Assessment of Feasibility of Minor Irrigation Project

Anu A J[1], Aparna B[2], Aravind Prasad[3] ,Dr.Binoy Alias M[4]

[1,2,3]Final Year Student, Dept of Civil Engineering, Mar Athanasius College Of Engineering, Kothamangalam, Kerala, India

[4]Proffessor, Dept Of Civil Engineering, Mar Athanasius College Of Engineering, Kothamangalam, Kerala, India

---

Abstract – *This project is an initiative to assess the performance of a minor irrigation project. The major objective of a minor irrigation project is to provide water for irrigation purpose. Thereby its performance is assessed in terms of various parameters like cropping pattern , crop water requirement , economic return , financial return , etc. Conveyance loss of the canal is found to be due to the seepage loss and unauthorized off taking of water for domestic purpose. Later the financial analysis is also done.*

Key Words: Irrigation, Canal, Discharge, Conveyance loss, Financial analysis, Economic return

1.INTRODUCTION

Due to increasing population, demand of food and fiber is increasing day by day. On the other hand, resources of water and per capita land are decreasing at scaring rate. Water is an important natural resource, which is used for agriculture, domestic, industrial and recreation purpose. For the development of Country, Agriculture is considered as major engine. As irrigation is the process of applying water artificially to the crop for the effective growth of the crop. Irrigation plays an important role in stabilizing the prices of food stuff and thus removing the worrying concern of food security. Irrigation not only helps in securing and increasing food production but helps in creating opportunities of decent life for their rural population. Over the last few years, it has been observed that there is drastic increase in the facility of the irrigation in the world and also in India. Minor irrigation project serves a good purpose for irrigation in India, but due to seasonal deficiency of availability of water for irrigation most of the minor irrigation project experience low efficiency and cropping pattern. The main reason for such a failure is the improper utilization and planning of irrigation water.

The feasibility of an existing minor irrigation project is assessed in various domains mainly in terms of its financial and economic feasibility.By evaluating these we are able to assess the performance of the system.

2. METHODOLOGY

In compliance with the objective of our project the following methodology has been used.

The main objective of minor irrigation projects are to provide water for irrigation purpose and also for drinking purpose as ground water recharge. Output of these projects can be assessed using certain parameters like crops, cropping pattern, crop water requirement, yield such as production and productivity, prices of the crop, revenue etc.

For this, various details like canal dimensions, area irrigated by the system, velocity of flow,discharge are to be collected. Canal dimensions can be measured at the site where as the area irrigated by the system can be obtained as a secondary data either from the village offices, or directly from the site. Velocity of flow can be calculated using the float method at various stretches of the canal.

Crop water requirements are defined as the depth of water [mm] needed to meet the water consumed through evapotranspiration by a disease-free crop, growing in large fields under non-restricting soil conditions including soil water and fertility, and achieving full production potential under the given growing environment.Cropping pattern along with the crop water requirement can be obtained from the agricultural office.

Water supply: Details regarding the amount of water supplied by the minor irrigation project at present can be found directly from the discharge values calculated.

Conveyance losses along the canal should be determined for assessing the performance of the canal system. The canal conveyance loss can be calculated by measuring discharge at different points separated by known distance using equation [2.1].

$$\text{Conveyance loss} = \frac{(Q1-Q2)}{LXP} \quad ...[2.1]$$

where,

Q1 is the discharge at first point (say A)

Q2 is the discharge at second point (say B)

L is the length between the two points

P is the wetted perimeter

This can be repeated for different stretches like head reach, middle reach and tail reach of the canal. From this, the average conveyance loss of the canal can be determined for assessing the performance of the system.

After this, secondary informations about the agricultural yield can be collected from either the agricultural offices, societies or from the local market.

Crop prices: The present prices of the crops being grown in the irrigated land can be collected from the local market and from the farmers, so that the amount of economic return generated from the land can be estimated.

Revenue can be estimated using the irrigated land tax rate which can be collected from the revenue department.

Operation and maintenance expenditure of irrigation infrastructure: The total expenditure occurred on operation and maintenance of the minor irrigation project is to be collected from the irrigation department to find out whether the project is economically feasible or not.

Financial analysis of the project can be done using the following method.

The financial analysis of a project involves the computation of (i)the present worth of a certain future amount or the benefits which would be derived from a project during certain number of years, (ii) amount to be recovered annually from the benefeciaries of the project so that if needed the project may be replaced by a new one ; and (iii)annual instalments for the recovery of the investment made for a project. All these aspects of financial analysis of a project are explained below:

(i)Present worth of a future amount:

Consider an investment P made today (i.e., at time 0 year) which is earning interest @ i% per annum compounded yearly.

