of farmers.
3. PC is the main decision making body at the irrigation system level for agricultural plan implementation and water management. It consists of officers of all line agencies (e.g. IMD, ID, Department of Agrarian Services, Department of Agriculture) and farmer representatives. Two farmer representatives from each DCO are seated in PC which is chaired by the Project Manager (IMD). Though cultivation decisions are finally made at cultivation meetings, it is PC that plans for the season and implements seasonal agricultural activities.

PM coordinates the activities of the line agencies and attempts to resolve problems relating to agriculture, irrigation, credit, marketing and training which are brought up by the farmer representatives at PC meetings (Panabokke 1989).

In spite of the existence of these institutions and organizations, inefficiencies such as poor water management that lead to water shortage problems are a recurrent phenomenon. It is understood that the farmer level institutions are weak due to various socio-economic reasons such as lack of benefits for the members through these organizations, poor farmer participation and low productivity. Therefore, a new institutional arrangement, which is discussed below, was proposed to activate the existing institutions and organizations for improved water management during the land preparation period on farm level.

1.3. Institutional arrangements to improve land preparation progress

The new institutional arrangements proposed by IMD is to create two committees, one at distributary canal level and the other at system level to monitor and improve operations of Major Irrigation schemes in the Anuradhapura district. After successful testing, the proposed institutional change would be replicated in other districts.

The distributary canal level committee, known as "Jala Meheum Committee", consists of Production and Research Assistant (P&RA) of the Department of Agrarian Development, President of Farmer Organization, Jalapalaka (turn-out attendant) of the Irrigation Department, Jalapalaka of the Farmers Organization.

The functions of the Jala Meheum Committee are as follows.

- to collect and process land preparation data for the identification of delays and monitoring water management at FO level
- to provide data and feed back on land preparation progress to the Project Manager (IMD)
- to intervene at field level to help farmers to overcome water related problems having negative impacts on the progress of land preparation
- to intervene when and where necessary to implement the cultivation meeting decisions with regard to land preparation

The Jala Meheum Committee is not a formal body. The format used by the committee for data collection for land preparation progress monitoring is given in appendix 3.

The system level committee consists of Resident Project Manager (IMD), Irrigation Engineer/ Technical Assistant (ID), Divisional Officer (Department of Agrarian Development), Agriculture Instructor (Department of Agriculture), and selected office bearers of farmer organizations. The system level committee has to supervise the Jala Meheum Committees on distributary canal level and provide guidance and assistance to improve land preparation progress.

2. Methodology

2.1. Selection of irrigation systems

IMD proposed a list of 11 INMAS systems in the North Central Province with and without institutional interventions for the study (table 1).

Table 1. Proposed irrigation systems for study.

With intervention	Without intervention
Rajangana	Tisawewa
Nuwarawewa	Parakramasamudra
Huruluwewa	Kawudulla
Minneriya Raja Ela (Right Bank)	Minneriya Yoda Ela (Left Bank)
Nachchaduwa	Mahavilachchiya
Giritale	Mahakanadarawa

During the first assessment, some systems were dropped due to logistical reasons and seven systems were selected for the research. However the selected systems Tisawewa and Kawudulla received no irrigation water during *maha* season, 2001/2002. Mahakanadarawa started land preparation and paddy cultivation with rainwater only and therefore, these systems could not be studied. Finally, four systems were studied in more detail: Huruluwewa, Rajangana, Nuwarawewa and Minneriya Raja Ela (Right Bank) with intervention, and Minneriya Yoda Ela (Left Bank) without intervention.

2.2. Data collection

All systems studied are classified as major schemes in Sri Lanka's classification of irrigation systems. All main canals are more than 10 kilometers long. The water distribution system comprises regulatory structures such as gates in branch and distributary canals and direct field canal off-takes. Due to the conditions of the physical system and manual operation of gates, it is difficult to maintain equity in water distribution between the head, middle and the tail end of the system. Maintaining equity is very difficult during land preparation as water requirement is very high. Therefore stratified samples were selected from head middle and tail portions of the system in order to examine whether this location specific characteristic has an impact on land preparation progress (table 2).

Table 2. Sample size and location within the system.

System	Head (No. of farmers)		Middle (No. of farmers)		Tail (No. of farmers)		Total sample
Rajangana	Paluwewa (Tract 1)	29	Ate Kanuwa (Tract 5)	23	Weerapura (Tract 7)	30	82
Nuwarawewa	Ambalawana	25	D123	25	Paniyankadawala	25	75
Huruluwewa	Padikaramaduwa	23	Nikawewa	24	Dutuwewa	25	72
Minneriya (RB)	DC 3	10	DC 6	7	FC 5	8	25
Minneriya (LB)	Kothalawelapura	27	Yoda Ela	26	Viharamawatha (Tmract 9)	15	68

After the selection of the pilot areas a survey was conducted on all farmers in the area. Inquiries were made on land tenure status, land size, sowing date as decided at cultivation meetings and actual date on which sowing was completed. After the analysis of the first survey a more detailed survey of delayed farmers was undertaken. Questions on the period of the land preparation delay and the reasons for the delay were asked.

After the harvest, a yield survey was conducted among all farmers to see if there is any difference in yield between delayed and non-delayed farmers. During the study, interviews were held with farmers and irrigation agency officials to better understand the management of the system, the general problems and the reasons for the land preparation delay.

2.3. Study area

The North Central Province is the largest province of Sri Lanka, covering an area of 10,533 km^2 or 16 percent of the land area and has a population of 1.2 million, of whom 90 percent live in rural areas (Sakthivadivel et al. 1996). The North Central Province's contribution to the gross domestic product is only 4.2 percent, largely attributable to the subsistence nature of its agriculture, which is the main source of income for about 70 percent of its population (Sakthivadivel et al. 1996). The North Central Province is among the poorest areas of the country.

2.3.1. Climate in the North Central Province

All irrigation schemes studied are located in the North Central Province-dry zone of Sri Lanka. The climate is characterized by a bimodal pattern of monthly rainfall distribution with two distinct dry periods; one short and the other prolonged.

The IWMI Water and Climate Atlas (www.iwmi.org/Watlas/atlas.htm) provides monthly summaries for precipitation, temperature, humidity, hours of sunshine, evaporation estimates, wind speed, total number of days with and without rainfall, and Penman-Monteith reference evapotranspiration rates. The core of the atlas has data assembled from weather stations around the world for the period 1961-1990. The resolution is 10-minute arc (one-sixth of a degree), meaning that the largest squares on the atlas grid are only 16 km^2 at the equator.

For the North Central Province of Sri Lanka and the selected systems it shows that the average annual rainfall is 1270 mm, with the lowest in Nuwarawewa (1150 mm) and the highest in Minneriya (1460 mm) (IWMI Water and Climate Atlas). Because of the large spatial variation in the mean seasonal rainfall, location specific rainfall data and their variation should be considered while planning and operating water resources systems (Sakthivadivel et al. 1996). About 60 percent of the total annual rainfall occurs in the Maha season from October through January. The smaller peak rainfall period, *yala* season, is between mid- March to mid -May. February, June, July, August and September are relatively dry (IWMI Water and Climate Atlas).

The monthly Penman-Monteith reference evaporation varies from 3.7 mm/day (December) to 5.4 mm/day (June) and is almost identical for the four systems. The average annual Penman-Monteith reference evaporation for the four systems is 1732 mm (IWMI Water and Climate Atlas).

The Department of Agriculture recommends the sowing of paddy before the 15th of January to capture the best climatic and environmental conditions for paddy cultivation.

2.3.2. Physical System Characteristics

Table 3 summarizes some physical characteristics of the schemes studied and table 4 gives more details about irrigation duty, cropping intensity and water utilization.

Table 3. Physical system characteristics.

System	Command area (ha)[a]	Natural water sources	Supplementary water
Rajangana	5,307[b]	Kala Oya	System H drainage water
Nuwarawewa	958	Malwatu Oya	Mahaweli water
Huruluwewa	3,306	Yan Oya	Mahaweli water
Minneriya	8,990[c]	Tributary of Mahaweli ganga	Amban ganga diversion at Elahera

[a] *Source:* Table 13 in Sakthivadivel et al. 1995.
[b] According to the Irrigation Department the actual command area is 6,200 ha and higher than the original design command area.
[c] *Source:* Irrigation Department. Additionally, there is 1600 ha cultivated under the Galamuna anicut depending on drainage water from Minneriya.

Table 4. Irrigation duty, cropping intensity and water utilization of selected systems.

System	Irrigation Duty (m)		Cropping intensity (%)	Water utilization (MCM)		
	Maha	Yala		Maha	Yala	Total
Rajangana	1.35	2.10	200	71.6	111.4	183.1
Nuwarawewa	1.29	1.79	200	12.4	17.1	29.5
Huruluwewa	1.09	1.25	125	36.0	10.3	46.4
Minneriya	1.18	1.39	200	55.3	65.1	120.4

Source: Table 13 in Sakthivadivel et al. 1995.

2.3.3. Socio-economic Conditions of Selected Systems

Rajangana

Rajangana irrigation system was constructed during1962-1965 (Alwis et al. 1983). Around 6,200 families were settled between 1964-1968 (Alwis et al. 1983) and mainly originated from Galle, Matara, Kalutara, Ratnapura, Gampaha, Kurunagala, Kegalle, Kandy and Matale. Originally an allotee was given 3 acres of irrigated land and a ½ acre of highlands in the settlement. At the second stage, it was reduced to 2½ acres of irrigated land and a ½ acre of highlands. In the third stage farmers were allocated 2 acres of irrigated land and a ½ acre of highland.

There are around ten thousand families in the project area. However with the families of the second and third generation (members of the original settler families) this must be more. The major problems faced by the communities in Rajangana scheme is land fragmentation and associated socio-economic problems and the dilapidated condition of the irrigation system.

Nuwarawewa

Nuwarawewa is an ancient tank system probably constructed by King Watta Gamini in the first century BC and the tank was rehabilitated in 1889 by the British (Brohier 1934). It has been built by constructing a dam across a tributary of Malwatu Oya. Nuwarawewa has been connected to the Nachchaduwa wewa scheme through a feeder canal to supply water received in Nachchduwa from the Mahaweli system to overcome water shortage in Nuwarawewa. Yoda Ela (Jaya Ganga) was built in the days of kings to augment the Malwatu Oya basin.

There are three kinds of irrigation communities in the Nuwarawewa scheme. They include Purana (old) villagers with Praveni (old) land, new settlers, and middle class families settled in the

area by the government. There are 700 families with entitlement to irrigated lands in the scheme. High variations are observed in the size of holdings. For example, middle class families have lands, each 10 acres (4 ha) in extent. Each new settler in the scheme was allocated 5 acres (2 ha) of irrigated land, but all these land has been fragmented with the population increase in the settlement community. Great variations are observed in land holdings in Purana village communities. Land fragmentation is a major problem reported in this scheme.

Huruluwewa

Huruluwewa was originally constructed under the reign of King Mahasen (275-301 AD) (Paranavitana1959a, Seneviratna 1989) who is said to have constructed Minneriya and also many other tanks in Sri Lanka. The Yan Oya has been dammed at Yakalla, a small township close to Galenbidunuwewa town, to augment the Huruluwewa reservoir. The British rehabilitated the tank in 1934. It was developed as an irrigation settlement colony in the 1950s. Originally 3,800 families from Anuradhapura, Matale, Kurunagala and Kandy were settled in the scheme and 8,936 acres (paddy and highland) was distributed among them. At present, the number of families has increased to 7,000 and the land distributed among them is around 11,200 acres (paddy and highland). Originally a family was allocated 5 acres of irrigated land and 2 acres of highland. Later it was reduced to 3 acres of irrigated land and 1 acre of highland. Almost all the land allocated to the originally settled families is fragmented now with the increase of population. The main problem in the scheme is water shortage for cultivating crops during *yala* (dry) seasons, but even in the *maha* (wet) season, water shortage problems occur. Although the Mahaweli Water Panel started allocating some water to this system from the1970s, the water released to Huruluwewa is used by the farmers along the Hurulu Feeder Canal (land under feeder canal was incorporated into the Mahaweli system recently) and three small tank systems on the Yan Oya upstream of Huruluwewa. Data on past inflow patterns show that out of each five-year period, adequate inflow for a cultivation season is received only in two years. Unemployment and lack of livelihood opportunities are grave problems for the communities in the scheme.

Minneriya

The Minneriya tank was originally constructed under the reign of King Mahasen (275-301 AD) (Paranavitana 1959b; Seneviratna 1989). Water is diverted to the Minneriya tank by constructing a dam across the Ambanganga, a tributary of the Mahaweli River at Elahara. Water diverted from the Ambanganga is brought to Minneriya through the Elahara Ela. After the fall of the ancient civilization in Polonnaruwa, the tank degraded and was in ruin when Sri Lanka came under the British rule. The British Colonial government started the first rehabilitation in 1903 (Siriweera 1991), but large-scale rehabilitation and settlement activities in Minneriya started in 1935, which makes it one of the oldest irrigation settlement schemes in the country. It was rehabilitated again in 1949-1954 and was accompanied by settlement and other infrastructure development activities. More settlement activities in the scheme are observed after 1985 with the implementation of the Mahaweli program. The total number of settler families in the scheme was 14,220 by 2000.

From 1935 on, in Phases I-III of the rehabilitation, settlers from Minneriya, Kawudulla, Raja Ela and Gal Mauna arrived and each family was given 5 acres (2 ha) of paddy land and 3 acres (1.2 ha) of highland (Somarasekra et al. 1987). In Phase IV of the project implemented in 1949, each settler family was allocated 3 acres (1.2 ha) of paddy land and 2 acres (0.8 ha) of highland (Somarasekra et al. 1987).

Like in many other old irrigation settlement schemes settlement communities are faced with problems such as land fragmentation, unemployment, problems related to marketing of paddy,

indebtedness, dilapidation of irrigation system and sedimentation of canals. Farmers face water shortages mainly due to the problems in the physical system. Water theft by highland farmers is a serious problem in the Minneriya scheme.

3. Results

3.1. Cultivation meetings

At the Project Committee (PC) meeting held prior to the commencement of the cultivation season, farmer representatives and agency officials discussed their plans for the season. However, water storage in each of these tank systems was not at appropriate levels and final decisions over the season could not be made. Decisions taken at the PC cultivation meetings in October were made expecting the commencement of the season after receiving sufficient inflow into the reservoirs. It was also expected to make maximum use of rainfall for land preparation. The decisions, such as the date of water issue had to be revised later due to water shortages. Final cultivation decisions are summarized in table 5.

Table 5. Cultivation decisions in irrigation systems studied.

	Schemes			
Activity /Area	Rajangana	Nuwarawewa	Huruluwewa	Minneriya
Extent to be cultivated	Paddy – 5,393 ha OFCs – 3,672 ha (under lift irrigation)	1,000 ha	10,400 ha	
Date of canal cleaning	On or before 30 Oct. 2001	On or before 23 Oct. 2001	On or before 15 Nov. 2001	On or before 26 Nov. 2001
Date of first water issue from main sluice	5 Nov. 2001 to the field – 7 Nov. 2001	23 Oct. 2001[a]	17 Nov. 2001[b]	26 Nov. 2001
Last date for sowing	26 Nov. 2001	20 Nov. 2001	Tail-end: 7 Dec. 2001 Rest: 12 Dec. 2001	20 Dec. 2001
Last date of water issue	1 March 2002	5 March 2002	12 March 2002	5 April 2002
Paddy variety duration group	3, 3½ months	3, 3½ months	3, 3½ months	3, 3½ months

[a]In Nuwarawewa, it was originally decided to commence cultivation with water issues on 15 October 2001, but this had to be postponed till 23 October 2001, as the LB main canal had not been fully cleaned.

[b]Water issue plan: the tail-end area will receive water first for about 5 days, after which the upstream parts of the system will receive water. Table 5. Cultivation decisions in irrigation systems studied.

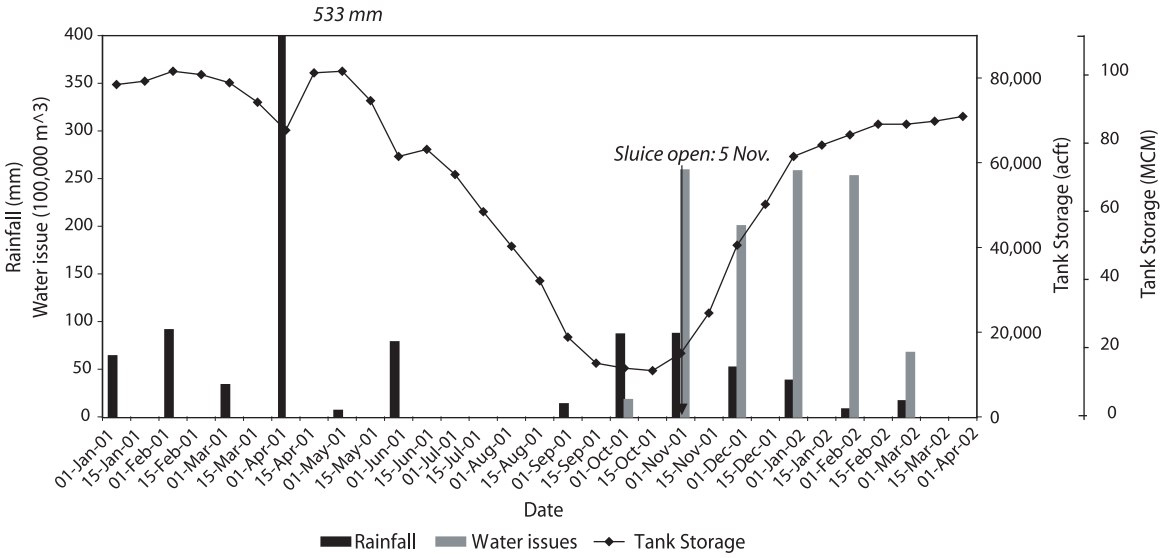
3.1.1. Water Situation at the Time of Cultivation Meetings

Rajangana

There was about 10,900 ac.ft. (13.5 MCM) in Rajangana reservoir and 1,800 ac.ft. (2.2 MCM) at the Angamuwa tank on 17th October, the day prior to the cultivation meeting. The Kalawewa reservoir in the Mahaweli system H upstream of Rajangana has been allocated 135,000 ac.ft. (166.5 MCM) by the Mahaweli Water panel for the Maha 2001/2002 season. All drainage water from the

Mahaweli system H drains into the Rajangana reservoir, and as can be seen in figure 1, tank storage continuously increased during *maha* cultivation season 2001/2002 due to drainage from the Mahaweli system H and local runoff. No water problems were observed during *Maha* season, 2001/2002 in the Rajangana scheme (figure 1). At the date of the first water issue (5th November 2001) tank storage was 16,500 ac.ft. (20.4 MCM).

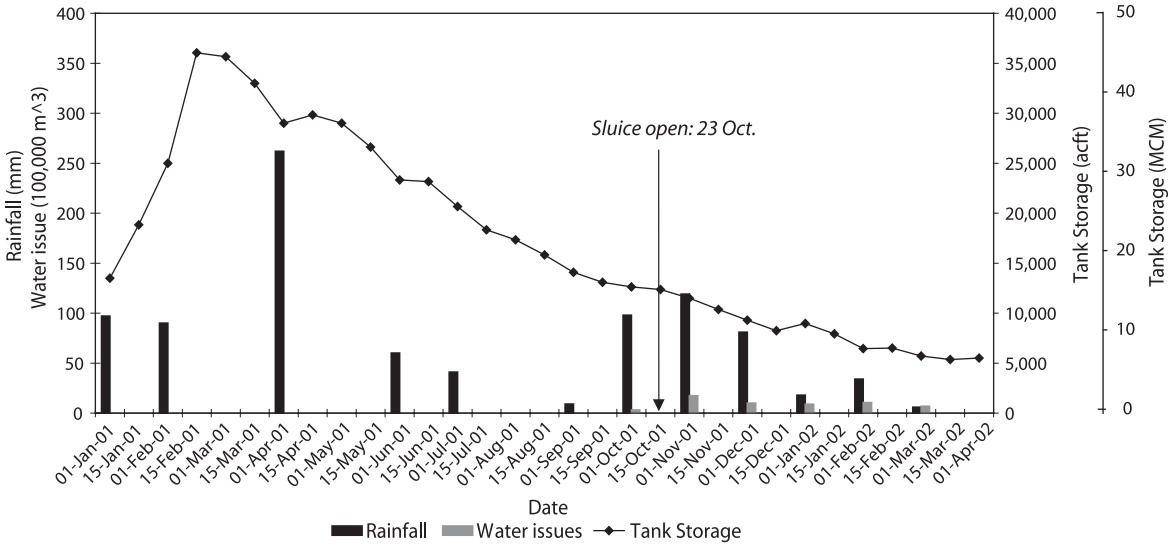
Figure 1. Rainfall, tank storage variation and water issues, Rajangana scheme, 2001-2002.



Nuwarawewa

About 11,000 ac.ft. (13.7 MCM) was available in the Nuwarawewa reservoir when water issues started for the season (figure 2). System managers and farmers expected more rain as well as some water from the Mahaweli system to complete the season. No water shortage was experienced during *Maha* cultivation season, 2001/2002.

