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Tertiary Level Irrigation Water Management Practices at Tail End : A Case Study from Uda Walawe Irrigation Scheme

Pieris, W.R., Dayawansa, N.D.K.[1], Mole, F. [1] and De Silva, W.P.R.P.[1]

Post Graduate Institute of Agriculture
University of Peradeniya
Peradeniya, Sri Lanka

ABSTRACT. *Most of the irrigated lands in the tail end of the Right Bank in Uda Walawe Irrigation Scheme (UWIS) face severe water deficit, and considerable extent of developed lands is left uncultivated. Reallocation of water for the new development area in Left Bank will cause further reduction in water flows to the already stressed lands at the tail end areas. The scope of this case study was to establish causes for irrigation water deficit in a water stressed distributary canal in the tail end reach of the UWIS. The study was conducted during the Yala season of 2003, in D4 distributary canal of Bataatha.*

The water balance of D4 canal reveals that almost 23% of the head inflow to D4 canal is lost in the canal due to unmanaged flows. It was observed that two thirds of regulating structures in D4 canal do not function properly causing difficulties in implementing proper water management plans for the D4 canal. Farmers of the downstream paddy fields of D4 command area tapped almost 35% of total water received by D4 canal. Significant differences in water distribution along the D4 during the past have resulted in establishing three different land use patterns in D4; as permanent paddy lands, homesteads with intermittent paddy/other field crops (pulses, grains or vegetables that require less water) and rainfed chena type cultivation. Poor information sharing between irrigation agency and farmers has resulted in poor performance in implementation of seasonal cultivation plan and in water distribution causing losses for both parties.

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INTRODUCTION

Uda Walawe Irrigation Scheme (UWIS) covers an irrigation area of 18,000 ha located in southern Sri Lanka. It is fed by Uda Walawe reservoir through two main canals (Right Bank Main Canal: RBMC, and Left Bank Main Canal: LBMC). Currently, the LBMC is being extended and the last block of 5,000 ha is under construction. The expansion of left bank command area requires additional 125-180 million cubic meters (mcm) of irrigation water (12-16% of annual inflow of Uda Walawe reservoir) annually (SAPI Report, 2000).

Most of the irrigated lands in the tail end of the irrigation system face severe water deficit and a considerable extent of developed lands is left uncultivated due to

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[1] International Water Management Institute (IWMI), Colombo, Sri Lanka.

water shortage. Reallocation of water for new development area causes further reduction of water flows into the already stressed lands at the tail end areas.

The scope of this case study was to identify causes for irrigation water deficit in a water stressed distributary canal (D canal) in the tail end reach of the UWIS. The study was conducted during the *Yala* season of 2003. The study covers technical aspects such as monitoring the daily discharges throughout the delivery canal, operation and maintenance of the D canal structures, land use pattern, water management targets and schedules, and non-technical aspects such as farmers profile, farmer- irrigation agency interface, and interaction between farmers and conflicts of water management.

MATERIALS AND METHODS

The study area

This case study was conducted in the BA17D4 canal (D4 canal), which is situated in the Bataatha branch canal at Angunukolapalassa irrigation block of UWIS, more than 40 km away form Uda Walawe reservoir. D4 is the largest D canal in Bataatha branch canal (BABC) with 420.4 ha of designed command area. There are 495 original irrigation land allotments of varying size from 0.4 ha to 1.0 ha (after the D canal rehabilitation in late 1980s). The major soil types in D4 are well drained RBE (27.6%), imperfectly drained RBE (41.1%) and poorly drained LHG (31.3%). The allotments were designated either to cultivate paddy in imperfectly drained RBE and LHG soils and other field crops (OFC) in well-drained RBE soils. However, the farmers in D4 canal always prefer cultivating paddy in their allotments, irrespective of the drainage situation. Farmers in tract 17 of Bataatha have never turned to cash crops like banana, which is very common practice in UWIS.

Tertiary level irrigation infrastructure of the study area consists of 32 field canals (FC), of which 12 are located along the D canal itself; while two sub D canals stemming from it have 20 field canals each. Field canals are designed to irrigate a cluster of land allotments hence, command area of field canals (Fig. 1) varies from 4 to 15 hectares.

