MODERNIZATION AND TRAINING IN CANAL OPERATIONS

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ABSTRACT

India has more than 17 percent of the world's population, but has only 4% renewable water resources and 2.6% of land area. Agriculture accounts for more than 80% of total water withdrawals in our country. Irrigation modernization is a process of change from supply-oriented to service-oriented irrigation. It involves institutional, organizational and technological changes and endeavor to transform traditional irrigation scheme from protective to productive irrigation. The modernization process is now accepted as a strategic option to increase water productivity and increased economic output from large gravity irrigation schemes. It is imperative that advances made in information technology and analytical capabilities are imbibed into water management practices of our country. CWPRS has been conducting training programmesfor water planners and managers, both in private and public sectors, in order to bridge the knowledge gap between lab and fields.

INTRODUCTION:

With growing prosperity and large population,India is confronted with the challenge of raising food production and ever growing water demands. Irrigation consumes nearly 80% of our utilizable water and uncertainties in irrigation supplies are a leading concern among farmers. Large parts of India have already become water stressed. Rapid growth in demand for water due to population growth, urbanization and changing lifestyle pose serious challenge to water availability.Major urban areas are unable to provide a reliable and regular water supply and industrial and energy development projects are facing water constraints. Environmental concerns have diminished construction of new dam on rivers and there is demand for more water diversion for its preservation. An important imperative in this scenario is to augment water supplies by improving the efficiency of existing irrigation schemes. Lack of adequate trained personnel for scientific planning, utilizing modern techniques and adaptation of information technology is constrainingin implementation of better water management.

Explosive growth in extraction of ground water over last decade and its progressive depletion is raising concerns on its sustainability. This shift to groundwater irrigation is mainly due to the fact that rains in India are seasonal, intense and infrequent. Further, the available water resources infrastructure is not being maintained properly resulting in under-utilization of available resources. Draft report of National Water Policy – 2012 mentions thatwater saving in irrigation use is of paramount importance and methods like micro irrigation (drip, sprinkler, etc.), automated irrigation operation, evaporation transpiration reduction, etc., should be encouraged and incentivized.

MODERNIZATION:

Irrigation modernization is defined (FAO, 1996) as - a process of technical and managerial upgrading (as opposed to mere rehabilitation) of irrigation schemes combined with institutional reforms, with the objective to improve resource utilisation (labour, water, economic, environmental) and water delivery service to farmers. A modern irrigation design is the result of a thought process that selects the configuration and the physical components in light of a well-defined and realistic operation plan that is based on service concept. A modern irrigation design is not defined by specific hardware components and control logic. Advanced concepts of hydraulic engineering, irrigation engineering, agronomy and social science are to be used to reach at the most simple and workable solutions.Modernization – which is custom-designed to fit local needs and circumstances is essential if irrigation systems and irrigated agriculture are to be sustainable (Plusquellec, H et al., 1994).

Most of the prevailing irrigation practices in our country are highly inflexible in nature, which restrict the adaptation of modern on-farm management methods. It is known that typical irrigation efficiencies are in the 25-35 percent range, most projects fail to collect fees from farmers sufficient to cover operation and maintenance (O&M) costs, nevertheless, there is a potential for higher crop yields. It is estimated that 80% of the additional food and feed production required to meet the demands of the future will have to come from irrigation intensification and yield increase. It is imperative to have strategy for (a) increasing water productivity in existing irrigation schemes through modernization of such schemes; and (b) increasing the area under irrigation.

Obviously, there is a clear and critical need for irrigation project investments. Water delivery systems need to (i)respond to changes in demand pattern resulting from on-farm improvements and implementation of on-farm irrigation scheduling techniques, (ii) provide water users with reliable and flexible water supplies, including on-demand water deliveries, (iii) be managed to achieve maximum farm water yield and to minimize the operational costs, (iv) continue to be able to meet the demand for which a system was constructed or will be called upon to provide in the future.

In order to achieve above imperatives, it is essential to address certain fundamentalissues, (i)What levels of water delivery service are currently provided by irrigation projects having some aspects of modernization?(ii) What hardware and software features affect these levels of service?(iii) Do modern water control and management practices in irrigation make a positive difference in performance? [The answer is a definite yes] and (iv) What universal lessons can be learned and applied?

KEY MODERNIZATION CONCEPTS:

(a)Rapid Appraisal Process (RAP)

The Rapid Appraisal Process (RAP) systematically determines key performance indicators of irrigation projects. RAP help in organizing perceptions and facts and indentifying(i) potential for water conservation within a project (ii) specific weakness in project operation, management, resources and hardware and (iii) specific modernization actions to improve project performance

Rapid appraisal methods are quick, low-cost techniques to gather data systematically in support of performance evaluation needs.Rapid appraisal methods fall on a continuum between very informalmethods, such as casual conversations or short site visits and highlyformal methods, such as censuses, surveys, or experiments.Properly executed RAP may provide valuable insight into many aspects of irrigation performance including project design, engineering, operations and management.A parallel activity to the RAP is called *Benchmarking*. Benchmarking is a systematic process for securing continual improvement through comparison with relevant and achievable internal or external norms and standards. The overall aim of benchmarking is to improve the performance of an organization, as measured against its mission and objectives. Benchmarking implies comparison – either internally with previous performance and desired future targets or externally against organizations performing similar functions.