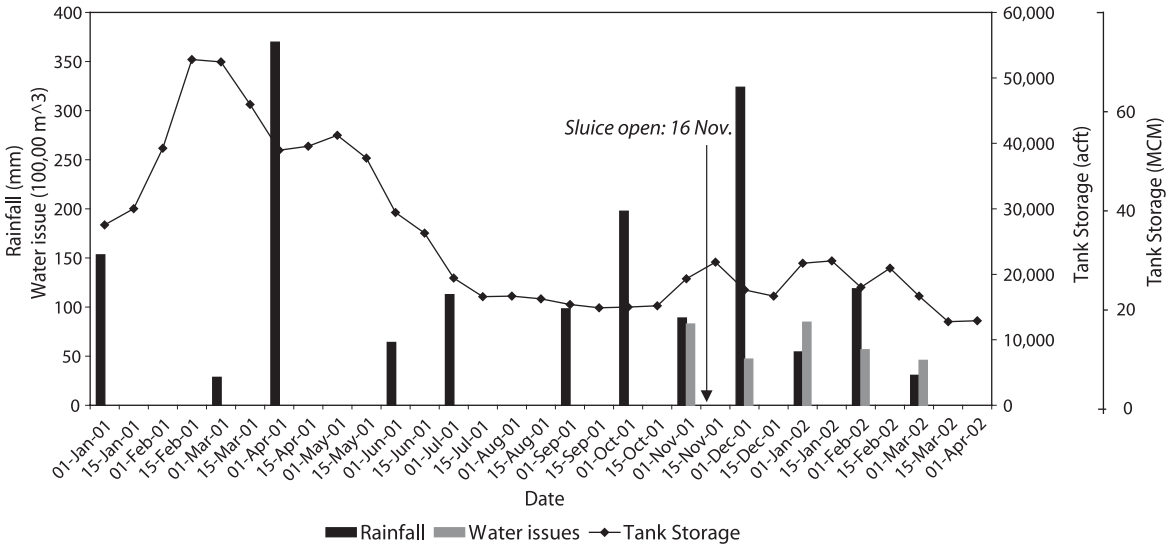
Figure 2. Rainfall, tank storage variation and water issues, Nuwarawewa scheme, 2001-2002.



Huruluwewa

About 22,000 ac.ft. (27.2 MCM) was available in the Huruluwewa reservoir when water issues started for the season (figure 3). In the 2001/2002 *Maha* season most of the water released to Huruluwewa from the Mahaweli system reached the Huruluwewa system as the three-tank system upstream of Huruluwewa was under rehabilitation. No water shortage was experienced during *maha* cultivation season, 2001/2002.

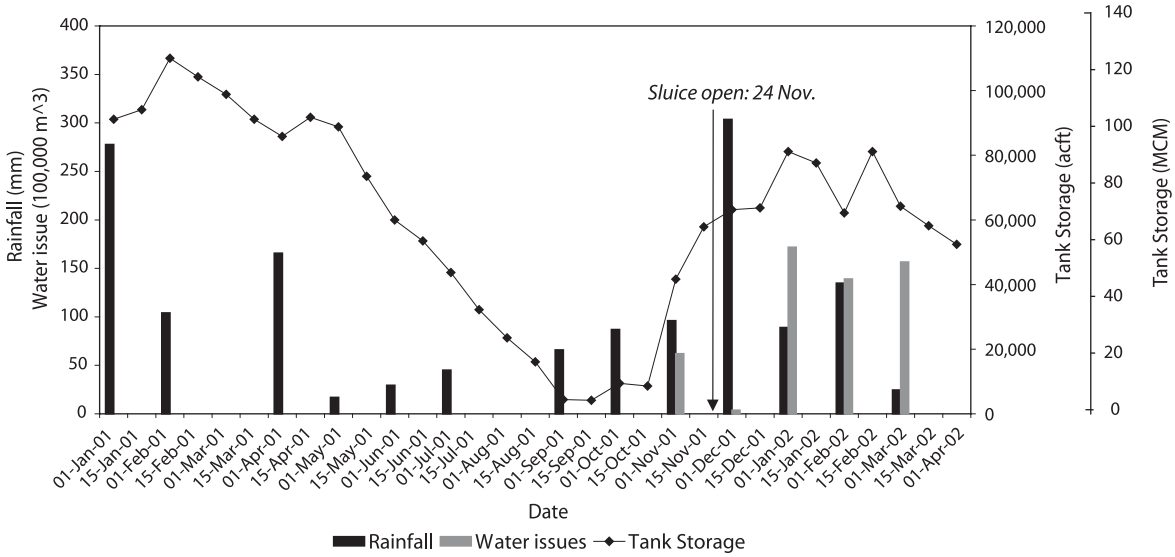
Figure 3. Rainfall, tank storage variation and water issues, Huruluwewa, 2001-2002.



Minneriya

About 66,200 ac.ft. (81.7 MCM) was available in the Minneriya reservoir when water issues started for the season (figure 4). No water shortage was experienced during *maha* cultivation season, 2001/2002. Figure 4 shows rainfall, tank storage variation and water issues in the Minneriya irrigation scheme.

Figure 4. Rainfall, tank storage variation and water issues, Minneriya scheme, 2001-2002.



3.2. Land preparation progress

3.2.1. Pre-seasonal Maintenance

In all the systems studied, ID is responsible for pre-seasonal maintenance of main and secondary systems of the irrigation schemes while the maintenance of tertiary systems is the responsibility of the Farmer Organizations and individual farmers. All the four schemes are old systems and are physically deteriorated. However, there were no serious problems over pre-seasonal maintenance of Main Canals (MCs) except in Nuwarawewa and Minneriya. In Nuwarawewa pre-seasonal maintenance of the tail-end of the main canal was not completed by the time of the first water issues. Farmers in the tail-end areas faced water problems due to this reason, and the canal had to be cleaned after the first water issues. Similarly, Minneriya Raja Ela had to be de-silted after water issues, because of water shortage problems faced by farmers.

DCOs are responsible for the pre-seasonal maintenance of DCs. The management responsibilities of DCs have been turned over to DCOs in these systems. However, IMD still allocates some funds for the operation and maintenance of DCs.

In the Rajangana scheme the respective DCOs had cleaned DCs in all the three sample areas by the time data collection and water issues had started. Due to this reason, DC maintenance activities could not be monitored. Pre-seasonal maintenance of FCs is the responsibility of farmers. FO has given each farmer a section of FC for cleaning. In many FCs in the sample areas cleaning was not satisfactory. There were 4-5 sections in each FC that remained unclean during the whole season. The role of FO representatives was minimal in getting farmers to maintain FCs. The DCO leaders explained that FC cleaning is not satisfactory in the sample FCs due to reasons such as leasing of land, lack of legal action against those who violate cultivation meeting decisions and non-residence of land owners in the settlement area (many of them live outside settlements, hence DCO representatives can not communicate with them).

In Nuwarawewa, different DCOs used different methods for DC maintenance. In Ambalawana area DCO cleaned the DC by organizing a self help campaign while the DCOs in charge of DC123 and DC 7 allocated a portion of DC to each farmer for cleaning. In all the samples DC cleaning was at a satisfactory level. FC cleaning too was at a satisfactory level in the sample areas.

In Huruluwewa, two DCOs allocated a portion of DC to each farmer for cleaning. The DC cleaning had not been completed by the date of water issues. In areas like Padikaramaduwa and Nikawewa, officers had to intervene and stop water issues to DCs and get farmers to clean the canal. In Dutuwewa sample area, 57 percent of the DC had been cleaned by the first week of water issue and 96 percent was cleaned by the fourth week of water issue. In Nikawewa, 73 percent of FCs had been cleaned by the first week after water issues and 91 percent was cleaned by the third week. In Padikaramaduwa, 50 percent of FCs had been cleaned by the first week and 87 percent by the third week after water issues. Our field observation substantiates that FC cleaning in this system is not done properly (partly) obstructing water flow.

In Minneriya Raja Ela, DC3 sample area had been cleaned by the day of water issue. DC6 was cleaned four days after water issues when they encountered water problems. DCOs allocated a section of DCs to each farmer.

In Minneriya Yoda Ela, DCOs in Kotalawalapura and Viharagama sample areas used maintenance funds allocated by the government to hire wage laborers to clean DC. Additionally, both DCOs collect money from the members and use them for maintenance activities. The Yoda Ela DCO allocated a section of DC to each farmer for cleaning. There were no serious problems in FC cleaning in the sample areas in Minneriya.

3.2.2. Land Preparation Progress: Period between Water Issues and First Plowing

Proper land preparation requires the field to be soaked for 2-5 days (depending on the soil type) before the first plowing (Somarasekra et al.1987). Tables 1 - 4 in appendix 2 present the land preparation progress during the period between water issues and the first plowing in the studied schemes.

Rajangana

In the Rajangana scheme (table 1, appendix 2), 21 percent of farmers in the total sample started land preparation within 5 days of the water issue and another 40 percent, between 6 – 10 days. About 39 percent of the farmers had a delay of more than ten days.

In LB Tract 1, nobody started land preparation in the first five days after the water issue, but the majority (62 percent) of the farmers started land preparation within 6-10 days after the water issue.

In LB Tract 5, only one third of the farmers started land preparation within ten days after the water issue while the rest had a delay of more than ten days with a considerable number of farmers (17 percent) having a delay more than 31 days.

In LB Tract 7, 80 percent of the farmers started land preparation within the first 10 days after the water issue.

There are no farmers in Rajangana who started land preparation with rainwater prior to the water issues. The majority of the farmers in the sample areas, except LB Tract 5, started land preparation within the first ten days after the water issues. Although there is a considerable variation in the time taken to start land preparation in the different tracts, there is no clear head-tail end problem visible.

Nuwarawewa

In the Nuwarawewa scheme (table 2, appendix 2), no farmer started land preparation before or immediately after (within five days) the water issues.

Out of the total sample, only about one-fourth of the farmers started land preparation between 6- 10 days, while the majority (77 percent) started land preparation after ten days.

In Ambalawana and D123, about one third of the farmers started land preparation within 6-10 days after the water issues and almost all the remaining farmers started land preparation between 10-15 days after the water issues.

A completely different situation can be seen in Paniyankadawala (tail-end of the system) where nobody started land preparation within the first 15 days after the water issues and the majority of the farmers (72 percent) started, only 21-25 days after the water issues. In the Nuwarawewa scheme a typical head-tail-end story unfolds with most delayed farmers located in the tail-end of the system.

Huruluwewa

In the Huruluwewa scheme (table 3, appendix 2), 86 percent of the farmers started land preparation within the first ten days after the water issues, with similar figures for the sample areas. It should be noted that the date of water release was 17, November for the tail-end of the system and around 22, November for the head and middle reaches.

All farmers started their first plowing within 15 days after the water issues in the Padikaramaduwa area (head-end of the scheme). In the Nikawewa area (middle of the system) and the Dutuwewa area (tail-end of the scheme) farmers took slightly longer, but all farmers started their first plowing within 20 days.

Minneriya

In Minneriya Raja Ela (table 4, appendix 2), about two-thirds of the farmers started land preparation just before and immediately after the water issues. Only 12 percent had a delay of more than ten days.

In Minneriya Yoda Ela (table 4, appendix 2), some farmers started land preparation prior to the water issues. However, the majority of the farmers, except in Viharamawatha, started land preparation within ten days after water issues.

In the Viharamawatha area (tail-end of the scheme), farmers started land preparation 16 days after the water issues, with the exception of 7 percent who didn't want to wait for the water issues, but started land preparations with rainwater.

In Minneriya Yoda Ela, a typical head-tail end story is clearly visible, with most delayed farmers located in the tail-end of the system.

If we compare across schemes, it becomes clear that in Minneriya Raja Ela, the farmers have the least delay in starting their first plowing after the water issues, and in Rajangana and Minneriya Yoda Ela, the farmers have the most delay.

3.2.3. Land Preparation Progress: Time between First Plowing and Second Plowing

The period between the first plowing and the second plowing in the studied schemes is presented in tables 5 - 8 in appendix 2. The Agricultural Department recommends a time of approximately 14 days between the first plowing and the second plowing for the decomposition of the incorporated organic residue.

Rajangana

In the Rajangana scheme (table 5, appendix 2), farmers were close to the recommended time between the first plowing and the second plowing. Only 12 percent of the farmers in the total sample started the second plowing more than 16 days after the first plowing. However, there is a difference between the head and the tail-end of the system. In the head, only 7 percent of the farmers started the second plowing more than 16 days after the first plowing. In the tail-end areas, the number of farmers that took more than 16 days to start the second plowing was around 17 percent.

Nuwarawewa

In the Nuwarawewa (table 6, appendix 2), all the farmers in all the sample areas started the second plowing between 6-15 days after the first plowing. In Paniyankadawala (tail-end of the system), the majority of the farmers (84 percent) started the second plowing within 6-10 days after the first plowing, to make up for the delay occurred during the first plowing. The general trend among the farmers who delayed starting land preparation is to shorten the period between the first and the second plowings to the maximum possible extent.

Huruluwewa

In Huruluwewa (table 7, appendix 2), all farmers started the second plowing within 15 days after the first plowing, which is in contrast with the general practice observed in the other irrigation systems.

Minneriya

In Minneriya Raja Ela scheme (table 8, appendix 2), almost two-thirds of the farmers started the second plowing within 15 days from the date of the first plowing. About 20 percent of the farmers started the second plowing between 21-30 days after the first plowing, which shows a considerable delay compared with other systems.

In Minneriya Yoda Ela (table 8, appendix 2), most farmers (94 percent) in the total sample started the second plowing within the first 15 days from the date of the first plowing. A similar trend is observed in the sample distributary canal areas, although most delayed farmers are found again in the tail-end of the system. Apparently, they could not shorten the time taken for the second plowing to make up their delay during the first plowing (as in Nuwarawewa).

When we compare across schemes, it becomes clear that in Nuwarawewa and Huruluwewa, the second plowing started within 15 days and Minneriya Raja Ela had the most delay during this period.

3.2.4. Land Preparation Progress : Time between Second Plowing and Third Plowing

The time between the second plowing and the third plowing is presented in tables 9 - 12 in appendix 2. There is no recommendation from the Agricultural Department about the time period between the second and the third plowings (or land leveling).

Rajangana

In the Rajangana scheme (table 9, appendix 2), the majority of the farmers (86 percent) of the total sample started the third plowing within ten days after the second plowing. When analyzing the performance in different tracts, it becomes clear that there is a small head-tail inequity, with 96 percent of the farmers in the head (LB tract 1) starting the third plowing within ten days after the second plowing while the figure for the tail-end (LB Tract 7) is 74 percent.

Nuwarawewa

In the Nuwarawewa scheme (table 10, appendix 2), less than 10 percent of the farmers in the total sample as well as the sample distributary canals, started the third plowing later than 11 days after the second plowing.

Huruluwewa

In the Huruluwewa scheme (table 11, appendix 2), the majority of the farmers started the third plowing on the very same day of the second plowing or the day after. Only a fraction (4 percent to 8 percent) started the third plowing more than one day after the second plowing. Nobody took more than 4 days to start the third plowing.

Minneriya

In the Minneriya Raja Ela scheme (table 12, appendix 2) the majority of the farmers (72 percent) started the third plowing within 5 days after the second plowing and about 12 percent of the farmers started the third plowing later than 11 days after the second plowing.

In the Minneriya Yoda Ela scheme (table 12,appendix 2) the majority of farmers (68 percent) in the total sample started the third plowing within 5 days after the second plowing and the same trend was observed in the studied distributaries. Only a fraction (3 percent) of the farmers in the total sample started the third plowing later than 11 days after the second plowing.

If we compare the different systems, it becomes clear that Huruluwewa starts the third plowing almost immediately after the second plowing. In Rajangana, a higher percentage of the farmers take more time between the second and third plowings than those in the other three systems.

3.2.5. Land Preparation Progress :Time between Third Plowing and Sowing

Tables 13 - 16 in appendix 2 present the time taken by the farmers in the four schemes to start sowing after the third plowing. Most farmers in Sri Lanka sow on the day of the third plowing or one day after.

Rajangana

In Rajangana (table 13, appendix 2), half of the farmers in the total sample started sowing on the very same day of the third plowing (leveling) and almost all the remaining farmers started within one day after the third plowing.

Nuwarawewa

In Nuwarawewa (table 14, appendix 2),no body started sowing on the very same day of the third plowing (leveling) as observed in many other systems in Sri Lanka. The majority of the farmers started sowing within two days and more than 80 percent had started within three days after the third plowing. However, about 15, percent of the farmers of the total sample started sowing only 4-7 days after the third plowing, which is quite unusual when compared with how sowing is done in many other systems in the country.

Huruluwewa

In Huruluwewa (table 15, appendix 2), the majority of the farmers started sowing on the very same day of the third plowing or the day after. Only 4 percent to 12 percent of the farmers started sowing more than one day after the third plowing, the majority of them were located in the Nikawewa area.

Minneriya

In Minneriya Raja Ela (table 16, appendix 2), the majority (92 percent) of farmers started sowing one or two days after the third plowing.

In Minneriya Yoda Ela (table 16, appendix 2) nobody started sowing on the very same day of the third plowing (leveling), but most farmers started sowing within two days after the third plowing.

Comparing across schemes shows that in Rajangana and Huruluwewa, almost all farmers started sowing within one day after the third plowing, while in Nuwarawewa, it took up to seven days to start sowing.

3.2.6. Overall Progress of Land Preparation

According to the Agricultural Department, 21 days is generally sufficient to complete land preparation. A land preparation period longer than 21 days should be necessary only where irrigation water is limited or in poorly maintained fields with large accumulations of organic residues. The design guidelines for Kirindi Oya Irrigation and Settlement Project (KOISP) quoted in IIMI (1990) recommends 5 days for land soaking and 10 days for actual land preparation, resulting in a total land preparation period of 15 days. The Operation and Maintenance Manual for KOISP (1989) recommends 7 days for land soaking and 14 days for actual land preparation, resulting in a total land preparation period of 21 days (IIMI 1990). However, in the same study (IIMI 1990), the observed land preparation length was much higher, with 8 days for land soaking and 30 days for land preparation, resulting in an actual land preparation period of 38 days.

Rajangana

In the Rajangana scheme, 72 percent (table 6) of the farmers completed land preparation within 21 days from the day they started the first plowing. There is no significant difference ($p>0.05$) between the head, middle and the tail end of the system. Table 17 in appendix 2 presents more details per 5 day-period, which show that 91 percent of the farmers completed land preparation within 25 days from the day they started the first plowing. The majority took between 11-25 days. There is a small difference between the head and tail tracts. In LB tract 1 (head end) 3 percent of the farmers and in LB tract 7, 13 percent of farmers took more than 26 days. This difference can be mainly attributed to the time taken during the period between the second and the third plowing. Figure 13 in appendix 1 shows the frequency distribution of the land preparation duration per day.

The data presented in table 21 in appendix 2 and figures 2 -4 in appendix 1 and also figure 5 below reveal to what extent farmers in Rajangana have deviated from the agreed upon cultivation calendar. Only 5 percent of the farmers in the total sample completed land preparation before

Table 6. Percentage of farmers finishing land preparation within and after 21 days, and average number of days and standard deviation taken for land preparation.

Scheme		Less than 21 days				More than 21 days			
			Farmers	Average number	Std de v.	Farmers		Average number	Std dev
		n	% of total	days	days	n	% of total	days	days
Rajangana	LB Tract 1	19	25.0	15.2	4.8	9	11.8	23.7	1.3
	LB Tract 5	18	23.7	15.8	3.3	5	6.6	25.0	2.9
	LB Tract 7	18	23.7	17.3	3.7	7	9.2	24.9	2.6
	Total	55	72.4			21	27.6		
Nuwarawewa	Ambalawana	21	28.0	18.1	2.4	4	5.3	24.0	1.8
	D123	16	21.3	16.9	1.9	9	12.0	24.7	2.5
	Paniyankadawala	19	25.3	16.2	1.9	6	8.0	24.7	1.5
	Total	56	74.7			19	25.3		
Huruluwewa	Padikaramaduwe	23	31.9	8.0	2.2	0	0.0	-	-
	Nikawewa	24	33.3	9.1	2.8	0	0.0	-	-
	Dutuwewa	25	34.7	8.6	2.0	0	0.0	-	-
	Total	72	100			0	0.0		
Minneriya	Head	3	12.0	19.0	3.5	7	28.0	32.0	3.6
Raja Ela	Middle	6	24.0	14.7	5.2	1	4.0	22.0	-
	Tail	8	32.0	16.0	3.4	0	0.0	-	-
	Total	17	68			8	32		
Minneriya	Kothalawelapura	24	35.3	14.7	3.7	3	4.4	23.3	1.5
Yoda Ela	Yoda Ela	26	38.2	15.2	4.1	0	0.0	-	-
	Viharamawatha	13	19.1	14.2	2.6	2	2.9	26.5	5.0
	Total	63	92.7			5	7.4		
Total sample	Head	90	28.5	14.0	5.0	23	7.3	26.2	4.5
	Middle	90	28.5	14.0	4.5	15	4.8	24.6	2.5
	Tail	83	26.3	13.8	4.4	15	4.8	25.0	2.4
	Total	263	83.2	13.9	4.7	53	16.8	25.4	3.5

Note: n = Number of farmers.

