Sustainable Practices of Engineering Management in Irrigation Projects to increase Water Use Efficiency :A case study in India

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ABSTRACT

The crop productivity per unit of water and project irrigation efficiencies in all irrigation projects of the world need to be urgently improved with ever increasing population. This is essential for food security, nutrient security, water security and soil security . Multidisciplinary Diagnostic Analysis (M.D.A) reports annually are necessary to thoroughly understand the strengths and weaknesses of the irrigation systems as they actually operate. There are six steps involved in M.D.A. M.D.A. procedure was proposed in India under Irrigation Management and Training Programme of Water Resources Management and Training Project ,which was funded by United States Agency for International Development(USAID).

Design Operation Plans (D.O.P) based on design standards of canals and hydraulic structures are urgently required to be prepared to provide reliable, equitable and predictable irrigation service.Seasonal Operation Plans (S.O.P) based on the actual availability of water at the start of the season ,can be prepared based on these Design Operation Plans for every khariff season and rabi season of every year. There are seven steps involved in the preparation of operation plans. Design operation plans and Seasonal operation plans were prepared for the irrigation projects included under National Water Management Project, which was aided by World Bank.

There are twelve steps involved for the Actual Implementation of Approved Seasonal Operation Plans (A.O.P).

These four reports M.D.A.,D.O.P, S.O.P and A.O.P are the key documents of every irrigation project for sustainable management of resources.

The Multidisciplinary Diagnostic Analysis (M.D.A.)report developed in a major irrigation project in Andhra Pradesh state of India is described. The Design Operation Schedules developed for a medium irrigation project in Andhra Pradesh state of India are explained.

KEY WORDS

Multidisciplinary Diagnostic Analysis (M.D.A), Design Operation Plans (D.O.P), Seasonal Operation Plans (S.O.P), Actual Implementation of Approved Seasonal Operation Plans (A.O.P).

1.0 INTRODUCTION

According to the Technical Advisory Committee (T.A.C.,2000) of global water partnership , Sweden; one third of world's population lives in countries that currently experience medium to high water stress . A report of United Nations, estimates the potential conflicts over water around the world to be around three hundred ; 3.4 million people, mostly children , die every year from water related diseases. Around one sixth of the world population lack access to the improved sources of water.

The concepts and guidelines for Crop water management research based on Operational Research (O.R) and farm trials are given by Bredero of World Bank (Bredero.J.Th,1988). The diagnostic analysis reports of trainee officers of Distributary D53 of Kakatiya canal of Sriramsagar Project give the insights into the methodologies involved in the multidisciplinary diagnostic analysis (Water and Land Management Training and Research Institute, 1987). The integrated four water concept developed by Sri T. Hanumantha Rao (former Chairman, State Level Technical Committee , Water Conservation Mission , Government of Andhra Pradesh) is a watershed development technology that deals with the effective utilization of (i) rain water (ii)Soil Moisture (iii) Ground water and (iv) Surface water , in order to derive the maximum benefits in a watershed. The four water concept can also be implemented in command areas, as Conjunctive water use management. Integrated Water

