Importance of Rehabilitation and Reconstruction of Irrigation Infrastructure, before the Introduction of *Pedma* Cultivation under Iranaimadu Irrigation Scheme of Northern Sri Lanka

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Abstract— *Iranaimadu tank is the only major irrigation scheme in the northern Sri Lanka. The major portion of the agricultural sector in northern districts depend on the Iranaimadu tank for their agricultural activities specially paddy cultivation. The water shortage in yala season of the Iranamadu tank, the primary source of water for the northern districts, signaled an imminent crisis to farmers, who are now grappling with an uncertainty. Therefore the "Pedma" cultivation was introduced with the limited irrigation water supply through the D4 canal in Maruthanagar Kilinochchi especially for the seed paddy production. The objective of this study was is to assess the suitability for selection of Maruthanagar D4 canal for the "Pedma" cultivation. The analysis of the water conveyance efficiency, water quality parameters and social impact analysis were done. The water conveyance efficiency was measured for different five flow rate at D4 canal. Electrical conductivity, pH, total dissolve solids were measured at site for ten days with morning and afternoon temperature difference within a day. Water conveyance efficiencies of D4 canal were always below the recommended level for all different flow rates and the values were ranging from 52.9% to 68.9%. The D4 canal water had the acceptable value in relation to the irrigation water quality parameters as pH, EC, TDS and salinity. Since the efficiency is lower than the recommended value, there is a need for construction and renovation of irrigation structures for optimize the efficiency in D4 canal. Income levels of the farmers under the "Pedma" cultivation were far below than the previous income levels. Inefficient land allocation and optimization and reduction in the household economy lead them to seek for an efficient alternative, after a full scale rehabilitation and reconstruction of the irrigation infrastructure and to practice good water management.*

Index Terms— Water *research Sri Lanka*, Conveyance efficiency, Iranamadu tank, Irrigation water quality, *Pedma* cultivation.

1 Introduction

IN Northern Sri Lanka, agricultural contribution is the major share to national GDP of the country and irrigation sector plays a vital role in the development of the nation. Irrigation has been practiced in Northern region since ancient times and is almost exclusively used for the cultivation of paddy. Irrigation Schemes in the Northern region have storage reservoirs which assure supplementary irrigation during dry spells in the *Maha* season and assure irrigation facilities to limited areas during the *Yala* season. There are 54 Major / Medium Irrigation schemes in Northern Province. The Provincial Irrigation Department maintains the non-interprovincial irrigation schemes, including eight major irrigation schemes within the province. Iranamadu irrigation scheme gets water from the largest provincial river basin starts from Chemamad, Vavuniya and run through Mullaitivu and impound water completely within Mullaitivu district. The entire irrigation facilities lie in Kilinochchi district.

Iranamadu tank built in 1902 is the biggest tank in the North and spread across an area of 50 Square Kilometers. The capacity of the tank is 106,500 acre feet. It helps to irrigate 21,985 acres of land in the Kilinochchi district, through 32.5 km of channels. Rice is cultivated either as a rain fed or as a supplementary or fully irrigated crops in this district. The farmers have always depended on tank water to cultivate their fields. The system of rice cultivation mainly depends on the available rainfall and its distribution. Paddy production has a higher sensitivity towards water shortages. They are in need of a steady supply of water, and it tends to immediately react by developing symptoms of water stress when the supply is disturbed. Therefore to ensure golden crop the cultivators should always maintain a sound water management systems ensuring sufficient amounts of water reaches every rice field from

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initial to final stage.

2 *Statement of the Research Problem*

Water is a scarce resource in the dry zone of Sri Lanka especially in Kilinochchi district and it is a major problem faced by the cultivators in the area. Since their cultivation totally depends on irrigation water, every possible effort should be put in order to optimize the water usage to achieve increased crop production. Recent reports on water management activities of several irrigation schemes in the Kilinochchi district indicate that the water distribution is not meeting the demands of farmers in terms of adequacy, reliability & timeliness. There is considerable potential to increase paddy yield through improved irrigation water management, especially by efficient irrigation scheduling.