26 November 2001, the last date for sowing as agreed upon at the cultivation meeting. About 82 percent of the farmers had a land preparation delay between 1-15 days. In LB tract 1 and 7 all farmers finished land preparation within 15 days after the agreed date. Only in LB tract 5 the delay was up to 30 days beyond the agreed date, although more farmers (9 percent) started land preparation before the agreed date than those in other tracts (3 percent).

Nuwarawewa

In the Nuwarawewa scheme, 75 percent (table 6) of the farmers completed land preparation within 21 days from the day they started the first plowing. There is no significant difference ($p>0.05$) between the head, middle and the tail end of the system. Table 18 in appendix 2 presents more details per 5 -day period, which shows that the majority of the farmers completed land preparation between 11 to 20 days from the date of commencement of land preparation activities. The number

of days allowed for land preparation activities in the Nuwarawewa irrigation system is 28 days, commencing from 23 October 2001. All farmers managed to finish within 28 days (see figure 14 in appendix 1 for the frequency distribution of land preparation duration per day). However not all farmers were able to start on time (table 22 in appendix 2; figures 5-7 in appendix 1 and figure 6 below), and only one-fifth of the farmers in the total sample completed land preparation before the date agreed upon at the cultivation meeting. Around 80 percent of the farmers in the total sample completed land preparation within ten days after the date agreed upon at the cultivation meeting. There is a clear head-tail inequity, where all farmers in Ambalawana (head end of the system) (figure 5, appendix 1) completed land preparation within ten days after the date agreed upon at the cultivation meeting while only about half of the farmers in Paniyankadawala (tail-end of the system) (figure 7, appendix 1) could achieve the same.

Huruluwewa

In the Huruluwewa scheme (figure 15, appendix 1 and table 19, appendix 2) the total time taken by farmers for the entire land preparation was very short. All farmers in our samples completed land preparation within a period of 15 days, with the majority of the farmers finishing within ten days from the date of the first plowing. A higher percentage of the farmers in the tail-end of the system (Dutuwewa area) took more time for the total land preparation period than those in the head end of the system (Padikaramaduwa area). In Huruluwewa, the majority of the farmers (87 percent) completed land preparation before the date agreed upon at the cultivation meetings (see table 23, appendix 2; figures 8 and 9, appendix 1 and figure 7 below). In the tail-end of the system (Dutuwewa area) where the water issues were made five days earlier than in the rest of the system, the percentage is slightly lower and 80 percent of the farmers completed land preparation before the date agreed upon at the cultivation meetings.

Minneriya Raja Ela

In the Minneriya Raja Ela, 68 percent (table 6) of the farmers completed land preparation within 21 days from the day they started the first plowing. The difference between the head, middle and the tail end of the system is significant ($p=0.003$), but the sample size is small and no conclusions about the performance of the parts of the system can be drawn.

Table 20 in appendix 2 presents more details per 5 day period and shows that about one-third of the farmers completed land preparation between 6-15 days. A considerable number of farmers took more than 25 days for land preparation and yet some other farmers took up to 38 days (figure 16, appendix 1).

In Minneriya Raja Ela, 44 percent of the farmers completed land preparation before the agreed upon date at the cultivation meetings (see table 24, appendix 2 and figure 8 below). Almost all farmers completed land preparation within five days after the agreed upon date.

Minneriya Yoda Ela

In Minneriya Yoda Ela, 93 percent (table 6) of the farmers completed land preparation within 21 days from the day they started the first plowing. There is no significant difference ($p>0.05$) between the head, middle and the tail end of the system. Table 20 in appendix 2 presents more details per 5 day period and shows that about half of the farmers completed land preparation within 15 days after the first plowing. Only in Viharamawatha (tail-end of the system), farmers had a delay of more than 25 days, but there is no clear head-tail inequity in the duration of land preparation. Figure 17 in appendix 1 shows the frequency distribution of the land preparation duration per day.

Figure 5. Land preparation progress, Rajangana (total sample).

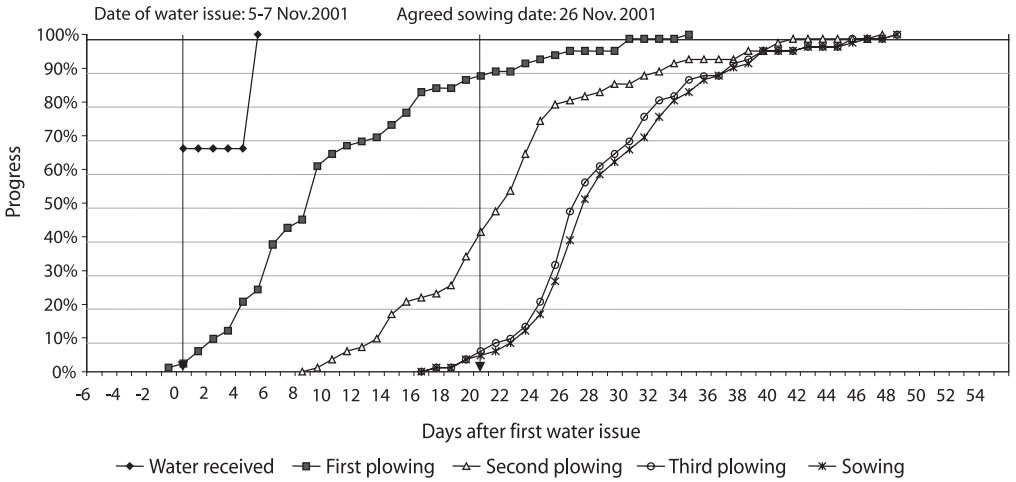


Figure 6. Land preparation progress, Nuwarawewa (total sample).

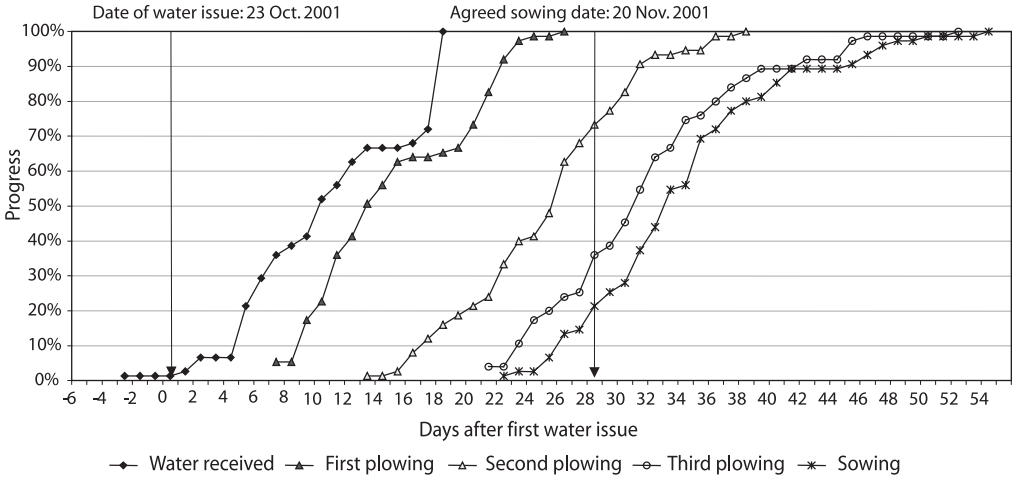


Figure 7. Land preparation progress, Huruluwewa (Dutuwewa area).

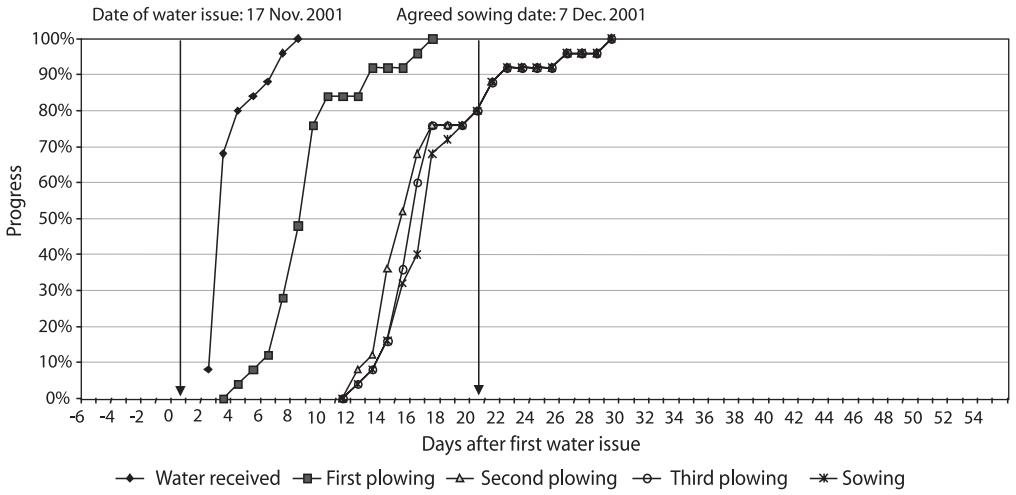


Figure 8. Land preparation progress, Minneriya-Raja Ela.

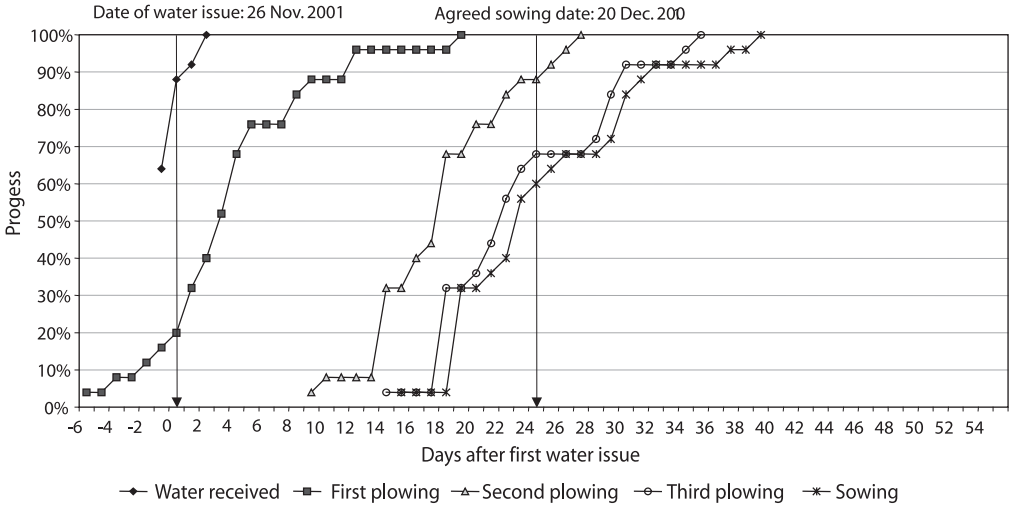
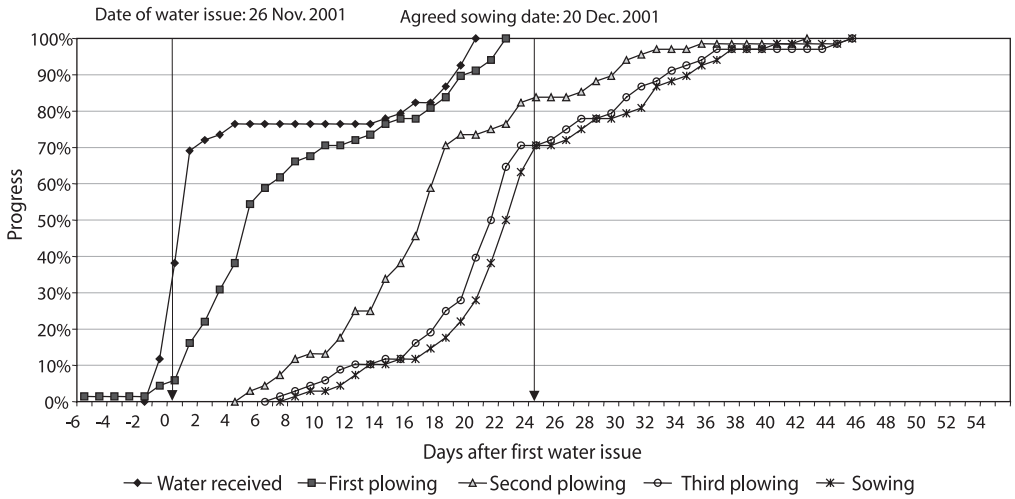


Figure 9. Land preparation progress, Minneriya-Yoda Ela (Left Bank) (total sample)



In Minneriya Yoda Ela, (table 24, appendix2 ; figures 10 - 12, appendix 1 and figure 9 below) 70 percent of the farmers completed land preparation before the agreed upon date at the cultivation meeting. In the head and middle of the system, this percentage was even higher, but in the tail-end only 7 percent of the farmers managed to finish land preparation before the agreed upon date. None of the farmers in the head and middle of the system had a delay of more than ten days, while almost half of the farmers in the tail-end (Viharamawatha) had a delay beyond ten days.

When comparing the non-delayed farmers with the delayed farmers, it becomes evident that out of all the farmers in all systems, the delayed farmers take an average of18.9 days for their land preparation, whereas the non-delayed farmers take significantly less time ($p<0.05$) and need only an average of 13.1 day to complete the land preparation. On examining the selected systems in detail it becomes clear that only in Huruluwewa the land preparation period for non-delayed and delayed farmers is significantly ($p<0.05$) shorter than other systems. In Minneriya Raja Ela, the land preparation period for delayed farmers is significantly longer than in all other systems.

Table 53 in appendix 2 is an extension of table 6 and presents the percentage of delayed and non-delayed farmers completing land preparation within and after 21 days at the head, middle and the tail-end of the system. It clearly shows that in all systems, except Minneriya Raja Ela (with a small sample size), even in the delayed farmer group, the majority of the farmers are able to complete the land preparation within 21 days.

When looking at all the selected systems, there is no significant influence of the location within the scheme (head, middle, tail end) on the time needed for land preparation for both the delayed ($p=0.484$) and non-delayed ($p=0.530$) farmer groups.

Looking into more details (table 54, appendix 2) the same is true for Rajangana. In Nuwarawewa,only the middle and the tail end of the system are significantly differently for the delayed farmer group. In Huruluwewa, the head and middle parts of the system are significantly different for the non-delayed farmer group. and for the delayed farmer group, the middle part of the system is significantly different. In Minneriya Raja Ela, the head and middle of the system are significantly different for the delayed farmer group, but the sample size is small. For Minneriya Yoda Ela, no significant influence of the location within the scheme could be found.

3.3. Reasons for deviation from the agreed upon cultivation calendar

The data presented in the previous section (figures 5 - 9) shows that 95 percent of farmers in Rajangana, 79 percent in Nuwarawewa, 47 percent in Huruluwewa, 56 percent in Minneriya Raja Ela and 30 percent in Minneriya Yoda Ela could not finish land preparation before the date agreed upon at the cultivation meetings. Data collected from the delayed farmers are discussed here in order to highlight the main reasons for delays in the progress of land preparation in these schemes.

3.3.1. Number of Days Delayed

Table 7 presents the percentage of delayed farmers by the number of days delayed for each scheme. In Huruluwewa, more than 80 percent of the delayed farmers finished land preparation with a delay between one to five days, while in the other schemes the majority of the delayed farmers had a longer delay. In all schemes, the majority of the delayed farmers finished land preparation with a delay between one to ten days and in Huruluwewa all the delayed farmers had a delay of ten days or less. In the other three systems a considerable group had a delay between 11 –25 days, with some having delays up to 40 days.

Table 7. Percentage of delayed farmers by number of days delayed.

Delay period	Scheme						
	Rajangana	Nuwara-wewa	Hurulu wewa	Minneriya Avg.	Raja Ela	Yoda Ela	Grand total
	%	%	%	%	%	%	%
1-5	19	41	80	27	30	25	32
6-10	38	34	20	43	50	40	37
11-15	25	12	0	23	20	25	19
16-20	13	10	0	3	0	5	10
21-25	3	2	0	0	0	0	2
26-30	1	2	0	0	0	0	1
36-40	0	0	0	3	0	5	1

3.3.2. Period in which Land Preparation Delay Occurred

Besides observed data on farmers' delay, delayed farmers were asked in which period most delays occurred (table 8).The majority of the farmers in all the systems except Minneriya Raja Ela felt that the land preparation delay occurred during the first plowing, although in Nuwarawewa, most farmers thought that the delay occurred both during the first and the second plowings. Farmers' response is much in line with the observed delays. In Huruluwewa, 60 percent of delayed farmers responded that the delay occurred at the time of sowing. There were some heavy rains at the time of the third plowing and sowing, which contributed to delays in this period. However, the total number of delayed farmers is very small in Huruluwewa (table 10), and 94 percent of the farmers of the total sample started sowing within one day after the third plowing (table 15, appendix 2).

Table 8. Delayed farmers' perception of the period of delay.

Delay period	System						
	Rajan-gana	Nuwara-wewa	Hurulu-wewa	Avg.	Minneriya Raja Ela	Yoda Ela	Grand total
	%	%	%	%	%	%	%
No response	7	3	0	0	0	0	4
First plowing	59	25	40	53	10	75	45
First plowing/second plowing	6	41	0	10	20	5	19
First plowing/second plowing/ third plowing	0	2	0	0	0	0	1
First plowing/second plowing/sowing	0	3	0	0	0	0	1
First plowing/sowing	9	7	0	0	0	0	6
Second plowing	10	5	0	20	40	10	10
Second plowing/third plowing/sowing	0	2	0	0	0	0	1
Second plowing/sowing	1	3	0	0	0	0	2
Third plowing	1	2	0	10	10	10	3
Third plowing/sowing	1	7	0	0	0	0	3
Sowing	4	0	60	7	20	7	7

3.3.3. Major Reasons for Delays

After knowing the duration and the period of delay, it is important to identify the major reasons for land preparation delays and whether they are water related or not. Table 9 provides information on the farmers in the four schemes who got delayed due to water related problems. Farmers ranked water related problems based on their impact on delay. In Rajangana and Huruluwewa, less than 15 percent of delayed farmers indicated that water related problems were the reason for the delay. The contrary can be seen in Minneriya (in both Raja Ela and Yoda Ela), and also in Nuwarawewa, where the majority of delayed farmers indicated that water related problems were the main reason for delay.

Table 9. Delayed farmers faced with water related problems (in rank order).

Rank order	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Minneriya			Avg.
				Avg.	Raja Ela	Yoda Ela	
	%	%	%	%	%	%	%
No problems	85	35	90	33	40	30	59
Rank 1	12	51	10	67	60	70	35
Rank 2	3	5	0	0	0	0	3
Rank 3	0	7	0	0	0	0	2
Rank 4	0	2	0	0	0	0	1

3.3.4. Reasons for Water Problems

The reasons indicated by farmers for their water related problems were different and numerous. They included problems at the main canal, distributary canal and the field canal level as well as soil related problems, inadequate rainfall, and uncertainty over water and other unspecified water related problems. These problems are summarized in tables 25 - 31 in appendix 2.

Rajangana

In the Rajangana scheme, out of the total number of farmers with water related problems, 6 percent reported problems associated with main canal operation as a reason (table 25, annex 2) and around 5 percent field canal problems (table 27, annex 2). Canal deterioration is the most important reason for delay. None of the delayed farmers reported distributary canal level problems. Some farmers reported uncertainty over water (due to political reasons and lack of rainfall) and other unspecified water related problems as reasons for delay.

Nuwarawewa

In Nuwarawewa, out of the total farmers who reported water related problems as the reason for delay 44 percent said that their water problems were associated with the main canal level and the biggest problem was canal maintenance (table 25, appendix 2). About 10 percent of the farmers reported that their land preparation delay was associated with problems at distributary canal level and the main reason was operational problems of the DC (table 26, appendix 2). About 17 percent of the farmers with water related problems reported field canal level problems. Maintenance problems are the most important reason for delay (table 27, appendix 2). Other important reasons for the land preparation delay are soil problems (table 28, appendix 2). According to the delayed farmers, their land consists of well-drained soils and cannot retain irrigation water. Almost half of the delayed farmers reported shortage of rainfall (table 29, appendix 2) and another quarter reported further unspecified water related problems as reasons for delay.

Huruluwewa

Farmers in Huruluwewa who reported water problems as reasons for delay did not have problems at MC, DC or FC levels. Their main problem was uncertainty over water, mainly due to the political situation prior to the 2001 general election, shortage of rainfall and other unspecified water related problems.

Minneriya

In Minneriya Raja Ela none of the farmers reported difficulties on MC and DC level as reasons for their water related problems. Main problems were reported at field canal level (table 27, appendix 2) and are focused around water sharing, canal deterioration and maintenance.

In Minneriya Yoda Ela, a half of the farmers reported problems on MC level (table 25, appendix 2), focused on canal system deterioration and operational problems. Going down to DC level up to 70 percent of the farmers reported problems relating to canal deterioration and maintenance problems (table 26, appendix 2). At FC level farmers reported no problems.

3.3.5. Non – water Factors Affecting the Progress of Land Preparation

The research revealed water related problems were less important reasons for land preparation delays in some systems, especially in Rajangana and Huruluwewa. However these systems, especially Rajangana, also had a delay in land preparation. Therefore, factors such as financial problems, farm-power, labor, seed and tenure related problems as well as the political situation (study was conducted just before the 2001 general elections) were considered as factors that could have negative impacts on land preparation progress.

3.3.5.1. Financial problems

Only Nuwarawewa farmers reported financial problems as a reason for land preparation delay (table 32, annex 2). Although almost one-third of the farmers reported this as a reason for delay, the majority of them did not consider it a serious problem.