Resource Management and Sustainable Water Development and Management are now urgently required as per Andhra Pradesh Water Vision (Government of Andhra Pradesh, 1999). Improved On-farm water management increases crop yields, frees more water to irrigate additional areas, reduces project drainage installations and operational costs(Government of India,1985).The design operation plan of Thandava reservoir project was prepared under National Water Management Project(Indo-Dutch Production Management Unit Training Module,1993).Conjunctive use of surface and groundwater in canal systems can bestow great economic benefits (Government of India,1972).As per the report of the commission for irrigation utilization ,an irrigation water management manual is to be prepared for each project, prescribing procedures for an integrated operation of the reservoir, the canal system upto the pipe outlet and rotational supply (Warabandi) below the pipe outlets (Government of Andhra Pradesh, 1982). A case study in Sriramsagar Project shows the optimal surface irrigation practices to improve the water utilization efficiency in irrigation project (Srinath .B, Mohd.Hussain, et.al 2004, & Syed Bahauddin and Mohd.Hussain, 1992). The synergic practices of engineering for sustainable development are described with case studies (Mohd. Azizullah Khan, Mohd Hussain et.al 2006). An integrated model for conjunctive water use planning and management in irrigation project commands is developed with a case study in Sriramsagar Project (Mohd. Hussain, 2002). The engineering management practices are described for the sustainability of quality and quantity of water resources in 21st century (Mohd Hussain, 2005). The training modules prepared under National Water Management Project describe the methodologies involved in the preparation and implementation of operation plans (Indo Dutch Production Management Unit Training Modules, 1992). The report on diagnostic analysis of Nirgudi Minor Irrigation Scheme in Maharashtra describes the procedure of M.D.A. (Water and Land Management Institute, Aurangabad, 1988). The procedure of diagnostic analysis of irrigation systems is also described, taking the irrigation system to have four components.
i) Physical system. ii) Cropping system iii) Social organization system iv) Economic system (Colorado state university ,1983).

The Bhadra reservoir project operation in Karnataka is described under National Water Management Project (Indo Dutch production management unit training modules 1993).

The approach to operational planning under National Water Management Project consists of the following steps: analysis of water resources, past project performance, cropping plan, water utilization plan, revised operating rules and water distribution plans (Branschied .V, 1988). Irrigation system planning can be done with computers: SIMYIELD software package for simulating crop performance under irrigation and RICEYLD program for simulating performance of rice crop under irrigation are developed (Narayana Murthy .S.G, 1998). The design and operating guidelines for structured irrigation networks are described to achieve equity and assured timely water supplies to all farmers
(Shanan .L, 1986). The yield response of various crops to water is described by irrigation and drainage paper No.33 of Food and Agricultural Organization (Doorenbos. J. and Kassam A.H. et.al, 1986). The diagnostic studies for rehabilitation of irrigation systems required an interdisciplinary approach (Training notes, 1996). Integrated water management involves systematic canal operation in the canal system above the pipe outlet and rotational water supply below the pipe outlet as per requirements (Sitapati .P, 1985). The water resources development and management for sustainable crop production require. i) Water and land use strategies ii) Irrigation system management iii) Watershed management iv) strategies for conjunctive use of ground water with surface water (Water and Land Management Training and Research Institute , 1999) . The concepts and methodologies of on- farm irrigation scheduling are dealt in detail in irrigation scheduling manual (Leroy Salazar, George H.Hargreaves and R .Kern Stutler,1987)

2.0 SUSTAINABLE MANAGEMENT OF IRRIGATION WATER QUALITY AND QUANTITY IN COMMAND AREAS

Mohd.Hussain (1994) reviewed the three internationally well known on-farm water management simulation models, SWASALT model, FAIDS model and SWACROP model and emphasized the need to calibrate and validate these models for the waterlogged command areas in India to study and manage the soil water balance for sustainable crop production.

The Utah State University (USU) Unit Command Area Model (1987) comprised of two integrated submodels – the on – field submodel and the Unit Command Area Water allocation and distribution submodel (or queuing system simulation submodel).

Prajamwong et.al (1997) developed a model called "Command Area Decision Support Model (CADSM)" to estimate aggregate crop water requirements and to study management options for irrigated areas.

Sastry P.G., Veeraiah.Ch, Raghuvardhan Reddy.S, Yaqoob.M, Hussain. Mohd (1993) presented a methodology to develop Design Operation Plan as a basic management tool for operation of irrigation schemes taking a case study of Thandava medium irrigation project in Andhra Pradesh.

3.0 SIX STEPS IN THE M.D.A OF IRRIGATION SYSTEMS

The following six steps are involved in carrying out the DIAGNOSTIC ANALYSIS of a live irrigation systems: (Colorado State University, 1983)

(i) Evolving "Preliminary Objectives" (based on the knowledge gained through discussion about the performance of the live irrigation system).