At the end of 1 year the amount would be = $(P + iP) = P(1 + i)$

At the end of 2 years the amount would be = $P(1+i) + iP(1+i)$

Thus at the end of N years the amount grows to

$F = P(1+i)^N$

Or, $P = \frac{1}{(1+i)N} F$ .... [2.2]

Equation 1 indicates that P is the present worth of an amount F after N years, i.e., an amount after N years is equivalent to an amount P today.

The term $[1/(1+i)^N]$ is known as discount factor.

(ii) Amount to be recovered annually from the beneficiaries of the project to develop a fund to replace the project.

Let A be the amount recovered from the beneficiaries of the project at the end of every year and it is invested to earn interest @ i% per annum compounded yearly. It grows to an amount F at the end of N years, (F being the probable cost of the new project to be undertaken to replace the earlier project). Thus

$F = A + A(1+i) + A(1+i)^2 + A(1+i)^3 + ... + A(1+i)^{N-2} + A(1+i)^{N-1}$ .... (i)

By multiplying equation (i) by (1+i), we get

$(1+i)F = A(1+i) + A(1+i)^2 + ... + A(1+i)^{N-1} + A(1+i)^N$ ....(ii)

By subtracting equation (i) from equation (ii) , we get

$iF = A[(1+i)^N-1]$

$A = \frac{i}{(1+i)N-1} F$ .... [2.3]

iii) Annual instalments for the recovery of the investment made for a project

Let P be the investment made for a project, which if invested for a period of N years at the interest rate i% per annum compounded yearly, would have grown to an amount F. Thus

$F = (1+i)^N \times P$

Introducing the value of F in equation [2.3], we get

$$A=\left[\frac{i(1+i)N}{(1+i)N-1}\right]P \quad .... [2.4]$$

Where A is the annual instalment for the recovery of the investment made for a project.

From these details, comparing the investment and the return the feasibility of the system can be assessed.

3. CASE STUDY

We contacted different offices for an irrigation scheme suitable for the analysis and Malayatoor No 1 Lift Irrigation scheme was finalized. Both reconnaissance survey and preliminary survey were conducted and the details about the existing system was collected. Also a detailed study about the cropping pattern and crop water requirement was conducted. The details we could collect from the minor irrigation office are listed below

1.Location of the minor irrigation project: Malayattoor-Neeleshwaramgramapanchayat in Kalady division.

2. Length of irrigation canal-2960m

3. Ayacut – 70.50 ha.

4. Year of commissioning – 1960

5. HP of pump – 100hp

3.1 ASSESSMENT

3.1.1 Conveyance Loss

Conveyance loss along the length of the canal is measured using Equation [2.1] and is shown in Table 3.1.

Table -1: Conveyance loss

Conveyance loss					
Sl.No	$Q_1(m^3/s)$	$Q_2(m^3/s)$	Length (m)	Perimeter (m)	Conveyance loss (cumec/m²)
1	0.18	0.13	317	2.27	$6.65x10^{-5}$
2	0.14	0.13	166	1.73	$5.9x10^{-5}$
3	0.18	0.13	486.5	2.00	$4.92x10^{-5}$

Average conveyance loss = $5.82x10^{-5}$ $m^3/m^2/sec$

3.1.2 Crop Water Requirement

The crop water need (ET crop) is defined as the depth (or amount) of water needed to meet the water loss through evapotranspiration. In other words, it is the amount of water needed by the various crops to grow optimally.Crop water requirement of different crops are shown in Table 2

Table-2: Crop water requirement

Crop water requirement			
Sl.No	Crop	Base period (days)	Water requirement (mm)
1	Rice	90-130	900-2500
2	Banana	300	3000
3	Tapioca	90-105	400
4	Peas	95-100	500

3.1.3 Area Calculation

Fig-1: Area plotted

Using the Area calculator app the irrigated area was found as shown in Fig-1. The app identifies the latitude and longitude of our location and the point will be recorded on the map. Thus by plotting the end points of the irrigated agricultural land, the app directly measures the area of the plotted land on the map.

From the survey, the obtained area under cultivation is 56 hectares. In that almost 54 hectares of land is under paddy cultivation , 4 hectares of banana cultivation and the rest 2 hectares are under different cultivation mainly tapioca.

3.1.4 Discharge and Pumping Power Required

Discharge required at the field = Area × delta

Area = 56 ha

Delta for paddy = 900mm for a base period of 90 days,

The pump is working for 10 hours a day $= 56 \times 100 \times 100 \times \frac{1}{100} \times \frac{1}{60 \times 60 \times 10}$

= 0.15 cumec

Maximum loss over the length of the canal= Avg.wetted perimeter x length x loss/m²

= 1.6 ×1780 × 6.65 x 10^{-5}

= 0.19 cumec

From this it is clear that the loss itself is higher than the discharge required, which is due to the unauthorised off taking from the canal.

Now,

Discharge at the pumping station = 0.155 + 0.189 = 0.344cumec

Pump required $= \frac{w \times Q \times H}{746}$

$= \frac{9810 \times 0.344 \times 20}{746}$ (maximum head = 20m)

= 92 hp

The pump provided 100 hp is therefore sufficient.