3.3.5.2. Tractor availability problems

Tractor availability is a major problem in Rajangana and Nuwarawewa (table 33,appendix 2). In Rajangana, 58 percent of the farmers reported non–availability of tractors as a reason for delay and almost all considered this a very serious problem. In Nuwarawewa, 92 percent of the farmers reported non-availability of tractors as a reason for land preparation delay. It is a very serious problem for one quarter of the farmers and a fairly serious problem for more than a half. In Huruluwewa and Minneriya Yoda Ela about 30 percent of the farmers reported non-availability of tractors as a reason for delay. Apparently non-availability of tractors is a problem having serious negative impacts on land preparation progress in all systems studied except Minneriya Raja Ela.

Table 34 in appendix 2 summarizes farmers' responses for reasons for tractor related problems. Main reasons in all systems, except Nuwarawewa, is the shortage of tractors and the tractor-owner undertaking too many jobs or a combination of both. In Nuwarawewa, a combination of tractor shortage and the tractor-owners giving priority to those who pay hire charges in cash over those who pay in kind after harvesting is reported as tractor related problems.

3.3.5.3. Labor problems

In general, there is a declining trend in labor input in paddy cultivation due to higher tractorization, direct sowing and chemical weeding (Senakaarachchi 1990). Mechanization of plowing and threshing with 4-wheel tractors has resulted in a reduction of the labor input of 20-30 man days per hectare, but tractor use has not contributed to raising the productivity of the land over the years (Senakaarachchi 1990). However land preparation and harvesting are seasonal peak labor demand periods where labor shortage can occur. Joshua et al. (1980) report that land preparation takes around 20 percent of the total labor input for paddy and harvesting and post harvest tasks require about 47 percent of the total labor. More recent research by IWMI (Renwick 2001) in 1999 in

Kirindi Oya Irrigation and Settlement Project showed similar numbers, with 17 percent of the total labor input used for land preparation and 45 percent for harvest-related activities. Renwick (2001) reported that the average man days needed for land preparation was 15.5 per hectare (with a standard deviation of 3.6).

North Central Province is classified as a labor deficit area in comparison with the total land area under paddy, and especially in the Polonnaruwa District, the percentage of hired labor is high when compared with family labor (Senakaarachchi 1990).

Table 35 in appendix 2 shows the percentage of farmers faced with labor problems in the studied irrigation schemes. Labor problems are reported in all systems, except in Rajangana, with most serious problems reported from Minneriya Raja Ela, where 70 percent of delayed farmers gave labor problems as a reason for the delay (40 percent, as a very serious problem). In Nuwarawewa, 44 percent (17 percent, as a very serious problem) of delayed farmers reported labor as a problem for the delay. Although 15 percent of the farmers in Minneriya Yoda Ela reported labor as a problem, only 5 percent reported it as a very serious problem affecting land preparation.

The main reason for labor problems as reported by the farmers in Nuwarawewa and Huruluwewa is labor shortage during peak labor demand periods (table 36, appendix 2). In Minneriya Yoda Ela, the major reason is a labor shortage throughout the season. In Minneriya Raja Ela, labor shortage during both the peak labor demand periods and throughout the season is reported as main reasons for land preparation delays. Interviews with farmers show that migration of young people for outside employment (as soldiers in the army and workers in garment factories in free trade-zone areas of the country) and the shortage of in-migrant labor into the areas during cultivation seasons are the main reasons for labor shortages in these schemes.

3.3.5.4. Seed paddy problems

Problems with timely procurement of seed paddy that lead to land preparation delays are reported in Huruluwewa (20 percent) and Nuwarawewa (27 percent) (table 37, appendix 2). However, only in Huruluwewa it was perceived as a very serious problem.

In Nuwarawewa, the main reason for paddy problems was the non-availability of funds for farmers to pre-arrange the procurement of paddy seed (table 38, appendix 2). Farmers in Huruluwewa indicated other reasons for the problems, but it is not clear what these are.

3.3.5.5. Share/leasing arrangement problems

Though it is generally believed that many farmers delay land preparation in search of prospective leased-in and mortgaged-in farmers, data in table 39 in appendix 2 shows that this is not a major reason for the land preparation delay. Only some delayed farmers in Nuwarawewa and Rajangana reported this as a problem affecting land preparation progress. However, the existence of a large number of non-owner operators creates problems for system maintenance and water sharing. It is harder to get their involvement in system maintenance and operation activities through formal or informal means for efficient water management in these systems.

In Huruluwewa and Minneriya Yoda Ela, the majority of the sample farmers are owner-operators (table 45, appendix 2). In Rajangana and Minneriya Raja Ela, a bit less than half of the farmers are owner-operators. In Nuwarawewa, the number of owner operators is around 43 percent. The non owner-operators include leased-in, mortgaged-in or share cropping farmers.

On examining the tenure status of delayed farmers (table 46, appendix 2), it is seen that, except in Nuwarawewa, the majority of delayed farmers are owner-operators. This is against the popular

belief that land preparation delays occur due to delays in making lease and share cropping arrangements. The percentage of delayed farmers who are owner-operators remains more or less the same in the systems compared with the total sample, except for Huruluwewa where there is a lower percentage of owners in the delayed farmer group and in Minneriya Yoda Ela, where it is higher. However the number of delayed farmers are very low in these two systems (table 10).

Table 10. Delayed and non-delayed farmer distribution.

Irrigation scheme	Non-delayed farmers		Delayed farmers	
	n	%	n	%
Rajangana	4	5.3	72	94.7
Nuwarawewa	17	22.7	58	77.3
Huruluwewa	64	88.9	8	11.1
Minneriya - Raja Ela	15	60.0	10	40.0
Minneriya - Yoda Ela	66	97.1	2	02.9
Minneriya (average)	81	87.1	12	12.9
Total	166	52.5	150	47.5

Note: n = Number of Farmers.

3.3.5.6. Delay due to political environment

The study was conducted just before the 2001 general election, therefore the political situation during this period and its impact on land preparation progress was considered. In Huruluwewa, one-tenth of the delayed farmers reported that the political situation in the area was a problem that affected their land preparation activities seriously (table 40, appendix2). In Minneriya Raja Ela (30 percent) and Yoda Ela (20 percent) farmers reported that the political situation affected their land preparation activities and ranked it as a serious problem. In Nuwarawewa the political situation was reported as a minor problem by 7 percent of the farmers. There were rumors in Huruluwewa and Minneriya that the ruling party issued water to have farmers vote for them, but the water issues would be stopped after the election. These rumors by opposition parties created a feeling of uncertainty in the farming communities.

3.3.5.7. Institutional issues

The cultivation meeting is one main institutional arrangement for cultivation decision making and the communication of decisions made. As discussed above, cultivation meetings were held prior to the season in all the four schemes studied. Therefore, data were collected on farmers' participation at this important meeting and their knowledge on decisions taken. In general, participation of farmers at cultivation meetings is very poor (table 47, appendix 2). In Rajangana, Huruluwewa and Minneriya, farmers' participation in the cultivation meetings was almost zero. In Nuwarawewa, 53 percent of the sample farmers went to the cultivation meeting.

Although participation in the cultivation meeting was low, the majority of the farmers in the studied systems, except in Rajangana, knew about the date of canal cleaning (table 48, appendix 2). In Nuwarawewa, a similar percentage of farmers as that attended the meeting was aware of the date of canal cleaning. Though the participation of farmers in Minneriya (both Raja and Yoda Ela) at cultivation meetings was very low, all the farmers knew the date of canal cleaning. This is mainly

due to the fact that farmer organizations in Minneriya are more active than in the other studied systems and the FO leaders attended the cultivation meeting and communicated the decisions to the members of the FO. Farmers have regular formal and informal contact with the FO leaders on O&M issues.

About two-thirds of the sample farmers in Rajangana and Huruluwewa did not know the date on which water issues were to be made to their areas (table 49, appendix 2). In the other studied systems almost all farmers knew when the water would be released. However, more than 90 percent of the sample farmers in all the studied schemes knew about the age group variety of seed paddy to be sown (table 50 in appendix 2).

In Nuwarawewa and Minneriya (in both Raja Ela and Yoda Ela), nearly all farmers knew about the last date of sowing (table 51 in appendix 2). In Huruluwewa, this was 58 percent and in Rajangana, less than one-third of the farmers were aware of the agreed upon last date of sowing.

3.4. Number of farmers and acreage with land preparation delay

The highest number of non-delayed farmers is reported from Huruluwewa and Minneriya schemes (table 10).The highest percentages of delayed farmers were found in Rajangana and Nuwarawewa schemes.

The average area cultivated by non-delayed farmers and the delayed farmers is significantly different ($p< 0.0458$) in the studied schemes. The average area cultivated by delayed farmers is 0.22 ha higher than that of non-delayed farmers (table 11). However when examined in detail the average area cultivated by non-delayed farmers is higher than that of delayed farmers in all the irrigation schemes except in Minneriya.

The highest percentage of the area cultivated by non-delayed farmers is observed in Minneriya Yoda Ela and Huruluwewa schemes while the lowest is in Rajangana, where almost 95 percent of the area cultivated was delayed.

Even though the number of farmers who completed their land preparation and started sowing in time is higher than the number of delayed farmers, a different trend quite opposite to this is observed when an analysis is made on the basis of area cultivated. More than a half of the cultivated area has a land preparation delay.

Table 11. Average cultivated area and percentage by non-delayed and delayed farmers.

Irrigation scheme	Farmer category according to land preparation			
	Non-delayed		Delayed	
	Average area cultivated	% area cultivated	Average area cultivated	% area cultivated
	ha		Ha	
Rajangana	0.66	5.5	0.62	94.5
Nuwarawewa	2.09	27.3	1.64	72.7
Huruluwewa	0.58	89.8	0.53	10.2
Minneriya - Raja Ela	0.62	47.9	1.01	52.1
Minneriya - Yoda Ela	0.77	95.4	1.21	04.6
Minneriya (average)	0.74	82.7	1.05	17.3
Average	0.82	46.5	1.04	53.5

3.5. Impact of land preparation delay on variety duration selection and crop yield

Land preparation delay may have different kinds of negative impacts. When farmers delay land preparation, water issues have to be extended beyond the dates agreed at cultivation meetings, resulting in a higher water requirement. The delayed farmers may have to cultivate short duration varieties with low yield performances. Irrespective of the variety duration group, delay may have impacts on yields. To have a better understanding of the delay on yield performance, a yield survey was undertaken in the four sample irrigation systems.

Data reveal that the farmers in these irrigation systems cultivate 3 month, 3½ month and 4 month duration paddy variety groups. Table 52 in appendix 2 shows different duration variety groups used in each irrigation scheme by non-delayed and delayed farmer. In general, delayed farmers in these systems have a tendency to shift to a shorter duration variety when compared with non-delayed farmers. However, there are some differences between the systems. In Rajangana all non-delayed farmers cultivated 3½-month varieties and delayed farmers shifted both to shorter (3 month) and longer (4 month) duration varieties. As almost all farmers in Rajangana have a delay the sample size of the non-delayed farmers is very small (n = 4). In Minneriya, the general trend of delayed farmers to shift to a shorter duration variety is not clear, but the sample of delayed farmers is relatively small in this scheme when compared with the number of non-delayed farmers.

As an average over the four systems, it is very clear that delayed farmers shift to shorter duration varieties. The three month variety is cultivated by 6.6 percent of the non-delayed farmers and by 11.3 percent of the delayed farmers, showing an increase of more than 70 percent (table 52, appendix 2).

Table 12. Area (%) cultivated by non-delayed and delayed farmers with different varieties.

Variety duration	Farmer category according to land preparation	
	Non–delayers	Delayers
	% of the area cultivated	
3 months	3.9	7.6
3 ½ months	86.0	90.1
4 months	10.1	2.3

As shown in table 12, the area cultivated with under 3 -month duration variety by delayed farmers is twice that of the non-delayed farmers. The tendency of the delayed farmers to avoid cultivating long duration varieties (4 months) is also observed in the data presented in this table. The percentage of the area cultivated with the 4-month duration variety by delayed farmers is only one-fifth when compared with non-delayed farmers.

The average yield of delayed farmers has dropped when compared with that of the non-delayed farmers (table 13) in the studied irrigation schemes, except in Minneriya Yoda Ela. However, the sample size of delayed farmers in Minneriya Yoda Ela is too small (table 10: n = 2) to conclude that the yield of delayed farmers has increased. The highest yield drop is observed in Minneriya - Raja Ela and Rajangana. However, the impact of the yield drop is the highest in Rajangana and Nuwarawewa where the majority of farmers have land preparation delays.

Even though the yield drop found among the delayers and non-delayers is not statistically significant as a whole ($p<0.1390$), when the yields of different varieties used by both non-delayed and delayed farmers are considered, the yield difference between the non-delayed and delayed farmer categories is highly significant ($p<0.01$). Since the varieties used by non-delayed and delayed farmers are changing, it is important to take different duration varieties into analysis.

Table 13. Average yield by non-delayed and delayed farmers.

Scheme	Average yield			
	Non–delayed	Delayed	Yield reduction	
	kg/ha	kg/ha	kg/ha	%
Rajangana	4807	4402	405	8
Nuwarawewa	4982	4656	326	7
Huruluwewa	5095	5045	50	1
Minneriya - Raja Ela	4392	3979	413	9
Minneriya - Yoda Ela	4165	4278	-113	-3
Minneriya –average	4207	4029	178	4

The average yield of all different duration varieties has dropped when land preparation delay occurred (table 14). However, the highest yield drop (17 percent) was found in the 3-month duration variety (table 14). With this knowledge, it might be questioned if the decision made by delayed farmers to shift from the long duration varieties to a short duration variety in order to capture the days lost is profitable. To have more insight on this matter, the price of paddy was taken into account in the analysis. However, we have to keep in mind that most farmers are cultivating paddy on subsistence basis and are aware that if they cultivate the 3-month duration variety they will have a lower yield. It might be that if all delayed farmers opted for the longer duration varieties they would face water shortage at the end of the growing season and even lower yields would be the result.

Table 14. Average yield of different varieties by non-delayed and delayed farmers.

Variety duration	Average yield			
	Non–delayers	Delayers	Yield reduction	
	kg/ha	kg/ha	kg/ha	%
3 months	4812	4005	807	17
3½ months	4599	4551	48	1
4 months	5103	4858	245	5

3.6. Impact of land preparation delay on farmer income

Delayed farmers who cultivated varieties other then the 3½- month variety were able to sell their paddy at higher prices (table 15). However, in general there is no significant difference ($p<0.63$) in the price paid per kilo of paddy, based on the variety duration or the time of harvesting (early or late, as a result of the land preparation delay) in all the four irrigation schemes. Due to this reason, it is most unlikely that farmers' variety selection is influenced by prices.

Table 16 shows that the income per hectare decreased in the delayed farmer group regardless of the varieties used. The highest income loss is found with the farmers using a 3- month duration variety, while the lowest has been found in the farmers using a 4-month duration variety.

With the results of the income reduction of the 3- month variety in table 16 the strategy of delayed farmers to shift to shorter duration varieties doesn't pay off very well.

Table 15. Price of paddy per kilogram received by different farmer categories for different paddy variety duration.

Variety duration	Price of paddy			
	Non–delayers	Delayers	Price change	
	Rs/kg	Rs/kg	Rs/kg	%
3 months	12.33	12.78	0.45	4
3½ months	13.56	12.76	-0.80	-6
4 months	12.94	13.10	0.16	1

Table 16. Income received by non-delayed and delayed farmers for different paddy variety duration.

Variety duration	Income			
	Non–delayers	Delayers	Income reduction	
	Rs/ha	Rs/ha	Rs/ha	%
3 months	59,332	51,184	8,148	14
3½ months	62,363	58,071	4,292	7
4 months	66,033	63,640	2,393	4

3.7. Impact of land tenure status on crop yields

Literature clearly links land tenure security with productivity of land (Kotagagama et al.1995; Wanigaratne 1990). The more secure the land tenure, the higher is the productivity of the land. Dunham and Fernando (1991) describe there are at least two complications in assessing the importance of tenancy: The range of variation that occurs (from money rents to sharecropping) and in its relative significance (whether the land is rented from a big money lender who controls much in the area, a relative, or a small absentee-owner who inherits a mere fraction of an acre). These factors might diffuse the impact of the tenancy status on yield. Table 17 shows the land tenure status of farmers and their yield for the selected irrigation systems.

Table 17. Impact of land tenure status on yield.

Irrigation scheme	Owner		Non – owner		
	n	Yield kg/ha	n	Yield kg/ha	Yield difference kg/ha
Rajangana	34	4453	42	4400	53
Nuwarawewa	33	4597	42	4837	-240
Huruluwewa	52	5101	20	5059	42
Raja Ela	12	4265	12	4218	47
Yoda Ela	44	4298	24	3930	368
Total	175	4621	140	4529	92

Note: n = Number of Farmers.

Although the yield varies along with the land tenure status, as an average over all the systems, the yield of owner-operators is not statistically significant ($p>0.05$) and different from farmers not

cultivating their own land, but having a leased-in, mortgaged-in, sharecropping or other arrangement. As an average over all the systems, owner-operators have a slightly higher yield. When looking into further details of the different systems, owner-operators are seen to have a slightly higher yield, except in Nuwarawewa. However, the yield difference between owner-operators and non-owner-operators is not statically significant except for Minneriya Yoda Ela ($p<0.0194$) where the owner-operators' yield is 368 kg/ha higher than that of the non-owner-operators. The link between land tenure security and the productivity of land mentioned in the literature could not be clearly established.

To relate the impact of land tenure status on the yield with land preparation delay, the owner-operators and non-owner-operators were regrouped as farmers with land preparation delay and with no delay. Table 19 shows the impact of land tenure status on yield for delayed and non-delayed farmers.

Table 18. Impact of land tenure status on yield for delayed and non-delayed farmers.

	Owner		Non– owner		
	n	Yield kg/ha	n	Yield kg/ha	Yield difference kg/ha
Non-delayed	105	4744	60	4479	265
Delayed	70	4436	80	4566	-130

Note: n = Number of Farmers.

As an average over all the systems, the owner-operators without a land preparation delay have a significant ($p<0.0241$) higher yield of 265 kg/ha when compared with non-delayed non-owner-operators. The owner-operators with a land preparation delay have a lower yield than non-owner-operators with a land preparation delay, but this difference is not statistically significant. It was impossible to regroup the owner-operators and non-owner-operators on the basis of land preparation delay per system. The sample size of the delayed and non-delayed group would be too small (table 10).

3.8. Contribution of institutional arrangements on land preparation progress

The farmer organizations (FOs) can contribute significantly to improve performance during land preparation in various ways. One important area for FOs' involvement and contribution is the operation and maintenance of the tertiary system. In the studied systems, FOs handle these activities to some extent, however, due to lack of farmer participation and deterioration of the physical system FOs are not in a position to improve the performance during land preparation. In addition, farmer organizations can play a very important role in increasing the productivity of small holdings, through support for non-water related problems like difficulties concerning credit, inputs and farm power (IMPSA 1992). However, only FOs in Minneriya could be observed helping farmers by providing these types of services. In other schemes, like Nuwarawewa, these services were provided in the past, but were given up due to defaulting.

FOs could contribute enormously in improving the communication between farmers, and also between farmers and government officials, for example in ID, IMD and Department of Agrarian Development. Especially, decisions made during the cultivation meeting could be easily and better disseminated through FOs. However, for implementing these activities, FOs need to be strong organizations and it was with the understanding of the weaknesses of FOs that a new institutional arrangement was proposed for the land preparation period.

The preliminary arrangements for implementing the new institutional structure and activate the Jala Meheum committees (Water Management Committees) had been made in Nuwarawewa, Rajangana, Huruluwewa and Minneriya. The Deputy Director (Irrigation) in Anuradhapura took a keen interest in initiating this activity in the projects in the Anuradhapura District.

Unfortunately, due to the political situation just prior to the general elections in the country, it was almost impossible for the proposed Jala Meheum committees to work. The committee needed the active participation of officers like P&RAs of the Department of Agrarian Development, DCO leaders and turnout attendants in the respective DCO areas, but some of them were involved in party political activities and had no time for other work.

In Rajangana, it was very difficult to obtain the services of the P&RAs due to their heavy involvement in party political activities. However, in some areas in Rajangana (outside our sample areas) with water shortage problems, FO leaders participated in the Jala Meheum committee meetings and the data were channeled to ID via IMD. The Jala Meheum committees did not work in our sample areas in Rajangana, and qualitative data on the performance of the committees could not be obtained due to this reason.

In Nuwarawewa, the Jala Meheum committee or the data collection system did not work at all and ID had to use its field workers to collect the data and information required. ID field workers collected data and information in the field and their presence had some positive impacts on the progress of land preparation as farmers tried to avoid delays to the maximum possible extent.

In Huruluwewa, attempts to establish and activate the Jala Meheum Committees were found in all the three samples areas. The Project Manager (IMD) with the involvement of ID, provided necessary training to the turnout attendants, farmer representatives and P&RAs on the proposed institutional changes and data collection, and weekly meetings were held at the field level.

In the the Huruluwewa - Padikaramaduwa area, the committee did not work due to weak leadership and lack of initiatives by P&RA. The FO-appointed turnout attendant finally initiated the DC cleaning activities. The FO appointed turnout attendant and the ID turnout attendant were the only people who effectively contributed to the program.