The total command area of D4 canal is divided into three administrative sub units called D4-head, D4-S1 and D4-S2. There are three farmer organizations (FO) representing each sub area of D4 canal and are responsible for irrigation water management in their respective command areas. The FOs also bear the responsibility for proper maintenance of tertiary level conveyance system. The irrigation agency, Mahaweli Authority of Sri Lanka (MASL) is responsible for delivering irrigation water upto tertiary level, therefore D4 take off gate at Bataatha branch canal and two other gates at the heads of D4-S1 and D4-S2 are operated by MASL.

An irrigation season is usually 18-20 weeks long, with 3-4 weeks of continuous water issue at the beginning of the season for land preparation followed by rotational water issues for the crop development.

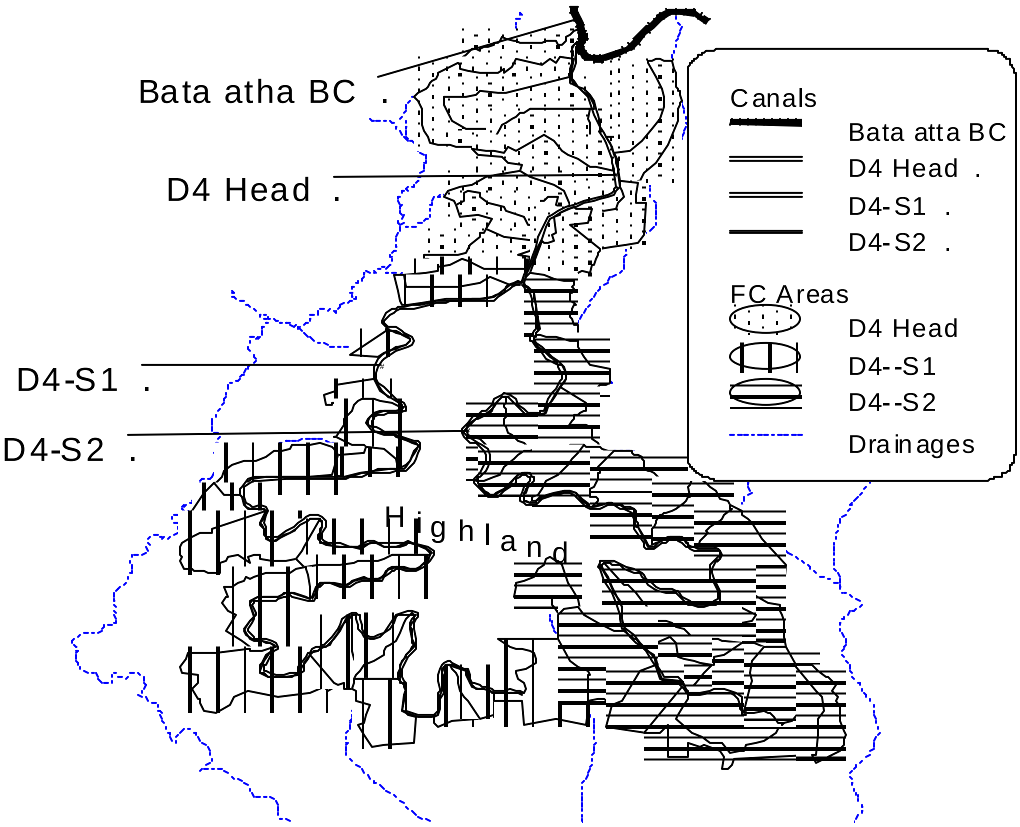


Fig. 1. Canals and Field Canal (FC) Area layout of D4.

Methods adopted in the case study

1. A detailed water balance study was conducted in order to establish the conveyance efficiency of the canal and daily water allocation for each field canal of D4. Inflows and outflows of the canal were measured twice a day during the season, and non-gauged out flows such as spill-out from the canal bunds, illegal tapping through holes in canal bunds and siphoning from canal were detected visually.

2. Operation and maintenance practices of conveyance system during the season, and water management practices in the D4 and the immediate supply canal – Bataatha branch canal were observed and evaluated against the targets and schedules of the season.

3. Passive observations of farmer–farmer and farmer–irrigation agency interactions in water management were made. Individuals and groups of people, who actively intervened in water management, were identified and their motives were investigated.