Due to the present trend of drought, the irrigation authorities faced critical situation to supply the water needed for paddy cultivation under the Iranaimadu irrigation scheme. The most important problem raised from the farmers side regarding the seed paddy for the next *Maha* season. Therefore Irrigation department and farmer organizations decided to go for the "*Pedma*" cultivation. "*Pedma*" cultivation is the type of cultivation method practiced under the limited water availability. But the "*Pedma*" cultivation in the unexpected situations, caused several social and economic impact of farmer. Allocation of land, selection of suitable canal and schedule the irrigation are the conflict situation faced by irrigation authorities and farmer organization. Recently D4 canal under the Iranaimadu irrigation scheme was selected for the "*Pedma*" cultivation in Iranamadu irrigation scheme in Kilinochchi district.

Irrigation efficiency is a critical measure of irrigation performance in terms of the water required to irrigate a field. Other than the efficiency of canal water quality used for irrigation is also essential for the yield and quality of crops, maintenance of soil productivity, and protection of the environment.

Hence the objective of this study was selected as Importance of Rehabilitation and Reconstruction of Irrigation Infrastructure, before the Introduction of *Pedma* Cultivation under Irrigation Schemes

3 Methodology

3.1 Study Area

Iranamadu settlement scheme in the Kilinochchi District, was established in several stages since 1902. Under the scheme each family was given a holding ranging from 1.2 to 4 ha of paddy and 1.6 ha of homestead. Total specified irrigable area under gravity irrigation system is 8,455 ha and that under Thiruvai Aru lift irrigation scheme is 447 ha. The cultivation under gravity irrigation was limited to about 7,000 ha in Maha and 3,000 ha in Yala. The lift irrigation system is not functioning now due to suspension of power.

The land tenure within the scheme is mixed with private ownership, lands distributed under Land Development Ordinance (LDO) and lands that belong to the colony. The last category includes the entire extent of 1,190 ha of irrigable land in the RB while the irrigable area of 7,265 ha in the LB represents all three types of land tenure. The minimum size of land holding in the scheme is 0.6 ha of low land and 0.1 ha of highland. However, individual holdings vary from 0.6 ha to 10 ha of paddy land while the majority of holdings vary from 1.2 ha to 2.0 ha in extent. Average size of land holdings in the highland is about 0.8 ha. About 40% of farmers have leased their paddy lands and the leaseholders do not show much interest in water management or cooperate with development activities in the area.

The D4 canal of this irranamadu irrigation scheme was selected for the study. The selected channel is located at the Maruthanagar area. Figure 1 shows the D4 canal distribution, water conveyance efficiency location and sample locations for water quality.

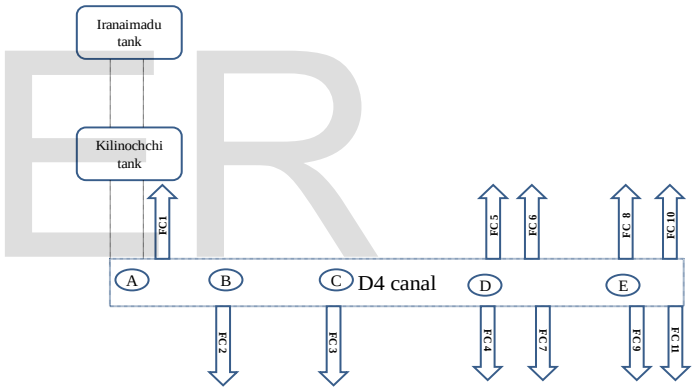

Figure2.1- Location of the study area

3.2 Collection of Water Sample and Measurement of Parameters

Water samples were collected from the D4 canal at ten different locations that include two collection point at Dry aru main canal and others at each diversion of field canal of D4. The water samples were collected simultaneously at two times morning and afternoon within a day for ten days continuously. The sample collection bottles were washed by the distilled water initially then by the channel water. Water samples were collected simultaneously with in the sample collection bottle at the selected sample collection points and were closed. Parameters were measured soon after the collection of water at the site. This includes the test for the pH, Electrical conductivity (EC), and total dissolved solids (TDS). The pH and EC with TDS of the water samples were digitally measured by using pH meter and EC meter respectively

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3.3 Canal Efficiency Analysis

The water conveyance efficiency of the canal was calculated by ratio between farm water supply to diverted water. Efficiency of the canal was estimated for four different flow rates. Flow rate of the main canal gate and field canal was by water two methods as equation method and rough method were used to measure the water flow rate. Equation method was used where the gate regulators are available in the canal. The rectangular weir equation derived from Bernulie's equation (Francis, 1986) was used to calculate the flow rate of canal. Crest length and head height were measured by using steel tape. From measured crest length and head the flow rate through particular gate was calculated by using following equation.