In the Huruluwewa - Nikawewa area, P&RA was actively involved in the program and although the FO was weak, the committee could function effectively due to P&RAs active involvement. The committee pursued action against farmers who had not completed canal cleaning and not found solution to water shortage problems due to non-attendance to pre-seasonal maintenance of DCs and FCs. However, the committee could not effectively control the water in DC due to infrastructure constraints, like the absence of regulatory structures and gates.

In the Huruluwewa - Dutuwewa area, several Jala Meheum Committee meetings were held. The meetings were not attended by the president of DCO and P&RA, nor by the turnout attendant appointed by DCO. However, the ID turnout attendant serving in the area attended the meetings. Participation of FC representatives was poor. The committee did not work well due to weak leadership and lack of initiative by P&RA.

In Minneriya, the proposed Jala Meheum Committees had not been introduced and there was no special monitoring program during the land preparation period. None of the selected systems established the proposed system level committee.

4. Discussion

The study highlights various factors affecting the performance in land preparation. The impact of these factors is different from scheme to scheme depending on the nature of the physical system,

and the socio-economic and institutional environment of the scheme. The study does not offer a detailed analysis of the socio-economic environment or community aspects influencing land preparation progress. The concern of the study is to grasp the factors of immediate relevance to land preparation progress, and the role of institutions to mitigate negative factors and investigate whether farmers adhering to timely cultivation have positive results such as higher yields and incomes when compared with those who got delayed.

In the Rajangana and Nuwarawewa schemes, the majority of the farmers had a land preparation delay. Minneriya Yoda Ela and the most water short Huruluwewa had the lowest number of delayed farmers. The length of the land preparation delay was higher also in Rajangana and Nuwarawewa, where one-third and one-fifth respectively of the farmers had a delay of more than ten days when compared with the date agreed upon at the cultivation meeting. In Huruluwewa and Minneriya Raja Ela, none of the farmers had a delay of more than ten days. In Minneriya Yoda Ela, less than 10 percent of the farmers had a delay of more than ten days and their lands were located mainly in the tail-end of the system. Data show beyond doubt that most land preparation delays occur in the period between the first water issue and the commencement of land preparation.

The reason for the land preparation delay can be divided between water related and non-water related factors. Water related factors play an important role only in Nuwarawewa and Minneriya, and non-water related factors are important in Rajangana and Huruluwewa. Lack of MC maintenance was the most serious problem in Nuwarawewa, where water related factors had a negative impact on land preparation progress. Additionally, farmers in Nuwarawewa mentioned operational problems at DC level, and canal maintenance and water sharing problems at FC level as reasons for the delay. Only Farmers in Nuwarawewa reported shortage of rainfall during the land preparation period and the character of their well-drained soils that don't keep standing water in the field as reasons for land preparation delay.

Although the number of delayed farmers in Minneriya was low, farmers reported water related factors as the main reason for the delay. In Minneriya Yoda Ela, MC and DC deterioration, and DC operation and maintenance problems were mentioned, whereas in Minneriya Raja Ela, problems reported were canal deterioration, maintenance and water sharing problems at FC level. In Rajangana, water related problems were less important and limited to MC level operational problems and canal deterioration at FC level. Similarly, in Huruluwewa, water related problems were less important even though uncertainty over water had some impact on delay. This uncertainty that prevailed in the minds of farmers was mainly due to political factors such as spread of rumors that water was issued for political gains only and would be stopped immediately after the general election. Farmers in Minneriya also reported political environment as a reason for land preparation delays.

Deterioration of the physical system at main canal level is a major reason for the water problems of farmers. The second most important reason is physical system deterioration at DC and FC levels and lack of efforts for DC and FC maintenance by farming communities. Field observation shows that farmers attend to DC and FC maintenance after water issues and do not clean them properly. This creates water problems at the commencement of the season.

During the study it became clear that non-water related factors are a major reason for land preparation delay, especially in Rajangana where only 5 percent of the sample farmers finished land preparation on time. Out of all the delayed farmers, only 15 percent indicated water as a major factor for delay. In all four systems, except Minneriya Raja Ela, tractor shortage and the tractor-owners accepting too much work at the same time was a major problem. In Rajangana and Nuwarawewa, this was the main reason for land preparation delay. In Nuwarawewa, tractor-owners giving priority to those who pay hire charges in cash over those who pay in kind after harvesting are reported as tractor related problems.

Labor shortage in the area, especially during peak demand period of the season, was reported as a major reason for land preparation delay in Nuwarawewa and Minneriya Raja Ela.

Delayed farmers in Huruluwewa reported paddy seed problems as major reason for delay, mainly due to problems associated with the procurement of seed through agencies within short notice. In Nuwarawewa, paddy seed problems were also reported and the major reason was non-availability of funds to make prior arrangements for the seed. Delayed farmers in Nuwarawewa were the only ones with financial problems that affected land preparation performance.

Land fragmentation is very high in all schemes, and leasing and mortgaging as well as share cropping arrangements are prevalent. However, it is difficult to measure their impacts on land preparation progress. The majority of delayed farmers, except in Nuwarawewa, are owner-operators and the percentage of owner-operators in the total sample and among delayed farmers remains more or less the same in schemes where a lot of farmers have land preparation delay. This is against the popular belief that land preparation delay occurs due to the delays in making leased-in and share cropping arrangements.

Farmers in the different irrigation systems cultivate three types of paddy varieties of different duration: 3 months, 3½ months and 4 months. Delayed farmers in these systems have a tendency to shift to a shorter duration variety, when compared with non-delayed farmers.

On average, in all four systems studied, the yield of delayed farmers is lower when compared with that of non-delayed farmers. This yield difference is not statistically significant as such; however, when the different varieties cultivated are taken into account, the yield drop of the delayed farmers is highly significant. The highest yield drop was found in the 3-month duration variety, which is used more often by delayed farmers. The farmer income per hectare is also lower in the delayed farmer group, regardless of varieties used, but the highest income loss is found among farmers using the 3- month duration variety. Thus, the strategy of delayed farmers to shift to the 3-month duration variety cannot be considered economically beneficial to them. Most farmers are aware that if they cultivate the 3-month duration variety, they will have a lower yield. It might be that if all delayed farmers opted for the longer duration varieties they would face water shortage at the end of the growing season and even lower yields would be the result.

Farmer attendance at cultivation meetings is extremely low (ranging from 0 to 7 percent). Only in Nuwarawewa, a bit more than a half of the farmers attended the cultivation meeting.

Although, in Rajangana, notices on cultivation decisions were displayed at public places, farmers' awareness of cultivation meeting decisions, like the date of canal cleaning, the date of first water issue and sowing was extremely low. This clearly demonstrates that this method is not as effective as attending the cultivation meeting.

In Huruluwewa, decisions of cultivation meetings were announced using loudspeakers and farmers' awareness of them was slightly higher than it was in Rajangana, but still, much lower than in Nuwarawewa where more people attended cultivation meetings. In Minneriya (both Raja and Yoda Ela), all farmers were aware of cultivation meeting decisions although attendance at the meetings was extremely low. Farmer organizations are more active in Minneriya than in the other studied systems, and FO leaders who attended the cultivation meetings communicated decisions to FO members.

Farmer organizations in the studied systems are too weak to implement a program for efficient water use at FC and DC levels by operating and maintaining DCs and FCs in a systematic way. Only FOs in Minneriya contributed to finding solutions to some non-water related problems like credit, input, and farm-power problems, and are providing required inputs to farming communities. Farmer organizations could contribute enormously in improving communication between farmers and government officials, and in disseminating decisions made during the cultivation meeting.

However for implementing these activities, FOs need to be strong organizations and it was with the understanding of the weaknesses of FOs that a new institutional arrangement was proposed for the land preparation period.

The proposed Jala Meheum Committees need functional FOs for implementing the water management program effectively. It seems that the proposed new institutional arrangement can work only when farmer organizations are strengthened and farmers are actively participating in FOs. Besides, the need for stronger FOs and actively participating farmers, and the active involvement of grass roots level officers like P&RAs and turnout attendants are required for a functioning Jala Meheum Committee. Yet, the active involvement of P&RA was observed only in the Huruluwewa - Nikawewa area, and although FO was weak, the committee could function effectively due to P&RA's active involvement in this area. This case, though an isolated one, shows that active involvement of grass roots level officers can help the Jala Meheum Committees to function even when FOs are weak. One of the reasons that grass roots level officers were not able to actively participate in the Jala Meheum Committees was the political environment just prior to the 2001 general election. Some of the grass roots level officers were involved in party political activities and had no time for other activities.

5. Conclusions and Recomendations

The study shows that the length of the land preparation delay and the number of delayed farmers vary from system to system. Rajangana and Nuwarawewa are the schemes where the majority of farmers have land preparation delay. The length of delay in these two systems is also longer than in the other schemes. In Minneriya Yoda Ela and Huruluwewa, the majority of farmers finished land preparation on time. The study further reveals that in most cases, the land preparation delay occurs in the period between the first water issue and the commencement of land preparation. Even though farmers can finish land preparation within the time agreed at the cultivation meeting, they fail to start it on time. Therefore, in order to reduce land preparation delays, it is necessary to focus on the period between the first water issue and the commencement of land preparation and introduce interventions to ensure that farmers start on time.

Both water and non-water factors can cause land preparation delay. Water related factors are associated with maintenance problems and canal deterioration at main canal and distributary level, the operation of the distributary canal, canal maintenance and water sharing problems at the field canal, and well-drained soils (Nuwarawewa) that prevent farmers from storing water on their fields. Non-water related factors include tractor shortage and tractor-owners accepting too much work at the same time, labor shortage in the area, especially during peak demand periods of the season, problems related to the procurement of seeds and financial problems (Nuwarawewa). The study does not show negative impacts of tenure statuses like share cropping and leasing on land preparation delay.

One major finding is the yield drop among the delayed farmers. Delayed farmers in all systems have a tendency to cultivate a 3-month duration variety. The farmers cultivating the 3-month duration variety reported the highest yield drop. They also reported the highest income loss. Yield and income are lower in the delayed farmer group, irrespective of the variety used. In the economic point of view, farmers did not benefit by shifting to a 3-month duration variety.

The most effective mechanism to obtain farmer participation in decision making and communicating cultivation decisions is the cultivation meeting, but farmer attendance at cultivation meetings is extremely low. The information and data collected from Minneriya shows that farmer organizations could contribute enormously in improving the communication between farmers and

government officials, in disseminating decisions made during the cultivation meetings and in finding solutions to non-water related problems.

The impact on land preparation progress of the Jala Meheum Committees could not be observed. The Jala Meheum Committee was in operation only to some extent in Huruluwewa due to the heavy involvement of the Project Manager (IMD) in the program. Even though the land preparation period was much shorter in this system than in the other studied systems, this cannot solely be attributed to the Jala Meheum Committee.

It should be noted that the water situation at the commencement of the season and the political environment just before the 2001 general elections had serious negative impact, especially on testing an institution like the Jala Meheum Committee requiring the participation of all stakeholders concerned. In none of our sample systems, the proposed system level committee was established.

A new institution like the Jala Meheum Committee cannot be successfully implemented within one or two seasons. It should be implemented during several seasons for pilot testing before replication. The research highlights that the active involvement of grass roots level officers can help the Jala Meheum Committees to function even when FOs are weak. However, the Committees need the help of the functioning FOs to attend to management activities during the land preparation period.

This research showed clearly that besides water related factors, non-water related factors too are important and are the main reason for the land preparation delay in some systems. The Jala Meheum Committees endeavor to solve water-related problems only and therefore, even a perfectly working Jala Meheum Committee will not be able to solve land preparation delays in the systems where non-water related problems are the main reason for land preparation delay.

The following steps are recommended for further strengthening this institutional development effort for improved performance during the land preparation period:

- Establish the system level committees to supervise the Jala Meheum Committees on distributary canal level and provide guidance and assistance to improve land preparation progress.

- Commitment of P&RAs should be obtained for the activities of the Jala Meheum Committee. Support for the program should be sought from Divisional Officers and Assistant Commissioners of the Department of Agrarian Development in the respective areas under whom P&RAs work..

- Farmer organizations should be further strengthened to improve communication between farmers and government officials, to improve the dissemination of decisions made during the cultivation meeting and to find solutions to non-water related problems.

- Maintenance and operation of the main system should be improved to avoid land preparation delays resulting from main canal system deterioration.

Literature Cited

Alwis, J.; Nelson, L.; Gamage, H.; Nandasena, R. A.; Griffin, R. E.; Yoo, K.; Ekanayake, A.; Haider, M.; Wickramasinghe, L.; Dunn, L.; Bandaranayake, M. A. W.; Reddy, J. M.; Laitos, W. R. 1983. *The Rajangana Irrigation Scheme, Sri Lanka: 1982 Diagnostic Analysis.* Water Management Synthesis Report no. 19. Fort Collins, CO, USA: Colorado State University. p 118.

Bhuiyan, S.I.; Sattar, M.A.; Khan, M.A.K. 1995. Improving water use efficiency in rice through wet seeding. *Irrigation Science* 16: 1-8.

Brohier, R.L. 1934. *Ancient irrigation works in Ceylon. Part II.* Colombo, Sri Lanka: Government Press. p 64.

De Datta, S.K.; Abilay, W.P.; Kalwar, G.N. 1973. Water stress effects in flooded tropical rice. In *Water Management in Philippine Irrigation Systems: Research and Operations*. Los Baños, Philippines: International Rice Research Institute. pp 19-36.

De Datta, S.K. 1981. *Principles and Practices of Rice Production.* Los Baños, Philippines: International Rice Research Institute. p 618.

Dunham, D.; Fernando, N. 1991. *Consolidation of fragmented paddy land: Is it really necessary?* Agricultural policy series no. 1. Colombo, Sri Lanka: Institute of Policy Studies. p 54.

Hukkeri, S.B.; Sharma, A.K. 1980. Water-use efficiency of transplanted and direct-sown rice under different water management practices. *Indian Journal of Agricultural Science* 50: 240-243.

IIMI (International Irrigation Management Institute). 1988. *Irrigation management and crop diversification in Sri Lanka: Progress report on Technical Assistance Study (TA 846 SRI).* Colombo, Sri Lanka: International Irrigation Management Institute. p 153.

IIMI (International Irrigation Management Institute).1989. *Irrigation management and crop diversification in Sri Lanka: Seasonal summary report on Technical Assistance Study (TA 846 SRI).* Colombo, Sri Lanka: International Irrigation Management Institute.

IIMI (International Irrigation Management Institute). 1990. *Irrigation management and crop diversification in Sri Lanka: Final report on Technical Assistance Study (TA 846 SRI), Volume II*, *Kirindi Oya Project.* Colombo, Sri Lanka: International Irrigation Management Institute. p 257.

IMPSA (Irrigation Management Policy Support Activity). 1992. *Sustainable and Productive Resource Management: Macro Policies for Land and Water Management.* IMPSA policy paper no. 7. Colombo, Sri Lanka: Irrigation Management Policy Support Activity. p 29.

Irrigation Department. 1975. *Register of Irrigation Projects in Sri Lanka.* Colombo, Sri Lanka. p 100.

IWMI (International Water Management Institute). IWMI Water and Climate Atlas (www.iwmi.org/WAtlas/atlas.htm). Colombo, Sri Lanka: International Water Management Institute.

Joshua, W.D.; Hale, J.T.; Rangit, W.J.K.V. 1980. *Returns to Upland and Lowland Rice Crops in Maha 1979-1980 in Terms of Land, Water, Labor and Income.* Report prepared for USAID. p 136.

Kotagagama, H.B.; Athukorale, T.; Athukorale, K.; Herath, P.K.; Jayasena, I K.; Pushpalatha, D.G.; Wijekoon, A.K. 1995. *Relationship of land tenure on land productivity, conservation and markets: Case study on non-irrigated agricultural systems.* Unpublished report of a study conducted by Associated Development Research Consultants Ltd. (ADRC), Hantana Place, Kandy, Sri Lanka, on behalf of USAID. p 75.

Panabokke, C.R. 1989. *Irrigation management for crop diversification in Sri Lanka: A synthesis in current research.* IIMI country paper - Sri Lanka no.3. Colombo, Sri Lanka: International Irrigation Management Institute. p 54.

Panabokke, C.R. 1996. *Soils and Agro-Ecological Environments of Sri Lanka.* Natural Resources Series no.2. Colombo, Sri Lanka: Natural Resources, Energy and Science Authority. p 220.

Paranavitana, S. 1959a. Civilization of the Early Period: Economic, Political and Social Conditions. In *History of Ceylon. Vol.1. From the earliest times to 1505. Part 1: Up to the end of the Anuradhapura period*. Colombo, Sri Lanka: Ceylon University Press. p 410.

Paranavitana, S. 1959b. Lambakanna Dynasty: Vasabha to Mahasena. In *History of Ceylon. Vol.1. From the earliest times to 1505. Part 1: Up to the end of the Anuradhapura period*. Colombo, Sri Lanka: Ceylon University Press. p 410.

Renwick, M E. 2001. *Valuing water in irrigated agriculture and reservoir fisheries: A multiple-use irrigation system in Sri Lanka.* IWMI Research Report 51. Colombo, Sri Lanka: International Water Management Institute. p 34.

Sakthivadivel, R.; Panabokke, C.R.; Wijayaratna, C.M.; Fernando, N.; Jinapala, K.; Bandula Sirimal, R.B. 1995. *Natural resources management study of North Central Province Sri Lanka. Annexures - Volume II*: Pre-project technical assistance study for proposed Area Development Project of North Central Province. p 20 and annexes.

Sakthivadivel, R.; Fernando, N.; Panabokke, C.R.; Jinapala, K.; Wijayaratna, C.M.; Bandula Sirimal, R.B. 1996. *Natural resources management study of North Central Province Sri Lanka.* Final report - Main report. Colombo, Sri Lanka: International Irrigation Management Institute. p 232.

Senakaarachchi, R.B. 1990. *Labour Availability affecting Irrigated Agriculture in Sri Lanka.* Irrigation Management Policy Support Activity (IMPSA) Staff working paper no. 1.4. Colombo, Sri Lanka: Irrigation Management Policy Support Activity. p 50.

Seneviratna, A. 1989. *The Springs of Sinhala Civilization (An illustrated Survey of the Ancient Irrigation System of Sri Lanka).* New Delhi, India: Navrang. p 160.

Siriweera, W.I. 1991. Irrigation and Water Management in the Dry Zone of Sri Lanka: A Brief Historical Survey. *Aquinas Journal*, Volume VII: 33-45.

Somarasekra, B.M.S.; Mohammed, R.A.; Imbulana, K.A.U.S.; Gates, T,K.; Bandaranayake, M.A.W.; Nelson, L.J.; Somasundera, J.W.D.; Shaner, W.M.; Hettige, S.; Kilkelly, M.K. 1987. *Diagnostic analysis of Minneriya Scheme, Sri Lanka: 1986 Yala - Discipline reports.* Water Management Synthesis report no. 59. Fort Collins, CO, USA: Colorado State University. p 211.

USAID (United States Agency for International Development). 1985. *Study of recurrent cost problems in irrigation systems: Sri Lanka.* Final Report. Colombo, Sri Lanka: Engineering Consultants Ltd.; Development Planning Consultants Ltd. p 206 and annexes.

Wanigaratne, R.D. 1990. *Land issues affecting irrigated agriculture in Sri Lanka.* Staff working paper 1.3. Colombo, Sri Lanka: Irrigation Management Policy Support Activity. p 34.

Appendix 1

Figure 1. Agro-ecological zones, North Central Province and location of selected systems, Sri Lanka (Agro-ecological zones adjusted from Panabokke, 1996).