RESULTS AND DISCUSSION

Water balance study

Daily water balance of D4 canal comprising inflow from Bataatha branch canal and the sum of outflows is shown in Fig. 2. Differences between inflows and total outflows are considered as unaccounted flows. There are two categories of unaccounted flows in this balance. The first category is natural losses due to seepage and percolation while the second category is unmanaged flows of spilling through canal banks and illegal tapping. High inflow-outflow differences associated with high inflows during the month of July can be explained with very high losses at the tail end reaches of D4-S1 and D4-S2 sub D canals when they receive water after a long dry period. Very crude/damaged hydraulic structures and continuous manipulation of canal flow by farmers (manipulation of D4 intake at Bataatha branch canal, field canal off takes in D4 canal and temporary damming of canals) caused highly variable, unsteady flows in D canal during discharge measurements causing errors in total outflow estimation. These errors are associated with negative values in water balance.

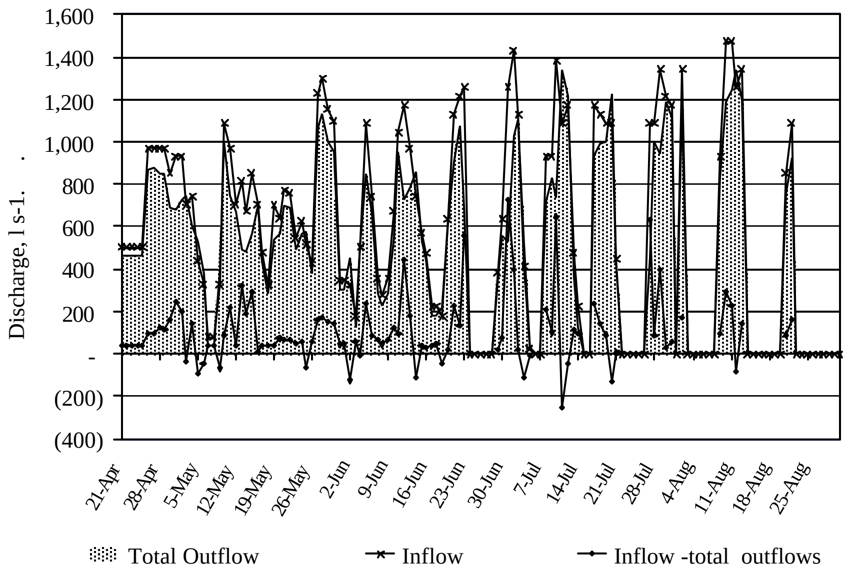


Fig. 2. Daily Water Balance difference of D4 canal.

D4 Canal has a high average conveyance efficiency (calculated based on Palacios, 1972; and Bos and Nugteren, 1990) value (86%) in *Yala* 2003, since most occasions total inflow to the canal was used by head end farmers and the effective length of the canal has shortened as a result. However, the daily conveyance efficiency values of D4 canal vary in a wide range with unacceptable values (42-138%), due to the frequent variation of effective length of the D4 canal and unsteady flows during flow measurements.

Achievement of irrigation area targets

Before the commencement of an irrigation season, MASL sets targets of the crop extents for each recommended crop, based on the water resources available and current policies promoted by MASL. The survived extents under each crop counted at the end of the season (actual extent) show the level of achievement.

During *Yala* 2003 season, MASL set targets to cultivate whole design irrigation area of D4 canal (420.7 ha) with their recommended crop combination; paddy 60% and other crops 40% (Embilipitiya Project Office, 2003). However, target achievements [(actual area / target area) x 100] were very low. Only 38% of target paddy area and 61% of whole target area were irrigated during the season (Table 1).

Table 1. Target and actual irrigated areas of D4 canal, *Yala* 2003.

Crop	Target (ha)	Irrigated (ha)	Percent achievement
Paddy	252.5	95.8	37.9
Other crops	168.2	161.3	95.9
Total	420.7	257.1	61.1

The achievement levels were not evenly distributed along D4 canal, and paddy was dominated at the head end reach with 100% target achievement (Fig. 3). Only around 75 % of irrigable lands in middle reach were irrigated and the tail end reach was not irrigated at all.