(ii) Carrying out a "Quick Reconnaissance Survey" of the entire system under study.

(iii) Revising the original objectives (if necessary) based on the observations during the reconnaissance survey.

(iv) Conducting a very detailed and in depth field study (direct observation and personal enquires through interview), collection and analysis of data).

(v) Carrying out an interdisciplinary analysis of the data collected and synthesizing the information as inter- disciplinary team

(vi) Report writing and presentation.

4.0 EXPERIMENTS AND INSTRUMENTS TO BE USED IN M.D.A.

(i) PHYSICAL SYSTEM

Diagnostic – Walk – Thru Survey, Participatory Rapid Appraisal, Double Ring infiltrometer test to determine the soil infiltration rates.

Evaluation of irrigation methods.

Evaluation of field irrigation efficiencies.

Flow measurements.

Land leveling and topographical survey.

Soil testing, water testing.

Experiments to evaluate seepage losses.

(ii) CROPPING SYSTEM

Crop Cutting Experiments, Cropping intensity.

Interview with farmers.
Crop calendar, Land preparation and tillage operation.

(iii) ECONOMIC SYSTEM

Interview with farmers.

(iv) SOCIO – ORGANIZATIONAL SYSTEM

Interview with farmers.
Perceptions and expectations regarding system performance.
Perceptions of Government officials towards farmers.
Perceptions of Government officials about their job responsibilities and environment.
Decision making and conflict resolution process adopted by farmers.

5.0SEVEN STEPS INVOLVED IN THE PREPARATION OF OPERATION PLANS(PMU Modules on Preparation and Implementation of Operation Plans)

Step(1): Assess past operations, including past operation rules, water availability and past irrigation practices.
Step (2) : Determine the water allowance.
Step (3) : Identify options for operation rules.
Step(4) : Adopt feasible operation rules
Step (5) : Prepare schedules for irrigation releases.
Step (6) : Develop operation rules for specific situations.
Step (7) : Obtain approval of the operation plan.

6.0 TWELVE STEPS FOR IMPLEMENTATION OF OPERATION PLANS

The twelve step action plan for the implementation of operation plans is as follows:
(i) Approved irrigation schedules are to be communicated to all concerned. (ii) Measurement of flow by flow measurement structures (iii) Monitoring the implementation process of operations (iv) Irrigation Operation Management Information Systems (IOMIS) have to developed, for all major, medium and minor irrigation projects of all states, similar to Hydrological Information System (HIS) for River Irrigation under World Bank funded Hydrology project and Data collection centers all over the country. The dates entered have to be given INTERNET connection, so as to have access for all at any time. (v) Network of rain gauges i.e. one raingauge upto 520 square Kilometers is to be provided in the entire command as per IS code 4987-1968 and field irrigation efficiencies are to be evaluated as per IS code IS 13062 -1991 . (vii) Seepage losses from canals have to be measured as per IS code 9452 – 1980 (parts I &II) (viii) Adequate communication network has to be provided for the information to be exchanged promptly. (ix) As per Sri Syed Hashim Ali's "Report of the Commission for Irrigation Utilization , Govt.of AP (1982)" , an irrigation guide (operational manual) is to be given to all irrigation mangers with the project specific information on soils, crop patterns, water requirement of crops, irrigation methods and irrigation scheduling. (x) Review and evaluation of the performance of all operations have to be done at the beginning, middle and end of all irrigation seasons (Kharif /Rabi). (xi) All the irrigation mangers are required to develop the skills of participatory Rural Appraisal Methods (PRA methods), communication skills, water reading and accounting skills, computer skills particularly in MS- Excel and skills in INTERNET operations. (xii) Periodically diagnostic analyses of irrigation systems have to be carried out and the Data are to be entered into the computer.