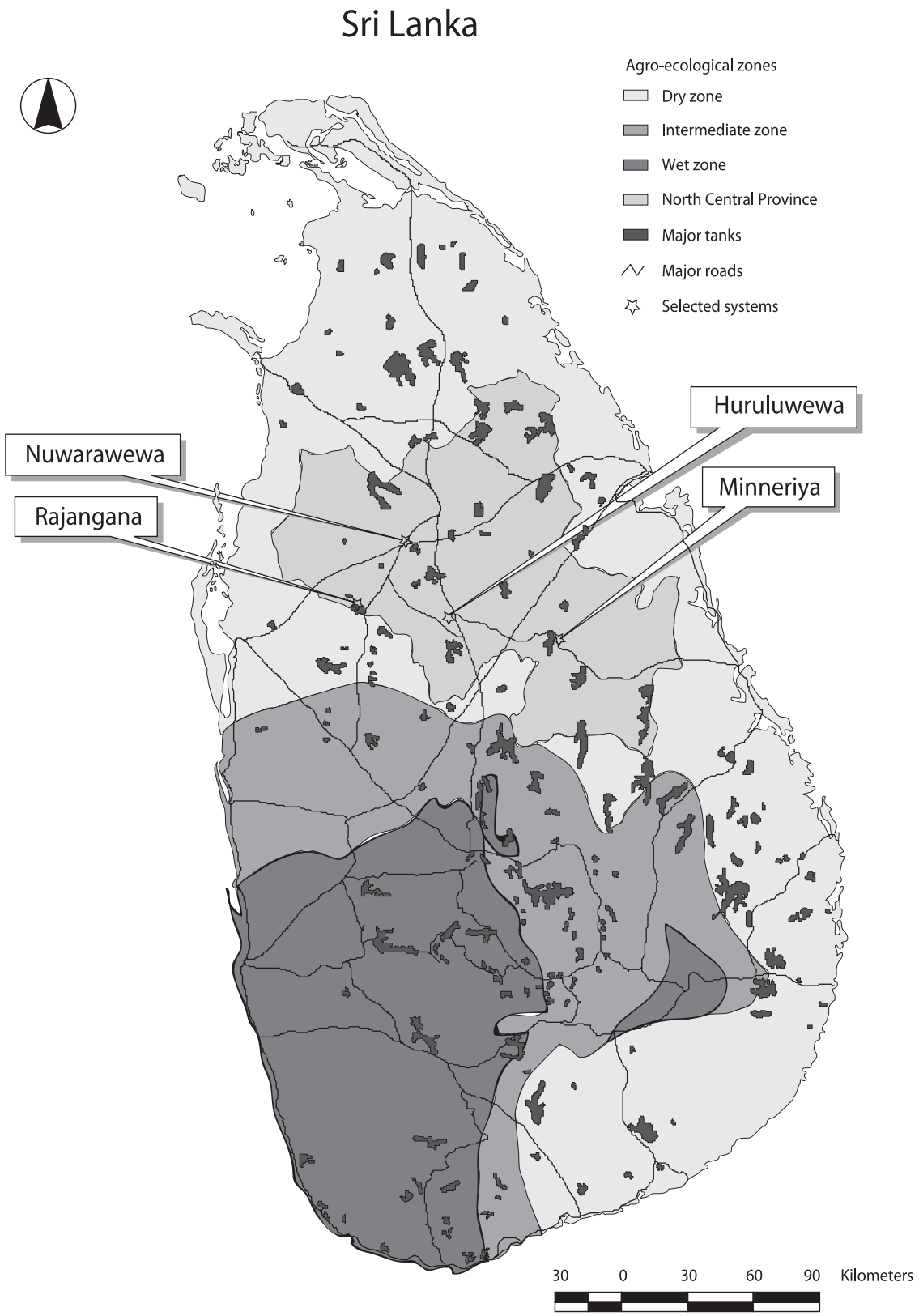


Figure 2. Land preparation progress, Rajangana–Paluwewa–Tract 1.

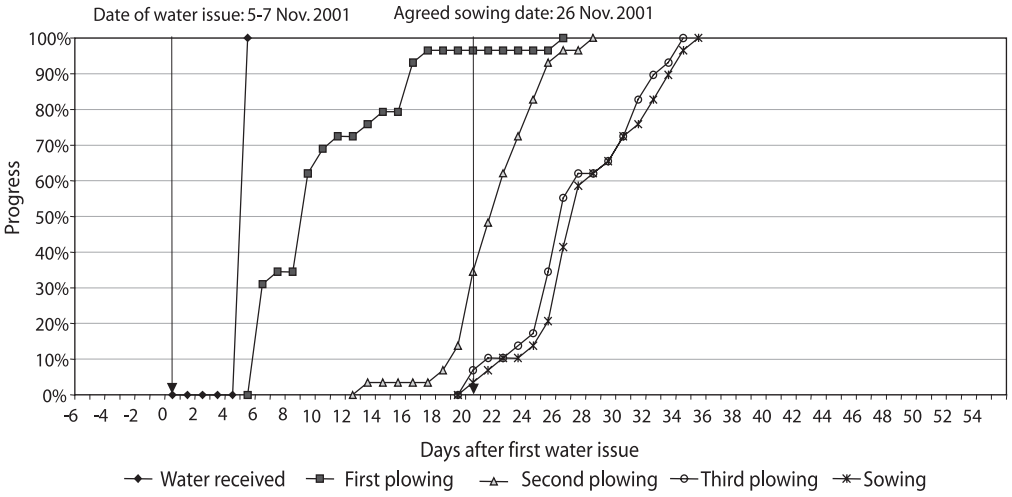


Figure 3. Land preparation progress, Rajangana–Ate Kanuwa–Tract 5.

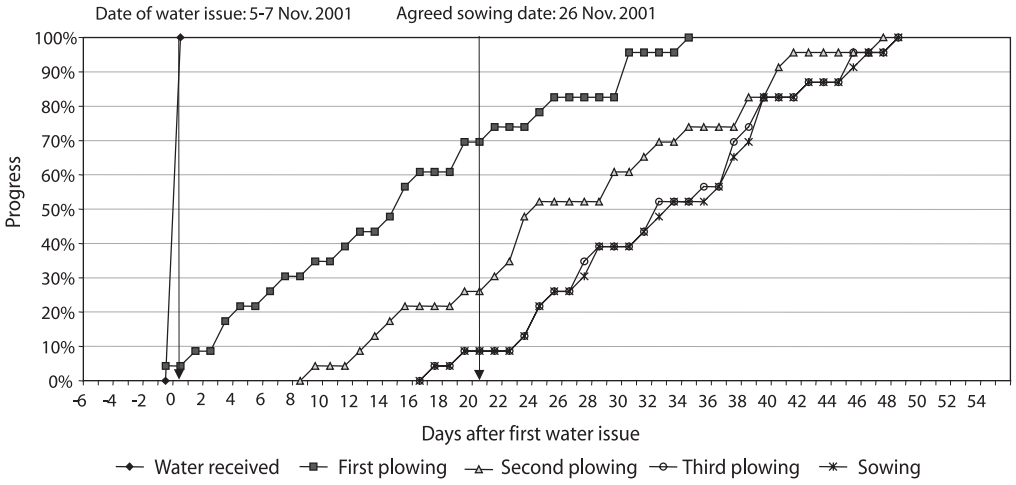


Figure 4. Land preparation progress, Rajangana–Weerapura–Tract 7.

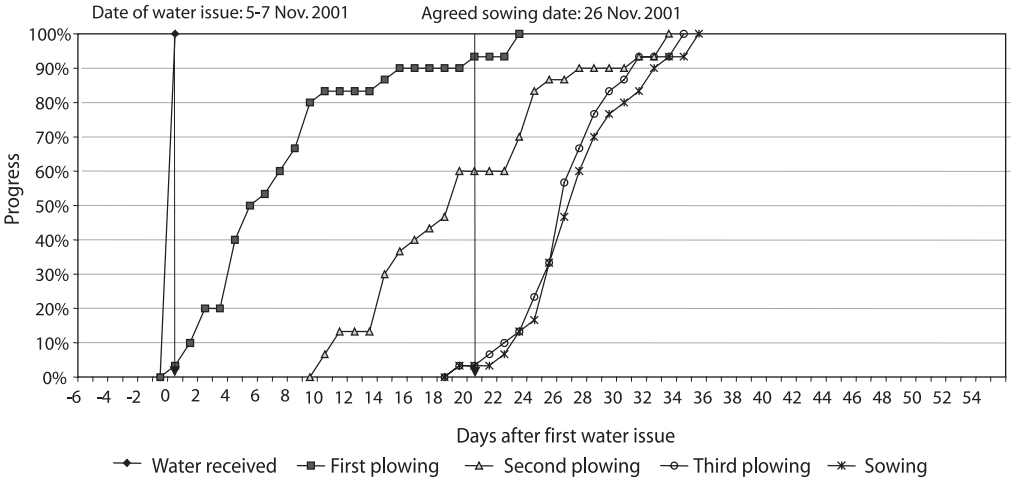


Figure 5. Land preparation progress, Nuwarawewa–Ambalawana.

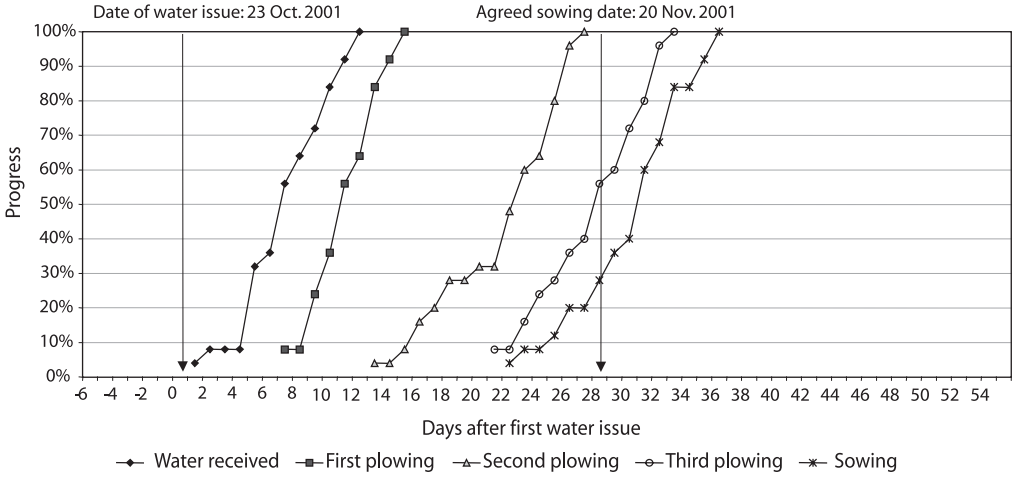


Figure 6. Land preparation progress, Nuwarawewa–DC123.

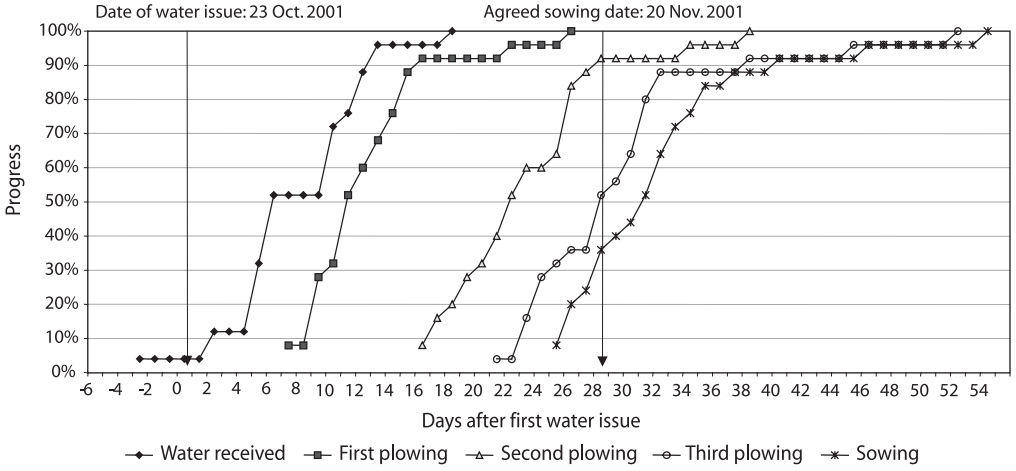


Figure 7. Land preparation progress, Nuwarawewa–Paniyankadawala.

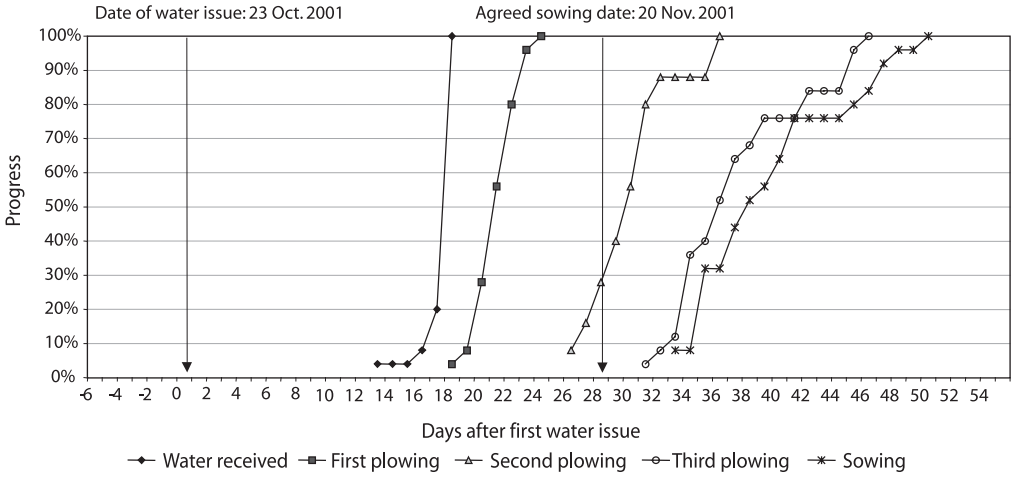


Figure 8. Land preparation progress, Huruluwewa–Padikarrmaduwa.

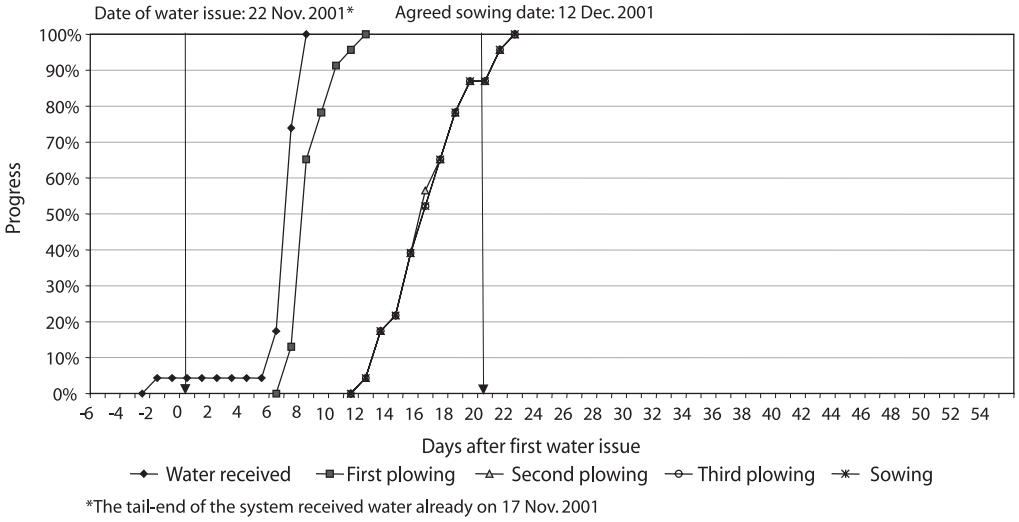


Figure 9. Land preparation progress, Huruluwewa–Nikawewa area.

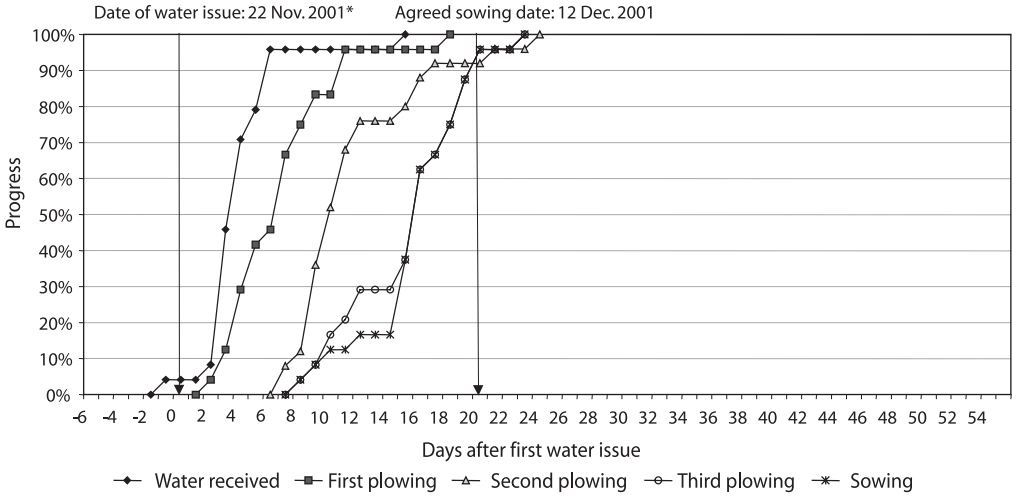


Figure 10. Land preparation progress, Minneriya–Kothalwalapura.

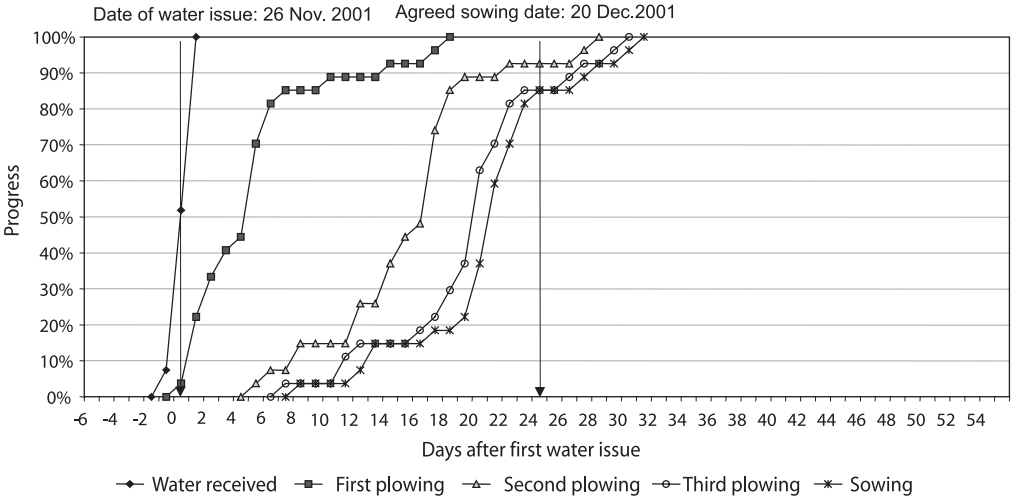


Figure 11. Land preparation progress, Minneriya–Yoda Ela.

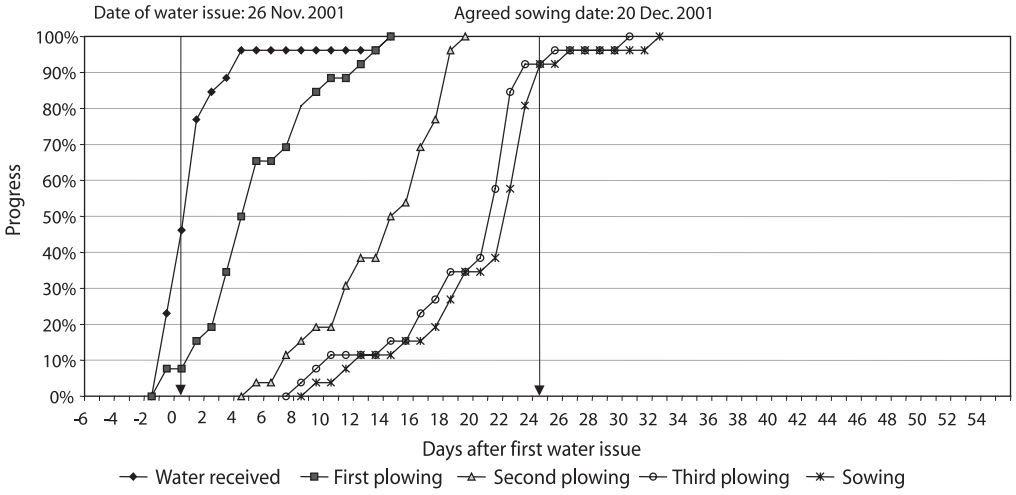


Figure 12. Land preparation progress, Minneriya–Viharamawatha.

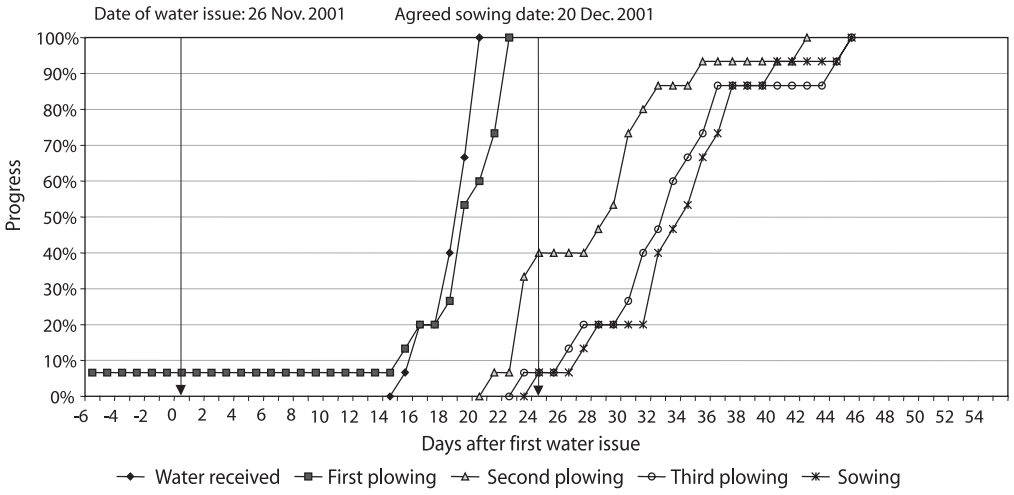


Figure 13. frequency analysis of land preparartion duration, Rajangana.