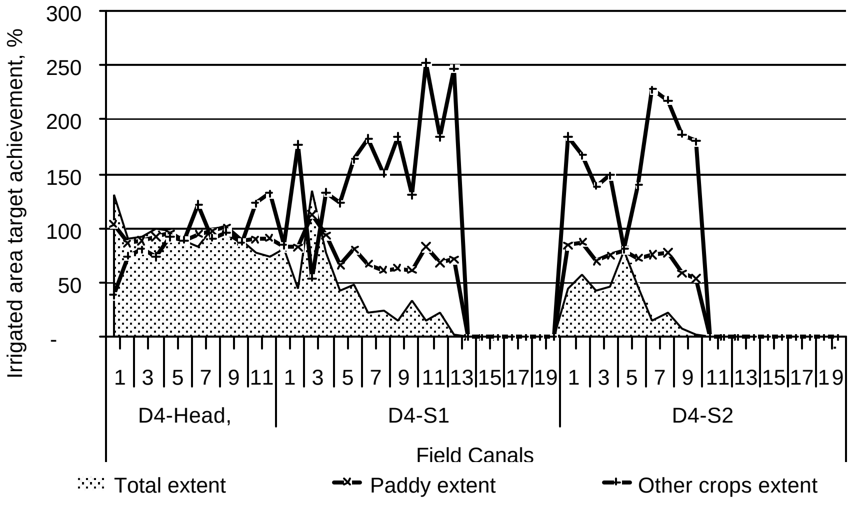
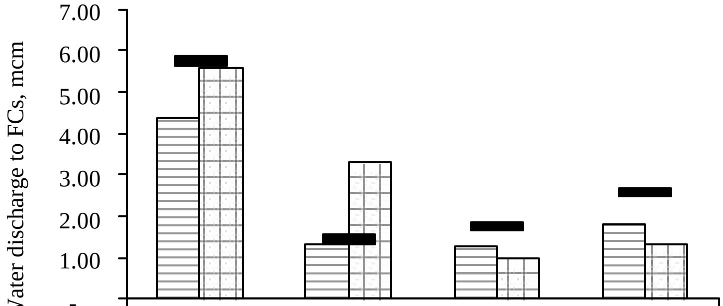


Fig. 3. Irrigated area; targets achievement in D4 canal, *Yala* 2003.

Target irrigation requirement vs. actual discharges of field canals

The sum of water discharged to field canals of D4 (5.59 mcm) during *Yala* 2003 is 130% greater than the estimated requirement for actual irrigation extent of D4 canal (4.39 mcm- calculated according to MASL (1992). The actual discharge volume of D4 is somewhat similar to the water requirement of target irrigation extent (5.74 cm) (Fig. 4) and it explains that during *Yala* 2003, D4 canal has received enough water to irrigate almost all the targeted extent. In sub areas, the head end sub area (D4-head) has received almost 2.5 times more water than it required. However, both tail end sub areas (D4-S1 & D4-S2) have not received their targeted amounts.



	D4	D4 head	D4- S1	D4- S2
Target for actual area, mcm	4.39	1.31	1.26	1.81
Actual discharge, mcm	5.59	3.28	0.98	1.34
Target for pre targeted area, mcm	5.74	1.42	1.74	2.59

Fig. 4. Target and actual water discharges in D4 canal and sub areas of D4.

Actual water depth distributions in field canals (actual water discharge to field canal/actual irrigation extent in paddy equivalents) show (Fig. 5) that the tail end sub areas have received inadequate amount of irrigation water with an uneven distribution. As a result, head end field canals of D4-S1 and D4-S2 sub area have received twice the amount that they required and the tail end field canal has not received irrigation water at all. The comparison of target and actual water requirements during land preparation stage shows that middle reach of D4-S2 sub area has not received irrigation water for land preparation for paddy.

The amount of water discharged through FC gates in D4 head (3.28 mcm) was almost 35% excess than the requirement of that of Head end FCs (1.31 mcm) and this excess water has drained through drainage canals that irrigate paddy lands located below the MASL command area.

Irrigation water availability in D4 area along the canals from head to tail end reach (Fig. 6) shows very close association with the dominated land cover patterns.

Head end reach was covered with paddy, while middle reach was covered with irrigated home gardens with established perennial crops and intermittent paddy in low lands. Finally, tail end reaches of sub areas were dominated with *chena* type cultivation. Above land cover pattern confirms the similarity in water distribution pattern in D4 canal during the recent past.