7.0 ACTUAL IMPLEMENTATION OF APPROVED SEASONAL OPERATION PLANS (A.O.P)

The report containing the actual level of implementation of approved seasonal operation plan during the current season is to be prepared. This gives the necessary feedback to further improve the seasonal operation plan in the next season.

8.0 SAMPLE REPORTS OF M.D.A. AND D.O.P.

A sample brief report of diagnostic analysis of a minor of a main canal of a major irrigation project in Andhra Pradesh is explained in a separate sheet.
A sample design operation schedule for a main canal for kharif wet (paddy) crop in a medium irrigation project of Andhra Pradesh is described.

9.0 CONCLUSION

The four reports M.D.A, D.O.P, S.O.P, and A.O.P. are the key documents of every irrigation project for sustainable management of resources.

10.SAMPLE BRIEF REPORT OF DIAGNOSTIC ANALYSIS OF A MINOR OF A MAIN CANAL OF A MAJOR IRRIGATION PROJECT IN ANDHRA PRADESH.

(I) PHYSICAL SYSTEM

There is one standing wave flume and one cross regulator near the offtake of the minor.
There is insufficient communication network. There is no practice of conjunctive utilization of ground water and surface water as the farmers completely depend on the canal water.
Canal inspection road is o.k. There is wide spread of weed growth in the channel Farmers follow check basin method of irrigation for paddy crop and furrow method for other crops.
Soil type is loamy and medium textured.
Infiltration equation fitted is $y = 0.345\ t^{0.70}$
Infiltration rate from double ring infiltrometer test is 42.5mm / hr. Hydraulic particulars are noted.
Manning's coefficient n:0.029. Rate of seepage :0.000056m^3/s/m
Ground water is available at the depth of 7.2 Meters from ground level.
Irrigation schedules are not being followed. There are inadequate agricultural drainage facilities .

(II) CROPPING SYSTEM

The command under the minor is localized as irrigated dry but farmers are growing paddy crops.
Major crops are Maize, Paddy, Chillies and Turmeric. Farmers are keeping more than 5cms depth of water for rice cultivation. There are no practices to enrich the soil nutrients. Farmers are applying excess dosages of fertilizers and pesticides. Soil testing is not being done. Land leveling is not being done to improve water application efficiency. Yields for the crops: Groundnut – 40 quintals / Acre.
Maize - 15 quintals / Acre
Jowar – 6 quintals / Acre

On farm application efficiency	:	95.39 %	Conveyance efficiency : 75.6%
Deep percolation Ratio (DPR)	:	4.62%	Bulk density of soil : 1.68grms /cm^3
Water requirement efficiency	:	97.83%	Field capacity : 21cm/m
Distribution uniformity	:	97.05%	

Meteorological data and soil particulars are noted

TESTING OF WELL WATER

pH	:	7.2
Electrical conductivity (EC)	:	1 Milli mhos /Cm.
Sodium Absorption Raito	:	2.3
Turbidity Test by Nephlometer	:	0
Flame photometer Test	:	Sodium – 84 milligrams / Litre
		Potassium – 2 milligrams / Litre
U.V.Spectrometer Test	:	Fluorides – 1.35 milligrams/ Litre

(III) ECONOMIC SYSTEM & (IV) SOCIO ORGANIZATIONAL SYSTEM

There is a questionnaire containing fourteen questions to interview farmers to assess their Socio – Economic status . These questions pertain to personal characteristics, types of organization giving information , irrigation behaviour of farmers , area irrigated, condition of structures , performance of physical system , types of crops grown , water charges, types of fertilizers used and source of information . There is no visible impact of water users associations on the irrigation behaviour of the farmers interviewed . Whenever the farmers take the water from the field channels, they do not close the bund , causing the shortage of water to the tailend areas. Farmers are medium to small in economic status. Net income for groundnut per quintal is Rs. 2350 /-and net income for maize and jowar per quintal is Rs.1850 /-