$Q=3.33(L - 0.2H) H^{(3/2)}$

Where L= crest length and H=head

Rough method was used where proper gate regulator is not available. The wool clod was allowed to move on the surface of the water in between two selected points. Distance between two selected points and time needed to pass the distance between two selected points for wool clod were measured using by steel tape and stop watch. This process was repeated three times to increase the accuracy. The cross sectional area was estimated by measuring water depth at a series of points across the stream and multiplied by width of stream within each segment represent by the depth measurement.

3.4 Social Impact Assessment

Socio economic changes occurred among the target farming community due to the sudden changes of their cultivation practices were assessed by administering questionnaires among the target group from Maruthanagar area. The study was adopted with 40% of the sample from the target group. Information were gathered in terms of their income levels, land use pattern, irrigation and fertilizer application, and preference of land allocation. The data were coded and entered in the excel sheet and analyzed by using statistical software application.

4 Results and Discussion

4.1 Water Conveyance Efficiency

There have been 50 contributions published by a single journal 'Agricultural Water Management'. It is ranked at the first position. The second position is taken by 'Proceedings of the 32nd WEDC International Conference', which is accounted to 37 publications. 'International Journal of Water Resources Development' was in third position with 31 publications. More than 14 Sources or journals have more than 10 publications during the study span. (Table 7.5) Conveyance efficiency of the D4 irrigation canal showed a wide range of variation from main sluice to the tail end field at each conveying level as shown in the table 1. Water conveyance efficiency was affected by water losses through evaporation, evapotranspiration, seepage and leakage through water control structures in the conveying system.

Table 4.1: Efficiency of D4 canal irrigation system at each conveying level.

Conveyance level	Conveyance efficiency
A-B (main start to F2 start)	77.35
B-C (F2 start to F3 start)	70.12
C-D (F3 start to F4 start)	54.75
D-E (F4 start to end)	32.79

Lining of an irrigation canal has the advantages of reduction in seepage losses from canals reaching water table and raising it resulting in water logging and reduction in yield, reduction in losses thereby making more water available for extension of irrigation to new areas and improvement of irrigation facilities in the areas already under irrigation. The conveyance efficiency values from Main sluice to F2 start (A-B) was higher compared to others due to the lining surface of the main, availability of regulatory structures and less over flow from the canal than other conveyance levels.

Conveyance efficiency values from Main sluice to F2 start (A-B) was greater than conveyance efficiency values from F2 start to F3 start (B-C) due to absence of lining surface on the B-C conveyance level, and leakage from the broken structures. F2 start to F3 start (B-C) conveyance level had large "V notch" irrigation structure in damaged condition due to improper management. Conveyance efficiency values of other conveyance levels was shown the significance reduction than previous conveyance levels due to less regulatory structures , broken regulatory structure , absence of lining and over flow from the canal.

Figure 4.1 shows the conveyance efficiency of the canal for different main inflow rate. The recommended conveyance efficiency levels for the distributary canals are 75%. But in the D4 canal conveyance efficiency for different input flow values were always below the recommended level. This situation indicates the needs for improvement in works to increase the conveyance efficiency above the recommended efficiency levels.

Furthermore the conveyance efficiency values were clearly shown the reduction in flow rate lead to increase in conveyance efficiency. Rise of flow rate lead to over flow condition from the canal and the losses from the canal. Rise of the flow rate increases the wetted perimeter of the canal and therefore seepage area was increased. The increase in seepage losses were lead to reduction in conveyance efficiency. High water flow through the canal lead to increases the leakage losses through the broken irrigation structures also. Thus the effi-

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ciency of the system was reduced.