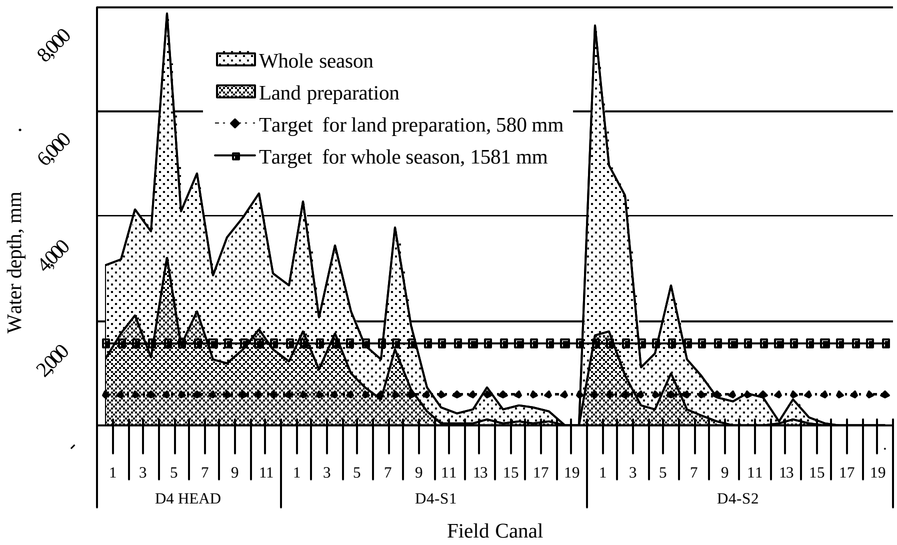


Fig. 5. Target vs. actual water depth distribution by field canals in D4, *Yala* 2003.

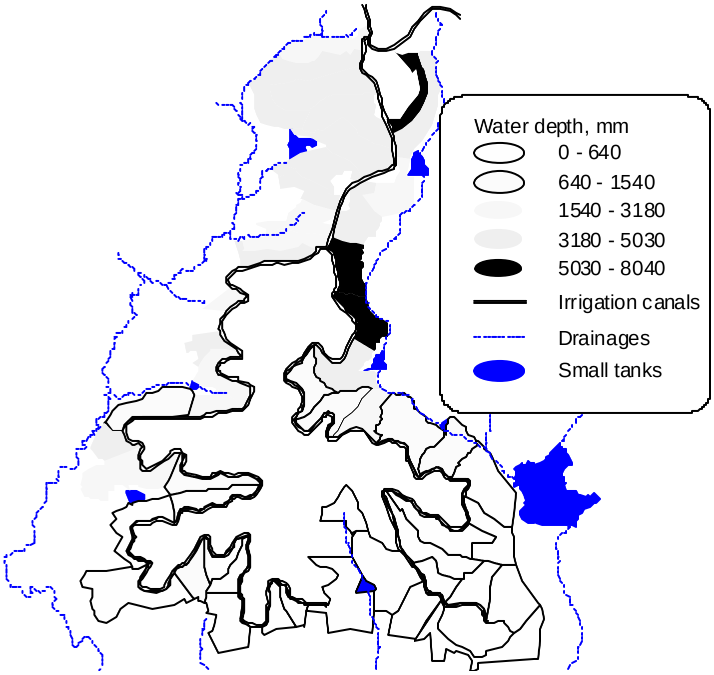


Fig. 6. Irrigation Water allocation for field canals in D4, *Yala* 2003.