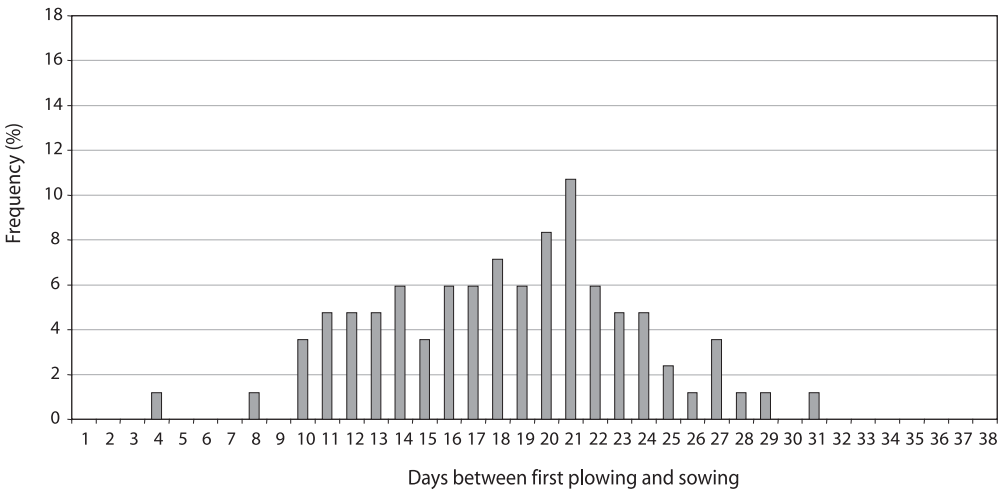


Figure 14. frequency analysis of land prepararti on duration, Nuwarawewa.

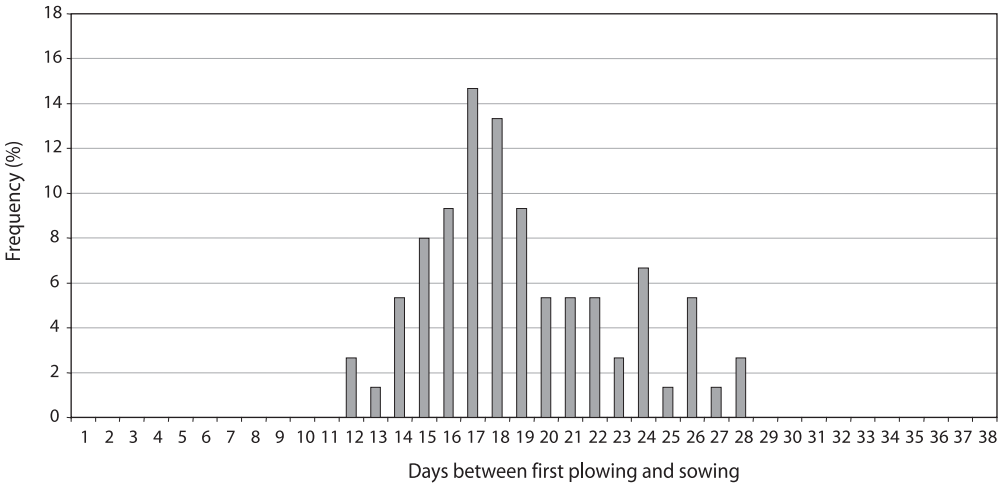


Figure 15. frequency analysis of land prepararti on duration, Huruluwewa.

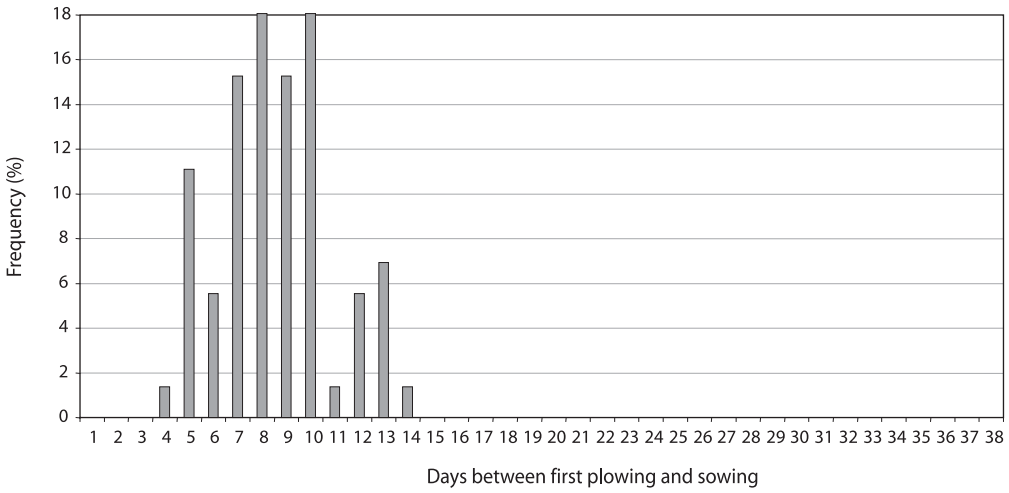


Figure 16. frequency analysis of land prepararti on duration, Minneriya—Raja Ela.

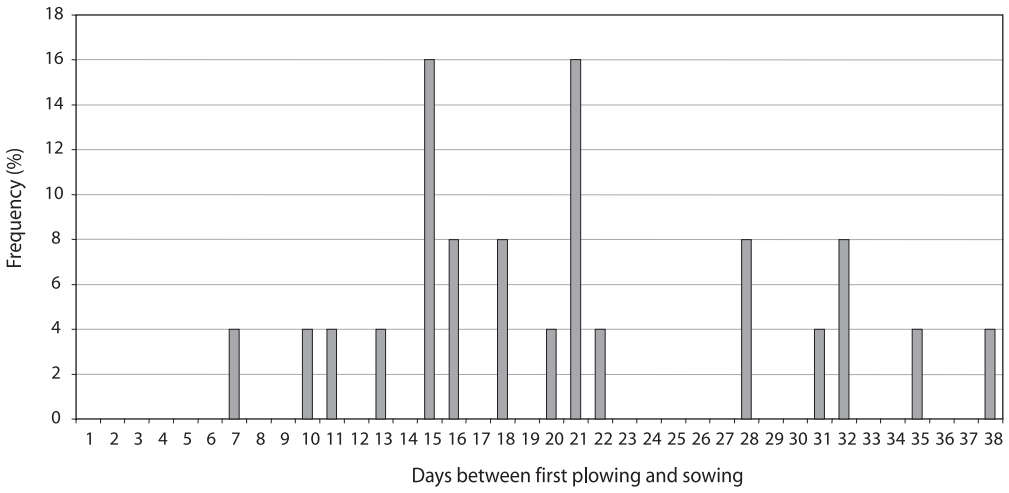
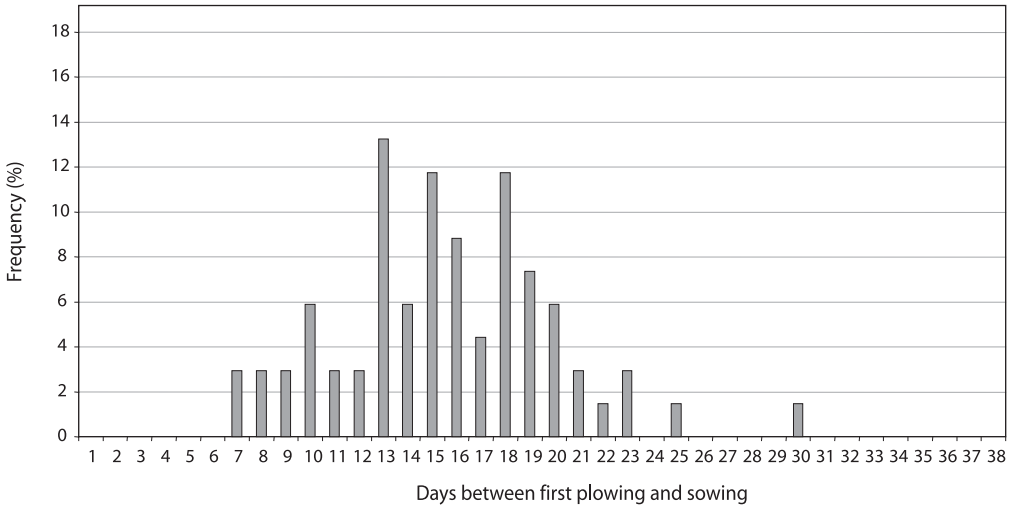


Figure 17. frequency analysis of land preparartion duration, Minneriya–Yoda Ela.



Appendix 2

Table 1. Period between water issues and first plowing (Rajangana).

Number of days	Total sample	LB Tract 1	LB Tract 5	LB Tract 7
	%	%	%	%
0 – 5	21	0	22	40
6 – 10	40	62	13	40
11 – 15	12	17	13	7
16 – 20	13	17	22	3
21 – 25	6	0	9	10
26 – 30	2	3	4	0
31 – 35	5	0	17	0
	(n = 82)	(n = 29)	(n = 23)	(n = 30)

Note: n = Number of farmers.

Table 2. Period between water issues and first plowing (Nuwarawewa).

Number of days	Total sample	Ambalawana	D123	Paniyankadawala
%	%	%	%	
0 – 5	0	0	0	0
6 – 10	23	36	32	0
11 – 15	40	64	56	0
16 – 20	11	0	4	28
21 – 25	25	0	4	72
26 – 30	1	0	4	0
	(n=75)	(n=25)	(n=25)	(n=25)

Note: n = Number of farmers.

Table 3. Period between water issues and first plowing (Huruluwewa).

Number of days	Total sample	Padikaramaduwe area	Nikawewa area	Dutuwewa area
	%	%	%	%
0 - 5	17	0	42	8
6 - 10	69	91	42	76
11 - 15	10	9	13	8
16 - 20	4	0	4	8
	(n = 72)	(n = 23)	(n = 24)	(n = 25)

Note: n = Number of farmers.

Table 4. Period between water issues and first plowing (Minneriya).

Number of days	Yoda Ela				Raja Ela
	Total sample	Kothalawelapura	Yoda Ela	Viharamawatha	
	%	%	%	%	%
(-5) - 0	4.4	0	7.7	6.7	16
1 - 5	33.8	44.4	42.3	0	52
6 - 10	29.4	40.7	34.6	0	20
11 - 15	8.8	7.4	15.4	0	8
16 - 20	13.2	7.4	0	46.7	4
21 - 25	10.3	0	0	46.7	0
	(n = 68)	(n = 27)	(n = 26)	(n = 15)	

Note: n = Number of farmers.

Table 5. Period between first plowing and second plowing (Rajangana).

Number of days	Total sample	LB Tract 1	LB Tract 5	LB Tract 7
	%	%	%	%
0 – 5	4	3	0	7
6 – 10	43	38	43	47
11 – 15	41	52	43	30
16 – 20	9	7	9	10
21 – 25	2	0	0	7
26 – 30	1	0	4	0
	(n = 82)	(n = 29)	(n = 23)	(n = 30)

Note: = Number of farmers.

Table 6. Period between first plowing and second plowing (Nuwarawewa).

Number of days	Total sample	Ambalawana	D123	Paniyankadawala
	%	%	%	%
0 – 5	0	0	0	0
6 – 10	56	40	44	84
11 – 15	44	60	56	16
	(n=75)	(n=25)	(n=25)	(n=25)

Note: n = Number of farmers.

Table 7. Period between first plowing and second plowing (Huruluwewa).

Number of days	Total sample	Padikaramaduwe area	Nikawewa area	Dutuwewa area
	%	%	%	%
0 - 5	21	22	33	8
6 - 10	65	74	42	80
11 - 15	14	4	25	12
	(n = 72)	(n = 23)	(n = 24)	(n = 25)

Note: n = Number of farmers.

Table 8. Period between first plowing and second plowing (Minneriya).

Number of days		Yoda Ela		Raja Ela	
	Total sample	Kothalawelapura	Yoda Ela	Viharamawatha	
	%	%	%	%	%
0 – 5	19.1	14.8	19.2	26.7	8
6 - 10	39.7	29.6	50.0	40.0	24
11 - 15	35.3	48.1	30.8	20.0	32
16 - 20	2.9	3.7	0	6.7	16
21 - 25	1.5	3.7	0	0	12
26 - 30	1.5	0	0	6.7	8
	(n = 68)	(n = 27)	(n = 26)	(n = 15)	

Note: n = Number of farmers.

Table 9. Period between second plowing and third plowing (Rajangana).

Number of days	Total sample	LB Tract 1	LB Tract 5	LB Tract 7
	%	%	%	%
0 – 5	48	48	61	37
6 – 10	38	48	26	37
11 – 15	7	3	4	13
16 – 20	7	0	9	13
	(n = 82)	(n = 29)	(n = 23)	(n = 30)

Note: n = Number of farmers.

Table 10. Period between second plowing and third plowing (Nuwarawewa).

Number of days	Total sample	Ambalawana	D123	Paniyankadawala
	%	%	%	%
0 – 5	39	44	48	24
6 – 10	53	52	40	68
11 – 15	6	0	8	8
16 – 20	2	4	4	0
	(n=75)	(n=25)	(n=25)	(n=25)

Note: n = Number of farmers.

Table 11. Period between second plowing and third plowing (Huruluwewa).

Number of days	Total sample	Padikaramaduwe Area	Nikawewa Area	Dutuwewa Area
	%	%	%	%
0	82	96	83	68
1	14	4	13	24
2	0	0	0	0
3	1	0	0	4
4	3	0	4	4
	(n = 72)	(n = 23)	(n = 24)	(n = 25)

Note: n = Number of farmers.

Table 12. Period between second plowing and third plowing (Minneriya).

Number of days	Yoda Ela				Raja Ela
	Total sample	Kothalawelapura	Yoda Ela	Viharamawatha	
%	%	%	%	%	
0 – 5	68	78	54	73	72
6 – 10	29	22	38	27	16
11 - 15	3	0	8	0	8
16 - 20	0	0	0	0	4
	(n = 68)	(n = 27)	(n = 26)	(n = 15)	

Note: n = Number of farmers.

Table 13. Period between third plowing and sowing (Rajangana).

Number of days	Total sample	LB Tract 1	LB Tract 5	LB Tract 7
	%	%	%	%
0	50	38	74	43.3
1	48	59	26	53.3
2	1	3	0	0.0
3	0	0	0	0.0
4	0	0	0	0.0
5	1	0	0	3.3
	(n = 82)	(n = 29)	(n = 23)	(n = 30)

Note: n = Number of farmers.

Table 14. Period between third plowing and sowing (Nuwarawewa).

Number of days	Total sample	Ambalawana	D123	Paniyankadawala
	%	%	%	%
0	0	0	0	0
1	28	36	16	32
2	33	24	40	36
3	23	20	24	24
4	5	4	8	4
5	4	0	8	4
6	5	12	4	0
7	1	4	0	0
	(n=75)	(n=25)	(n=25)	(n=25)

Note: n = Number of farmers.

Table 15. Period between third plowing and sowing (Huruluwewa).

Number of days	Total sample	Padikaramaduwe area	Nikawewa area	Dutuwewa area
	%	%	%	%
0	83	100	83	68
1	11	0	4	28
2	1	0	0	4
3	3	0	8	0
4	0	0	0	0
5	1	0	4	0
	(n = 72)	(n = 23)	(n = 24)	(n = 25)

Note: n = Number of farmers.

Table 16. Period between third plowing and sowing (Minneriya).

Number of days	Yoda Ela				Raja Ela
	Total sample	Kothalawelapura	Yoda Ela	Viharamawatha	
	%	%	%	%	%
0	0	0	0	0	0
1	82.4	85	81	80	76
2	16.2	11	19	20	16
3	1.5	4	0	0	4
4	0.0	0	0	0	4
5	0.0	0	0	0	0
	(n = 68)	(n = 27)	(n = 26)	(n = 15)	

Note: n = Number of farmers.

Table 17. Length of land preparation period (Rajangana).

Number of days	Total sample	LB Tract 1	LB Tract 5	LB Tract 7
	%	%	%	%
0 - 5	1	3	0	0
6 - 10	5	7	4	3
11 - 15	22	21	35	13
16 - 20	34	31	35	37
21 - 25	29	34	17	33
26 - 30	7	3	9	10
31 - 35	1	0	0	3
	(n = 82)	(n = 29)	(n = 23)	(n = 30)

Note: n = Number of farmers.

Table 18. Length of land preparation period (Nuwarawewa).

Number of days	Total sample	Ambalawana	D123	Paniyankadawala
	%	%	%	%
0 – 5	0	0	0	0
6 – 10	0	0	0	0
11 – 15	17	12	12	28
16 – 20	52	56	52	48
21 – 25	21	28	20	16
26 – 30	9	4	16	8
	(n=75)	(n=25)	(n=25)	(n=25)

Note: n = Number of farmers.

Table 19. Length of land preparation period (Huruluwewa).

Number of days	Total sample	Padikaramaduwe area	Nikawewa area	Dutuwewa area
	%	%	%	%
0 – 5	13	22	17	0
6 – 10	72	74	58	84
11 – 15	15	4	25	16
	(n = 72)	(n = 23)	(n = 24)	(n = 25)

Note: n = Number of farmers.

Table 20. Length of land preparation period (Minneriya).

Number of days	Yoda Ela				Raja Ela
	Total sample	Kothalawelapura Yoda Ela		Viharamawatha	
	%	%	%	%	%
0 – 5	1	0	4	0	0
6 – 10	13	15	15	7	8
11 – 15	37	30	31	60	24
16 – 20	38	44	42	20	20
21 – 25	9	11	8	7	20
26 – 30	1	0	0	7	8
31 – 35	0	0	0	0	16
36 – 40	0	0	0	0	4
	(n = 68)	(n = 27)	(n = 26)	(n = 15)	

Note: n = Number of farmers.

Table 21. Number of days delayed (in comparison with the date agreed upon at the cultivation meeting) (Rajangana).

Number of days	Total sample	LB Tract 1	LB Tract 5	LB Tract 7
	%	%	%	%
(-10) - (-6)	0	0	0	0
(-5) - 0	5	3	9	3
1 - 5	22	17	17	30
6 - 10	39	52	13	47
11 - 15	21	28	13	20
16 - 20	9	0	30	0
21 - 25	2	0	9	0
26 - 30	2	0	9	0
	(n = 82)	(n = 29)	(n = 23)	(n = 30)

Note: n = Number of farmers.

Table 22. Number of days delayed (in comparison with the date agreed upon at the cultivation meeting (Nuwarawewa).

Number of days	Total sample	Ambalawana	D123	Paniyankadawala
	%	%	%	%
(-6) – 0	21	28	36	0
1 – 5	33	56	36	8
6 – 10	25	16	16	44
11 – 15	9	0	4	24
16 – 20	8	0	4	20
21 – 25	1	0	0	4
26 – 30	1	0	0	0
	(n=75)	(n=25)	(n=25)	(n=25)

Note: n = Number of farmers.

Table 23. Number of days delayed (in comparison with the date agreed upon at the cultivation meeting (Huruluwewa).

Number of days	Total sample*	Padikaramaduwe area	Nikawewa area	Dutuwewa area
	%	%	%	%
(-12) – (-11)	3	0	8	0
(-10) - (-6)	15	22	8	16
(-5) – 0	69	65	79	64
1 – 5	10	13	4	12
6 – 10	3	0	0	8
	(n = 72)	(n = 23)	(n = 24)	(n = 25)

Notes: n = Number of farmers.
*Two different dates were agreed upon during the cultivation meeting.
For the tail-end of the system (Dutuwewa area): 7 December 2001.
For the rest of the system (Padikaramaduwe and Nikawewa areas):12 December 2001.

Table 24. Number of days delayed (in comparison with the date agreed upon at the cultivation meeting (Minneriya).

Number of days	Yoda Ela				Raja Ela
	Total sample	Kothalawelapura	Yoda Ela	Viharamawatha	
	%	%	%	%	%
(-20) - (-16)	1	4	0	0	0
(-15) - (-11)	9	11	12	0	8
(-10) - (-6)	9	4	19	0	24
(-5) - 0	51	67	62	7	12
1 - 5	7	7	4	13	52
6 – 10	12	7	4	33	4
11 - 15	7	0	0	33	0
16 - 20	1	0	0	7	0
21 - 25	1	0	0	7	0
	(n = 68)	(n = 27)	(n = 26)	(n = 15)	

Note: n = Number of farmers.

Table 25. Reasons for water problems in MC – delayed farmers.

Nature of problems	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Avg.	Minneriya Raja Ela	Minneriya Yoda Ela	Grand total
	%	%	%	%	%	%	%
No problems	94	56	100	67	100	50	76
Maintenance problems	0	39	0	0	0	0	14
Canal system deterioration	0	0	0	23	0	35	4
Operation problems in MC	6	2	0	0	0	0	3
Maintenance problems/ canal system deterioration	0	3	0	0	0	0	1
Canal system deterioration/ operation problems inMC	0	0	0	10	0	15	2

Table 26. Reasons for water problems in DC – delayed farmers.

Reasons for problems	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Avg.	Minneriya Raja Ela	Minneriya Yoda Ela	Grand total
	%	%	%	%	%	%	%
No problems	100	90	100	53	100	30	88
Operation problems in DC	0	8	0	0			3
Canal deterioration	0	2	0	23	0	35	5
DC maintenance problems/ canal deterioration	0	0	0	10	0	15	2
DC operational problems/ DC maintenance problems/ canal Deterioration	0	0	0	10	0	15	2
Water shortage in MC/ DC operational problems/ DC maintenance problems/ canal deterioration	0	0	0	3	0	5	1

Table 27. Reasons for water problems in FC – delayed farmers.