But if the flow rate is become low that lead to failure of the flow of advancement of water along the canal due to the storage of water in the canal. Therefore the conveyance efficiency may show reduction with low flow rate.

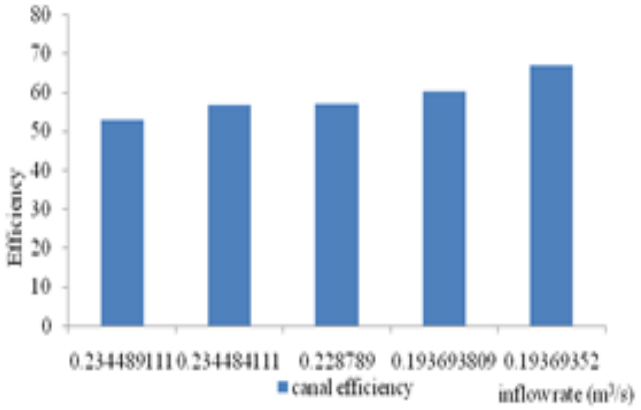

Figure 4.1- Efficiency of D4 canal irrigation system for different main inflow rate

4.2 Chemical Parameters

The EC value of irrigation water of the D4 canal ranges from 132 to 560 µS/cm. All chemical parameters values at afternoon were higher than the morning time within same sample collection points because of the temperature. According to Wilcox (1955) irrigation water quality falls within the irrigation water quality classification stand of 'good'. In terms of the 'degree of restriction on use', EC value of less than 700 µS/cm refers the water to 'none'; 700-3000 µS/cm 'slight to moderate' and above 3000 µS/cm 'severe'. It is easily presumable from the average EC value that in terms of EC value, the irrigation water of the D4 canal is suitable for irrigation purpose as it falls under category 'none'.

The most influential water quality guidelines developed on crop productivity is the water salinity hazard as measured by electrical conductivity. The degree of salinity is positively correlated with the EC of the water. While considering the average EC result it was clearly shown that the D4 canal water had no salinity problems according to the primary water quality criteria. The normal pH range for irrigation water is 6.5 to 8.4. The pH value of irrigation water of the study area ranges from 6.76 to 7.07, which is within the permissible limit for irrigated agriculture.

TDS value of the D4 canal was range from 175 – 487 mg/l. While considering the average TDS result it was clearly shown that the D4 canal water come under the class 2 "Good" quality irrigation water (175 – 525 mg/l) according to the primary irrigation water quality standard and considered to have low to moderate salinity hazards.

4.3 Social Impact of Pedma Cultivation

Due to the pro-long dry spells, Farmer organizations and Irrigation department had decided to go for the Pedma cultivation practices. As there was a situation of water scarcity, farmers couldn't able to afford their optimum water requirement for cultivation practices which caused several socio economic impacts on the farmers. Farmers were not happy about the location and extent of the paddy lands given under the Pedma scheme.

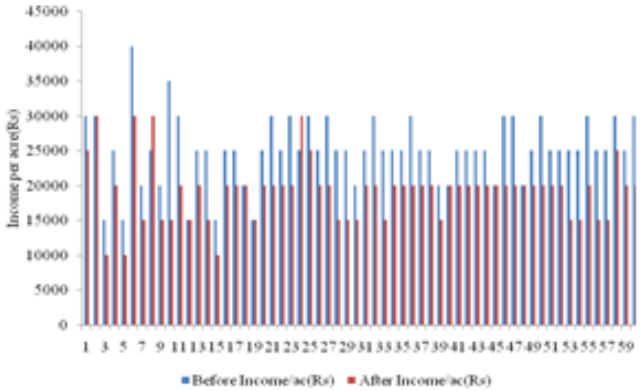

Figure 4.2- Comparison of income/acre by Pedma cultivation and before Pedma cultivation

From the above diagram, it is very obvious that the Pedma cultivation made adverse changes in the farmers' economy.

Main reason for that variation was most of the farmers' cultivated lands were located far away from their village. Therefore the cost of production was increased than previous cultivation due to transport cost, spending of money for transportation of machineries and equipments to field which are needed for cultivation and improper management due to time allocation and allocation of small land for cultivation.