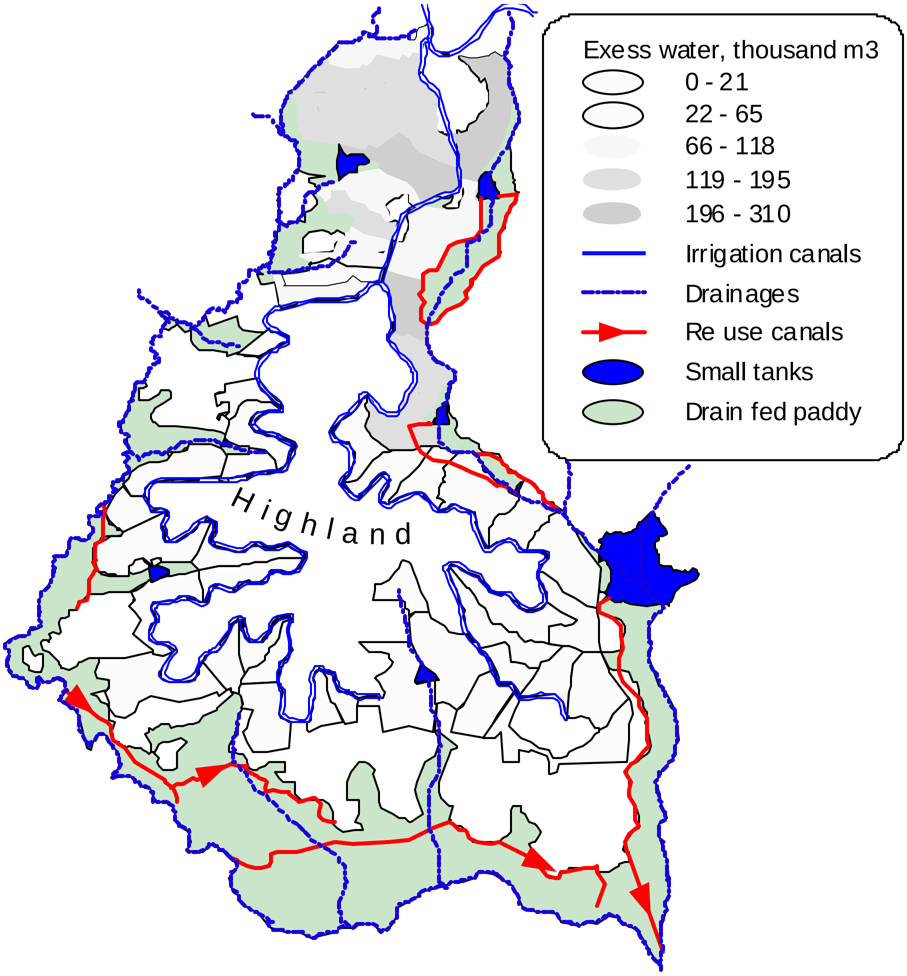


Fig. 7. Excess irrigation water distribution in D4, *Yala* 2003.

The average daily seepage and percolation losses for *Yala* season in Bataatha branch canal are 7.7 mm day-1 (MASL, 1992). Hence, average daily discharge of over 10 mm day-1 was regarded as a good approximation for estimation of drainage from field canal areas. The Fig. 7 provides evidence for close association between areas with high drainage and location of small tanks / anicuts and drainage canals, which feed paddy fields in downstream of D4 official command area. Those paddy fields are not provided with irrigation water from UWIS, however, lush paddy fields (established through field observations and analysis of air photos) suggest abundance of irrigation water.

Water management practices in D4 canal

Operation and maintenance of D4 canal

Since handing over of D canal operation and maintenance from MASL in late 1990s to farmer organizations (FO), which bare the responsibility of conveyance system operation and maintenance, with limited canal clearance once before the commencement of the season, two thirds of the water regulating structures in D canal were either damaged due to negligence or broken intentionally. The most common intentional damages observed in D4 canal and motives of destructions are listed in Table 2. It is obvious that there are three categories of farmers involved in destruction. The first category is farmers who own / cultivate paddy land located below D4 command area, entirely depend on either drainage from paddy lands or directly tapped water from the D canal. The second category is the farmers in head end reach, who do not prefer measured and regulated discharge and received more than required. Third group is the farmers from tail end reach, who are really affected from the actions of above two categories.

Table 2. Intentional damages of hydraulic structures observed in D4 canal.

Nature of damage	Responsible party	Motive
Damage to FC stilling well weir & staff gauge.	Farmers of head end reach.	To prevent gate operators from making accurate discharge adjustment
Damage to FC gate	Farmers who own private lands in small tanks located below the MASL command area.	To divert more water to small tanks / diversion structures
Making holes in canal bank	Do	Discharge water to drainage, diverting water to small tanks
Damage to the heading up/drop structures in DC	Farmers from tail end FCs	To deepen the DC bed, reducing the discharge to head and middle FCs.
Reopening old direct farm outlets from DC, or creating new ones	Do	Increase flow to plots to make sure they can access water during short and intermittent supply

Progress of seasonal cultivation calendar

The seasonal cultivation calendar is the official target schedule with deadlines that is agreed between farmers and MASL officials. Progress of the seasonal cultivation plan is illustrated in Fig. 8. At the end of *Yala* 2003, D4 canal activity was almost 21 days behind the target schedule.