Reasons for problems	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Minneriya Avg.	Raja Ela	Yoda Ela	Grand total
	%	%	%	%	%	%	%
No problems	94	83	100	80	40	100	88
Maintenance problems	1	10	0	0	0	0	4
Water sharing problems	0	3	0	0	0	0	1
Canal deterioration	4	2	0	0	0	0	2
Maintenance problems/ canal deterioration	0	2	0	0	0	0	1
Water sharing problems/ canal deterioration	0	0	0	13	40	0	2
Maintenance problems/ water sharing problems/ canal deterioration	0	0	0	7	20	0	1

Table 28. Soil problems – delayed farmers.

Soil condition	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Minneriya Avg.	Raja Ela	Yoda Ela	Grand total
	%	%	%	%	%	%	%
Ill drained	100	56	100	100	100	100	84
Well drained	0	44	0	0	0	0	16

Table 29. Shortage of rain during LP period – delayed farmers.

Availability of rain	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Minneriya Raja Ela	Avg.	Yoda Ela	Grand total
	%	%	%	%	%	%	%
Available	100	54	100	100	100	100	84
Not available	0	46	0	0	0	0	16

Table 30. Uncertainty over water – delayed farmers.

Uncertainness	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Minneriya Avg.	Raja Ela	Yoda Ela	Grand total
	%	%	%	%	%	%	%
Not uncertain	99	98	90	100	100	100	98
Uncertain	1	2	10	0	0	0	2

Table 31. Unspecified other problems – delayed farmers.

Other reasons	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Avg.	Minneriya Raja Ela	Yoda Ela	Grand total
	%	%	%	%	%	%	%
No	97	76	90	100	100	100	90
Yes	3	24	10	0	0	0	10

Table 32. Delayed farmers faced with financial problems (in rank order).

Rank order	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Avg.	Minneriya Raja Ela	Yoda Ela	Grand total
	%	%	%	%	%	%	%
No problem	100	69	100	100	100	100	89
Rank 1	0	2	0	0	0	0	1
Rank 2	0	8	0	0	0	0	3
Rank 3	0	14	0	0	0	0	5
Rank 4	0	3	0	0	0	0	1
Rank 5	0	3	0	0	0	0	1

Table 33. Delayed farmers faced with tractor availability problems (in rank order).

Rank order	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Avg.	Minneriya Raja Ela	Yoda Ela	Grand total
%	%	%	%	%	%	%	
No problem	41	8	70	80	100	70	38
Rank 1	57	25	30	17	0	25	37
Rank 2	1	53	0	3	0	5	20
Rank 3	0	8	0	0	0	0	3
Rank 4	0	5	0	0	0	0	2

Table 34. Reasons for delays due to tractors – delayed farmers.

Reasons for delays due to tractors	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Avg.	Minneriya Raja Ela	Yoda Ela	Grand total
	%	%	%	%	%	%	%
No problem	46	10	80	83	100	75	42
Shortage of tractors	7	12	0	3	0	5	8
Shortage of tractors/ owns a tractor but hired	0	2	0	0	0	0	1
Shortage of tractors/ tractor owner had undertaken too much work	24	17	0	0	0	0	16
Shortage of tractor/tractor owner had undertaken too much work/ tractor owner delayed work as payment is made in kind after harvesting	0	8	0	0	0	0	3
Tractor shortage/tractor owner had undertaken too much work/others	0	2	0	0	0	0	1
Tractor shortage/tractor owner delayed work as payment is made in kind after harvesting	0	36	0	0	0	0	13
Owns a tractor but was on hire	1	7	0	0	0	0	3
Owns a tractor but on hire/others	0	3	0	0	0	0	1
Tractor owner had undertaken too much work	15	3	20	10	0	15	10
Tractor owner had undertaken too much work/others	3	0	0	0	0	0	1
Other reasons	4	0	0	3	0	5	2

Table 35. Delayed farmers faced with labor problems.

Rank order	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Avg.	Minneriya Raja Ela	Yoda Ela	Grand total
	%	%	%	%	%	%	%
No problem	100	56	90	67	30	85	78
Rank 1	0	17	10	17	40	5	10
Rank 2	0	17	0	13	30	5	8
Rank 3	0	10	0	3	0	5	4

Table 36. Reason for labor problems – delayed farmers.

Reason for labor problems	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Avg.	Minneriya Raja Ela	Yoda Ela	Grand total
	%	%	%	%	%	%	%
No problem	100	56	90	70	40	85	78
Labor shortage in the area	0	2	0	17	30	10	4
Labor shortage in the area/labor shortage during peak periods	0	2	0	0	0	0	1
Labor shortage in the area/labor shortage during peak periods/ no in-migration of labor	0	0	0	3	0	5	1
Labor shortage during peak periods	0	34	10	10	30	0	14
No immigration of labor	0	2	0	0	0	0	1
Labor shortage during peak periods/no in-migration of labor	0	5	0	0	0	0	2

Table 37. Delayed farmers faced with seed paddy problems (in rank order).

Rank order	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Avg.	Minneriya Raja Ela	Yoda Ela	Grand total
	%	%	%	%	%	%	%
No problem	99	73	80	100	100	100	89
Rank 1	1	2	20	0	0	0	2
Rank 2	0	5	0	0	0	0	2
Rank 3	0	12	0	0	0	0	4
Rank 4	0	8	0	0	0	0	3

Table 38. Reason for seed paddy problems – delayed farmers.

Reasons for seed paddy problems	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Avg.	Minneriya Raja Ela	Yoda Ela	Grand total
	%	%	%	%	%	%	%
No problems	100	71	70	100	100	100	88
Non availability of funds to make prior arrangements for seeds	0	15	0	0	0	0	5
Non availability of funds to make prior arrangements for seeds/ non availability of seeds with private traders	0	3	0	0	0	0	1
Non availability of funds to make prior arrangements for seeds/ no seed farmers in the area/others	0	2	0	0	0	0	1
Non availability of funds to make prior arrangements for seeds/others	0	3	0	0	0	0	1
Other reasons	0	5	30	0	0	0	4

Table 39. Delayed farmers faced with share/leasing arrangement problems (in rank order).

Rank order	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Avg.	Minneriya Raja Ela	Yoda Ela	Grand total
	%	%	%	%	%	%	%
No problem	99	93	100	100	100	100	97
Rank 1	0	2	0	0	0	0	1
Rank 2	1	2	0	0	0	0	1
Rank 3	0	3	0	0	0	0	1

Table 40. Delay due to political environment – delayed farmers.

Rank order	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Avg.	Minneriya Raja Ela	Yoda Ela	Grand total
	%	%	%	%			%
No problem	100	93	90	77	70	80	93
Rank 1	0	0	10	0	0	0	1
Rank 2	0	0	0	23	30	20	4
Rank 3	0	5	0	0	0	0	2
Rank 4	0	2	0	0	0	0	1

Table 41. Land size distribution of delayed and non-delayed farmers (Rajangana).

Area		Total sample	LB Tract 1	LB Tract 5	LB Tract 7
Acres	hectares	%	%	%	%
0.50	0.20	18	48	0	3
0.75	0.30	4	7	0	3
1.00	0.40	23	17	26	27
1.50	0.61	4	3	4	3
1.75	0.71	1	3	0	0
2.00	0.81	49	21	65	63
3.00	1.21	1	0	4	0
		(n = 82)	(n = 29)	(n = 23)	(n = 30)

Note: n = Number of farmers.

Table 42. Land size distribution of delayed and non-delayed farmers (Nuwarawewa).

Area		Total sample	Ambalawana	D123	Paniyankadawala
Acres	hectares	%	%	%	%
0.50	0.20	8	0	0	24
1.00	0.40	19	24	4	28
1.50	0.61	11	12	0	20
1.75	0.71	1	4	0	0
2.00	0.81	8	20	0	4
2.50	1.01	3	0	4	4
3.00	1.21	9	16	8	4
3.50	1.42	1	4	0	0
4.00	1.62	5	4	0	12
5.00	2.02	7	4	12	4
6.00	2.43	3	4	4	0
7.00	2.83	5	4	12	0
7.50	3.04	1	0	4	0
9.00	3.64	1	0	4	0
10.0	4.05	9	0	28	0
10.50	4.25	1	0	4	0
11.00	4.45	3	0	8	0
12.00	4.86	1	0	4	0
15.00	6.07	1	0	4	0
21.00	8.50	1	4	0	0
		(n=75)	(n=25)	(n=25)	(n=25)

Note: n = Number of farmers.

Table 43. Land size distribution of delayed and non-delayed farmers (Huruluwewa).

Area		Total sample	Padikaramaduwe Area	Nikawewa Area	Dutuwewa Area
Acres	hectares	%	%	%	%
0.50	0.20	22	35	29	4
1.00	0.40	17	35	8	8
1.25	0.51	3	0	0	8
1.50	0.61	39	22	42	52
2.00	0.81	4	4	8	0
2.50	1.01	6	4	4	8
3.00	1.21	8	0	8	16
4.50	1.82	1	0	0	4
		(n = 72)	(n = 23)	(n = 24)	(n = 25)

Note: n = Number of farmers.

Table 44. Land size distribution of delayed and non-delayed farmers (Minneriya).

Area			Yoda Ela		Raja Ela	
		Total sample	Kothalawelapura	Yoda Ela	Viharamawatha	
Acre	hectare	%	%	%	%	%
0.50	0.20	12	30	0	0	28
1.00	0.40	24	19	23	33	28
1.50	0.61	16	15	27	0	12
2.00	0.81	13	11	15	13	4
2.50	1.01	4	7	4	0	16
3.00	1.21	16	4	8	53	0
3.50	1.42	4	7	4	0	0
4.00	1.62	6	7	8	0	0
4.50	1.82	1	0	4	0	0
5.00	2.02	3	0	8	0	4
8.00	3.23	0	0	0	0	8
		(n = 68)	(n = 27)	(n = 26)	(n = 15)	(n = 25)

Note: n = Number of farmers.

Table 45. Land tenure status of delayed and non-delayed farmers.

Scheme			Mortgage	Own	Rent	Andha*	Lease	No reply
		n	%	%	%	%	%	%
Rajangana	LB Tract 1	29	7	34	59			
	LB Tract 5	23	0	65	35			
	LB Tract 7	30	6.7	46.7	46.7			
	Total sample	82	4.9	47.6	47.6			
Nuwarawewa	Ambalawana	25	0	44	0	8	44	4
	D123	25	0	20	40	0	40	0
	Paniyankadawala	25	8	64	0	0	28	0
	Total sample	75	3	43	13	3	37	1
Huruluwewa	Padikaramaduwe	23	0	100	0			
	Nikawewa	24	13	67	21			
	Dutuwewa	25	16	52	32			
	Total sample	72	10	72	18			
Minneriya Raja Ela			48	48			4	
Minneriya Yoda Ela	Kothalawelapura	27	4	56	41			
	Yoda Ela	26	11.5	57.7	31			
	Viharamawatha	15	7	93	0			
	Total sample	68	7	65	28			

* Share cropping arrangement.
Note: n = Number of farmers.

Table 46. Land tenure status of delayed farmers.

Tenure status	Scheme						
	Rajangana	Nuwara wewa	Hurulu wewa	Average	Minneriya Raja Ela	Yoda Ela	Grand total
	%	%	%	%	%	%	%
No response	4	0	0	3	10	0	2
Owner operator	51	41	60	73	50	85	52
Owner/leased in	0	2	0	0	0	0	1
Owner/share cropper	1	0	0	0	0	0	1
Leased in	0	53	30	23	40	15	25
Mortgaged in	6	2	10	0	0	0	4
Share cropper	32	2	0	0	0	0	14
Other	4	2	0	0	0	0	2

Table 47. Participation at cultivation meetings (delayed and non-delayed farmers).

Scheme		Yes	No	
		n	%	%
Rajangana	LB Tract 1	29	0	100
	LB Tract 5	23	0	100
	LB Tract 7	30	0	100
	Total sample	82	0	100
Nuwarawewa	Ambalawana	25	36	64
	D123	25	64	36
	Paniyankadawala	25	60	40
	Total sample	75	53	47
Huruluwewa	Padikaramaduwe	23	0	100
	Nikawewa	24	0	100
	Dutuwewa	25	4	96
	Total sample	72	1	99
Minneriya Raja Ela			4	96
Minneriya Yoda Ela	Kothalawelapura	27	4	96
	Yoda Ela	26	12	88
	Viharamawatha	15	7	93
	Total sample	68	7	93

Note: n = Number of farmers.

Table 48. Awareness of the date of canal cleaning (delayed and non-delayed farmers).

Scheme			Yes	No
		n	%	%
Rajangana	LB Tract 1	29	0	100
	LB Tract 5	23	4	96
	LB Tract 7	30	10	90
	Total sample	82	5	95
Nuwarawewa	Ambalawana	25	92	8
	D123	25	96	4
	Paniyankadawala	25	72	28
	Total sample	75	87	13
Huruluwewa	Padikaramaduwe	23	57	43
	Nikawewa	24	42	58
	Dutuwewa	25	60	40
	Total sample	72	53	47
Minneriya Raja Ela			100	0
Minneriya Yoda Ela	Kothalawelapura	27	100	0
	Yoda Ela	26	100	0
	Viharamawatha	15	100	0
	Total sample	68	100	0

Note: n = Number of Farmers.

Table 49. Awareness of the date of water release (delayed and non-delayed farmers).

Scheme			Yes	No
		n	%	%
Rajangana	LB Tract 1	29	10	90
	LB Tract 5	23	57	43
	LB Tract 7	30	40	60
	Total sample	82	34	66
Nuwarawewa	Ambalawana	25	96	4
	D123	25	100	0
	Paniyankadawala	25	100	0
	Total sample	75	99	1
Huruluwewa	Padikaramaduwe	23	13	87
	Nikawewa	24	0	100
	Dutuwewa	25	92	8
	Total sample	72	36	64
Minneriya Raja Ela			100	0
Minneriya Yoda Ela	Kothalawelapura	27	100	0
	Yoda Ela	26	100	0
	Viharamawatha	15	100	0
	Total sample	68	100	0

Note: n = Number of farmers.

Table 50. Knowledge of the age group variety of seed paddy to be sown (delayed and non-delayed farmers.

Scheme			Yes	No
		n	%	%
Rajangana	LB Tract 1	29	83	17
	LB Tract 5	23	100	0
	LB Tract 7	30	93	7
	Total sample	82	91	9
Nuwarawewa	Ambalawana	25	96	4
	D123	25	100	0
	Paniyankadawala	25	100	0
	Total sample	75	99	1
Huruluwewa	Padikaramaduwe	23	100	1
	Nikawewa	24	96	4
	Dutuwewa	25	100	0
	Total sample	72	99	1
Minneriya Raja Ela			100	0
Minneriya Yoda Ela	Kothalawelapura	27	100	0
	Yoda Ela	26	100	0
	Viharamawatha	15	100	0
	Total sample	68	100	0

Note: n = Number of farmers.

Table 51. Awareness of the agreed date of sowing (delayed and non-delayed farmers).

Scheme			Yes	No
		n	%	%
Rajangana	LB Tract 1	29	21	79
	LB Tract 5	23	22	78
	LB Tract 7	30	47	53
	Total sample	82	30	70
Nuwarawewa	Ambalawana	25	96	4
	D123	25	100	0
	Paniyankadawala	25	100	0
	Total sample	75	99	1
Huruluwewa	Padikaramaduwe	23	74	26
	Nikawewa	24	37.5	62.5
	Dutuwewa	25	64	36
	Total sample	72	58	42
Minneriya Raja Ela			100	0
Minneriya Yoda Ela	Kothalawelapura	27	100	0
	Yoda Ela	26	100	0
	Viharamawatha	15	100	0
	Total sample	68	100	0

Note: n = Number of farmers.

Table 52. Different age group varieties cultivated by delayers and non-delayers.

Scheme	Variety age group	Farmer category according to land preparation			
		Non–delayers		Delayers	
	months	%	n	%	n
Rajangana	3	0.0	0	5.6	4
	3½	100.0	4	84.7	61
	4	0.0	0	9.7	7
Nuwarawewa	3	0.0	0	19.0	11
	3½	76.5	13	81.0	47
	4	23.5	4	0.0	0
Huruluwewa	3	17.2	11	25.0	2
	3½	78.1	50	75.0	6
	4	4.7	3	0.0	0
Minneriya – Raja Ela	3½	93.33	14	90.0	09
	4	06.67	01	10.0	01
Minneriya – Yoda Ela	3½	96.97	64	100.0	02
	4	03.03	02	0.0	00
Minneriya – Average	3½	96.3	78	91.7	11
	4	3.7	3	8.3	1
Total	3	6.6	11	11.3	17
	3½	87.4	145	83.3	125
	4	6.0	10	5.3	8

Note: n = Number of farmers.

Table 53. Percentage of delayed and non-delayed farmers finishing land preparation within and after 21 days at head, middle and tail-end of the system.

Scheme		Non-delayed				Delayed			
		< 21 days		>21 days		< 21 days		>21 days	
		n	% of total	n	% of total	n	% of total	n	% of total
Rajangana	LB Tract 1	0	0.0	0	0.0	19	26.4	9	12.5
	LB Tract 5	2	50.0	0	0.0	16	22.2	5	6.9
	LB Tract 7	2	50.0	0	0.0	16	22.2	7	9.7
	Total	4	100.0	0	0.0	51	70.8	21	29.2
Nuwarawewa	Ambalawana	8	47.0	0	0.0	13	22.4	4	6.9
	D123	8	47.0	0	0.0	8	13.8	9	15.5
	Paniyankadawala	1	5.9	0	0.0	18	31.0	6	10.3
	Total	17	100.0	0	0.0	39	67.2	19	32.8
Huruluwewa	Padikaramaduwe	20	31.3	0	0.0	3	37.5	0	0.0
	Nikawewa	23	35.9	0	0.0	1	12.5	0	0.0
	Dutuwewa	21	32.8	0	0.0	4	50.0	0	0.0
	Total	64	100.0	0	0.0	8	100.0	0	0.0
Minneriya	Head	3	20.0	1	6.7	0	0.0	6	60.0
Raja Ela	Middle	3	20.0	0	0.0	3	30.0	1	10.0
	Tail	8	53.3	0	0.0	0	0.0	0	0.0
	Total	14	93.3	1	6.7	3	30.0	7	70.0
Minneriya	Kothalawelapura	24	36.4	3	4.6	0	0.0	0	0.0
Yoda Ela	Yoda Ela	24	36.4	0	0.0	2	100.0	0	0.0
	Viharamawatha	13	19.7	2	3.0	0	0.0	0	0.0
	Total	63	92.4	5	7.6	2	100.0	0	0.0

Note: n = Number of farmers.

Table 54. Average number of days taken for land preparation by delayed and non-delayed farmers at head, middle and tail-end of the system.

Scheme		Non-delayed			Delayed		
			Avg			Avg	
		n	days		n	days	
Rajangana	LB Tract 1	0	-	p>0.05 (0.836)	28	17.9	p>0.05 (0.472)
	LB Tract 5	2	17.0		21	17.9	
	LB Tract 7	2	18.0		23	19.6	
	Total	4	17.5		72	18.4	
Nuwarawewa	Ambalawana	8	18.4	p>0.05 (0.172)	17	19.4	p=0.0553
	D123	8	16.1		17	21.4	for the difference between
	Paniyankadawala	1	18.0		24	18.3	middle and tail end of the system
	Total	17	17.3		58	19.5	
Huruluwewa	Padikaramaduwe	20	7.5	p<0.05 (0.020)	3	11.0	p=0.0539
	Nikawewa	23	9.3	for the difference	1	5.0	for the difference between the
	Dutuwewa	21	8.0	between head and middle part of the system	4	11.8	middle part of the system and the rest
	Total	64	8.3		8	10.6	
Minneriya	Head	4	21.3	p>0.05 (0.119)	6	32.7	p<0.05 (0.0009),
Raja Ela	Middle	3	15.7		4	15.8	but sample size is small
	Tail	8	16.0		0	-	
	Total	15	17.3		10	25.9	
Minneriya	Kothalawelapura	27	15.7	p>0.05 (0.875)	0	-	-
Yoda Ela	Yoda Ela	24	15.1		2	16.5	
	Viharamawatha	15	15.8		0	-	
	Total	66	15.5		2	16.5	

Note: n = Number of farmers.

COLLECTION OF DATA ON PADDY CULTIVATION

1. Irrigation scheme:
2. Season:
3. Main Canal/Distributory Canal:
4. FC No:
5. Farmer Organization:
6. Total command area under the FC:
7. Date on which the sluice was opened:
8. Data on which water was received in the allotment:
9. Progress of land preparation:
   …… Week from ..... to ……

Date	Extent in which first plowing started	Extent in which second plowing started (acres)	Extent of sown area (in acres)			Condition of water supply	Area in which LP was done with rain (in acres)	Other information
			3 months	3½ months	4 months			

10. Observations and recommendations:
    .....
    .....
    Date: Signature of the investigator

Postal Address:
P O Box 2075
Colombo
Sri Lanka

Location
127, Sunil Mawatha
Pelawatta
Battaramulla
Sri Lanka

Tel:
+94-11 2787404

Fax:
+94-11 2786854

E-mail:
iwmi@cgiar.org

Website:
http://www.iwmi.org

IWMI International Water Management Institute

FUTURE HARVEST
IWMI is a Future Harvest Center supported by the CGIAR

ISBN: 92-9090-549-2