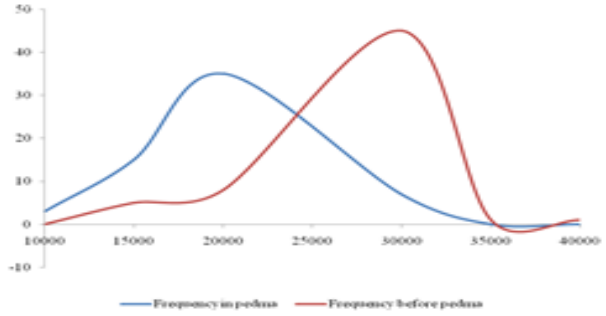

Figure 4.3 - Comparison of income/acre frequency distribution in Pedma cultivation and before Pedma cultivation

In this situation the large portion of the farmers comes under category of highest income receivers through the cultivation before P*edma* (78% of the sample were under Rs.30,000 - Rs.40,000). While compare this income range of the cultivation

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with the income levels under the Pedma scheme, 83% of the sample were found with the low income range from Rs.15,000-Rs.20,000 . Therefore the figure clearly had shown the income reduction in P*edma* cultivation.

Allocation pattern of land area for cultivation was a major problem faced by farmers compare with their preference.

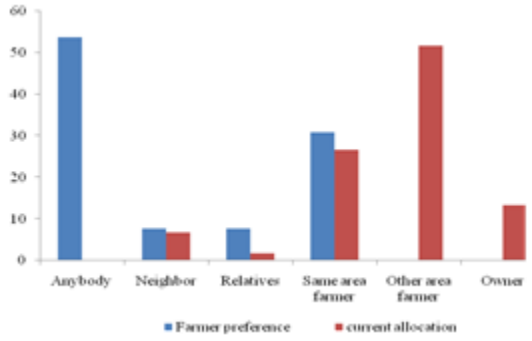

Figure 4.4 - Comparison between current allocation of surrounding farmer and farmer preference for allocating surrounding farmer

While considering the farmer preference 46.2% of them want to allocate as the surrounding farmer like same area farmer, neighbor and relatives. For that decision they had the mentality like loss of support and conflicts raised from the management activities while allocating others. Other hand 53.8% farmer preference was to allocate anybody as surrounding farmers. They had the flexible and challenging mentality than others.

But the present allocation indicated the highest value (51.7%) given for other area farmers. That allocation was entirely different from the farmer preference. So that Pedma condition leads to unnecessary impact on the farmer welfare due to the conflict between farmers.

5 CONCLUSIONS AND RECOMMENDATIONS

Chemical parameters such as pH, EC, TDS values were within the recommended range. The EC value of irrigation water of the D4 canal ranges from 132 to 560µS/cm and do not have any problem to irrigate paddy land. The pH value ranges from 6.76 to 7.07, which is within the permissible limit for irrigation. TDS value was ranges from 175 to 487 mg/l .The result of irrigation water quality categorize the D4 canal water as good quality water with no any hazards for irrigating the paddy land. The water conveyance efficiency of the canal always had lesser values for all regulated flow rate. The values were 52.9 %, 56.8%, 56.9%, 60.3%, and 68.9% for different flow rate. And also the values changing pattern were indicated the increased flow rate lead to reduction of conveyance efficiency values. The selected D4 canal was exhibit lower water conveyance efficiency than recommended level for all flow rate. There is a need to increase the conveyance efficiency higher than the recommended values with optimized the flow rate. The P*edma* cultivation impact analysis was indicated the income reduction and reduction in social status of farmer. Income levels of farmer majority in the study area were reduced by 50% and the farmer preference for the land allocation is fairly deviated than their preference. Therefore the study indicated the Importance of Rehabilitation and Reconstruction of Irrigation Infrastructure, before the Introduction of *Pedma* Cultivation under Iranaimadu Irrigation for optimized the efficiency, continuous assessment in the water quality parameters for maintain the optimum range and construct the farmer welfare without conflict among them.

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