Area that can be irrigated with the discharge,

$\frac{A \times 100 \times 100 \times 1}{60 \times 60 \times 10 \times 100} = 0.344$ cumec

A = 123.84 ha

Actual loss = 6.65×10^{-5}cumec / m²

Standard permitted loss through lined canal

=2 × 10^{-5}cumec/m²

Difference in actual loss and permitted loss =(6.65–2) × 10^{-5} = 4.65×10^{-5}cumec/m²

Extra area that can be irrigated if the loss is made as per the standards,

Loss = 4.65 × 10^{-5}cumec /m² × 1780 × 1.6= 0.121 cumec

$\frac{A \times 100 \times 100 \times 1}{60 \times 60 \times 10 \times 100} = 0.121$ cumec

Area = 43.5 ha

With the extra water that is lost we could have irrigated 43.5 ha more.

3.1.5 Economic Return of the System

- Rice

Average yield per hectare =2.5 tonnes

Rice is cultivated two times a year. Therefore,

Cost of production per hectare per annum = ₹ (40,750) × 2 = ₹ 81,500

Return per hectare per annum = ₹ 25.30 × 2500 × 2 = ₹ 1,26,500

Net balance per hectare per annum = ₹ 45,000

- Banana

Average yield per hectare = 30 to 35 tonnes

Cost of production per hectare per annum = ₹ 150 × 2500 = ₹ 3, 75,000

Return per hectare per annum = ₹ 35 × 9 × 2500 = ₹ 7, 87,500

Net balance per hectare per annum = ₹ 4, 12,500

Considering losses due to unpredictable factors like wind, rain etc.

Net balance becomes 0.8 times ₹ 4, 12,500 = ₹ 3, 30,000

- Tapioca

Average yield per hectare = 12.5 tonnes

Cost of production per hectare per annum = ₹ 6 × 6175 = ₹ 37, 050

Return per hectare per annum = ₹ 18 × 12.5 × 1000 = ₹ 2, 25,000

Net balance per hectare per annum = ₹ 1, 87,950

- The total economic return obtained from the whole system is calculated,

Area under paddy cultivation = 50 ha

Area under banana cultivation = 4 ha

Area under tapioca cultivation = 2 ha

Economic return of the system = (50 × ₹ 45,000) + (4 × ₹ 3, 30,000) + (2 × ₹ 1, 87,950)

= ₹ 39, 45,900

3.1.6 Financial Analysis of the project

For this system, the annual instalment they obtain is the land tax.

For land greater than 2 hectares, a tax of ₹400 along with ₹2 per are for the extra ares excluding 2 hectares.

₹400 + (₹2 × 5400) = ₹ 11,200

Let ₹1, 00,000 be the investment made for the project as for maintenance at an interest rate say, 6% per annum compounded yearly.

The period taken N is calculated and is as follows ;

$$11,200 = \frac{0.06(1+0.06)N}{(1+0.06)N-1}\ 1,00,000$$

N = 15 years

So, it takes 15 years to get back the money invested for maintenance.

4. CONCLUSIONS

The water from the Malayattoor No.1 project was initially designed for the irrigation purpose only. Now after 50 years of commencement of the project the canal is used for not only irrigation purposes but also for domestic purposes like drinking and washing.

- The conveyance loss from the canal is very high.
- Unauthorised off taking from the canal is often which result in insufficient supply of water at the tail end.
- Two 100hp pumps are provided at the pumping station. One pump works at a time. A total area of 56ha is irrigated using the water from the project. The head difference between the canal and the river is 20m. The pump requirement for irrigating 56 ha land is only 92 hp. So the provided pump would be sufficient.
- An economic return of ₹39, 45,900 is obtained from the whole system per annum.
- After doing the financial analysis, it is found that for an investment of ₹1, 00,000 the payback period is 15 years.
- As per the standard criteria, loss of a lined canal should be less than 2×10^{-5}cumec.If proper measures were taken to reduce the losses then an area about 43.5 ha could be extra irrigated

5. REFERENCES

[1] P. M. Ingle, S.E. Shinde , M.S. Mane, R.T. Thokal and Ayare B.L 2012-2013 , *"Performance Evaluation of a Minor Irrigation Scheme"*; Research International Journal of Scientific Research in Science, Engineering and Technology (ijsrset.com) 281 Journal of Recent Sciences", ISSN 2277-2502,Vol. 4(ISC-2014), 19-24 (2015)

[2] Himmat Patel (1990) , *"Financial working of irrigation projects – A case study of four projects in Gujarat"* ; Department of Economics , Sardar Patel University

J.S. Sindhu (2010), "*Water pricing and sustainable surface irrigation management*" ; Department of Economics, A.M. Jain College, Chennai,India

[3] Official website of Department of Agricultural and Farmers' Welfare "KarshikaKeralam".