The observations over the progress of implementation of seasonal cultivation calendar indicate that the canal clearing has been completed only in 40% of the canals, in which 20% of clearing was done only after delaying the supply of initial irrigation demands (the usual way to force farmers to clear canals). Middle and tail end reach farmers never interested on clearing as they were not assured with irrigation water supply. Land preparation progress was very slow with unusual reasons for the delay such as no deadlines were informed to some farmers, head reach farmers were never hurried as they had no water problem, and middle reach farmers had never been assured with reliable supply etc. Only farmers who depend on drainage water were hurried in land preparation.

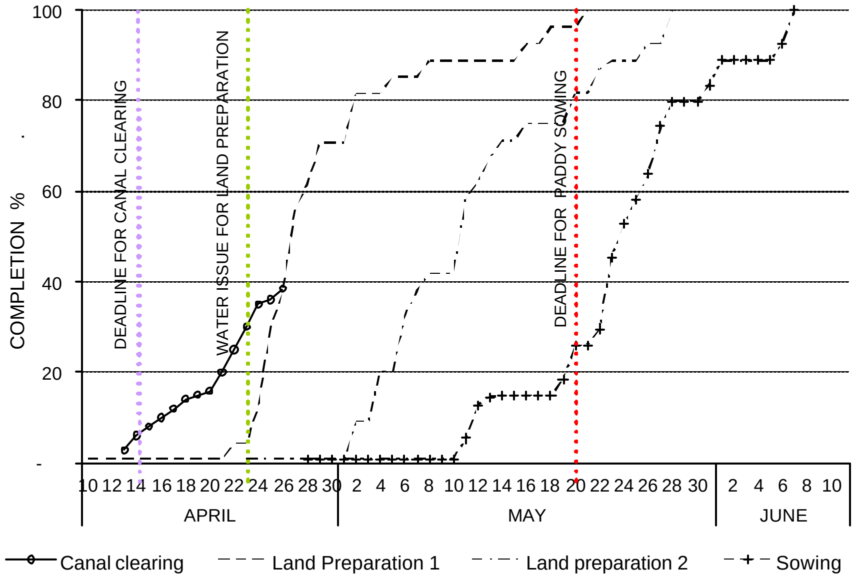


Fig. 8. Progress of land preparation

Unscheduled cease of water supply during the peak of land preparation activities caused heavy burden to many and MASL had to provide additional 10 days of water issues.

It was remarkable that only one farmer out of 35 in the sample has cultivated a recommended 3-month paddy variety, while all other farmers have cultivated 3.5-month varieties, delaying growth period by 15 days.

Rotational water issues during crop development stage

Water issuing date is fixed for a week and it helps in more productive water use. However, from June 2003, a new rotation plan was devised by MASL for

Gajamangama and Bataatha BCs, with a time length of 9.5 days and it was different from the accepted norms. The objective was to deliver water to tail-end farmers in the block.

CONCLUSIONS

This study reveals that the unsteady canal flow, caused by frequent irregular gate manipulation and temporary damming of canal by individuals cause significant error in discharge estimations. Almost 23% of the head inflow to D4 canal is lost in the canal due to unmanaged flows such as illegal tapping, spill out from canal banks and stagnation in canal bed. It was observed that two thirds of regulating structures in D4 canal do not function properly causing difficulties in implementing a proper water management plan for D4 canal.

Overall irrigation area target achievement in D4 canal was moderate (61%) and the paddy area target achievement was too low (38%). D4 canal received 5.6 mcm of irrigation water which was almost adequate to cultivate its total design area (420.7 ha) during the *Yala* 2003, that amounts to 130% of actual requirement of the season, but due to very poor water management inside D4 canal, both tail end sub areas never received their anticipated targets.

Almost 35% of total water received by D4 canal was discharged to drains through its head end field canals, and ultimate users of these waters are farmers of downstream paddy fields of D4 command area who have initially irrigated from small tanks, not in operation at present. Hence, almost all those paddy fields now depend on direct drain / tapping from D4 canal.

The downstream farmers attempt to withdraw high amount of water by damaging hydraulic regulatory structures of field canals and banks that eventually led to very high losses through unregulated gates.

Very sharp difference in water distribution along the D4 during the past has resulted in three different land use patterns in D4; as, permanent paddy lands, homesteads with intermittent paddy/OFC (other field crops–pulses, grains or vegetables that require less water) and rainfed *chena* type cultivation. Accordingly, middle and tail end farmers do not demand water for paddy but for their perennials.

Poor performance in implementation of seasonal cultivation plan and water distribution has resulted in weak interface between farmers and irrigation agency and the poor information sharing has caused losses for both parties.

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