Measures for modernization of irrigation network may include: (a) Automatic cross-regulators on major irrigation canals i.e. reduce unauthorized withdrawals, provide information on significant leakage and seepage losses and data to improve operational management (b) Reconfiguration planning of minor irrigation channels (including redesign) for future requirements (c) Undertake targeted channel remediation works based on accurate, real-time measurement data and rationalize assets in accordance with reconfiguration planning like construction of high pressure or gravity pipelines, lining of channels or rebuilding of channel banks and (d) Replace out-dated flow-meters at farms with automated gates and accurate meters.

Rapid appraisal methods are especially useful and appropriate when:

(i) Qualitative, descriptive information is sufficient fordecision-making, i.e. thereis no great need for precise or representative quantitative data, rapid appraisal is a good choice. When there is a need to understand complex cultural, social, or economic systems and processes, qualitative information from rapid appraisal methods have an advantage over formal methods—for example, when assessing organizations and institutions, socioeconomic conditions of an area or the cultural patterns, behaviors, values, and beliefs of a group or population.

(ii) An understanding is required of the motivations and attitudes that may affect behavior**,** for instance of a developmentactivity's customers, partners, or stakeholders.Rapid appraisal methods are successful in answering the "why" and "how" questions. For example, "Why are farmers not adopting the recommended techniques of irrigation?"

(iii) Available quantitative data must be interpreted.

(iv) The primary purpose is to generate suggestions andrecommendations.

Broad goals of irrigation modernization are to achieve improved irrigation efficiency, better crop yields, minimal canal damage from uncontrolled water levels, more efficient use of labor, improved social harmony and an improved environment by reducing a project’s diversions or increasing the quality of its return flows. There are three key service indicators, as described in RAP

a. Flexibility, composed of frequency, flow rate and duration
b. Reliability and
c. Equity

Application of advanced techniques from hydraulics, information and communication technology are required for bringing flexibility into system of irrigation canal network. Reliability and equity facilitates good social order against vandalism and non-payment of water fees and are therefore cornerstones of projects.

(b) Supervisory Control And Data Acquisition (SCADA):

SCADA is an appropriate technology for consideration for modernization of irrigation canals. The objective of the SCADA system is collecting real-time data, storing them into a structured database for remote monitoring and sending commands for control of canal system. SCADA systems provide centralized monitoring and controlof field devices spread over large geographic areas, like water level, flow measurement and gate operations. As SCADA enables more frequent remote operations of gate, therefore canal operations become more responsive and precise.

SCADA, once perceived to be too expensive is no longer so. The hardware and software finding application in canal operational management are getting advanced and increasing in functions but decreasing in cost. On the contrary, the value of water has been rising with time. The cost of implementation of SCADA has fallen to a price point, where SCADA is getting affordable and useful to system of irrigation network. SCADA offer many cost effective features of monitoring and remote gate operation, which will significantly improve reliability of canal operations with reduced liabilities and can be implemented with up gradation of conventional office and staff training per se. The distinct advantages of SCADA will encourage various stakeholders to adopt and adapt these technologies due to rising demands and operational challenges, in not very distant future.

(c) Automatic Operation of Irrigation Canals:

Canal Automation is widely acknowledged as a technology to improve the operation of canal systems and to conserve water. Automatic control systems are being installed on many new canals and older canals are being modernized for data collection, telemetry and control equipments. Improvement in canal operations through modernization of existing control structures and introduction of overall canal automation management concept on existing irrigation schemes is important as the first potential source of water saving on the existing irrigation networks. An increase of at least 5% of water use efficiency may be accepted as a reasonable, which can be achieved by improving the canal system control and operational procedure. Also, improved canal system control would facilitate equitable, reliable and flexible distribution.

Automation implies that, control structures maintain desired flow rates or water levels in canals without manual intervention. Regardless of what performance might be theoretically attainable with a large staff and minimal hardware, the evidence shows that properly designed, located, and installed structures greatly enhance staff performance with fewer personnel. Studies on canal automation have found that the quality of water delivery service in irrigation projects is inversely proportional to the number of field employees per delivery point. This is especially important during the night and where communicationand accessibility is poor.

Appropriate automation helps project managers in distribution of water to users flexibly, reliablyand equitably. Application of right kind of structures and remote monitoring can improve project efficiency and water delivery service simultaneously. Canal operations are improved if operation of structure is simple and features that simplify canal operations are existence of flow measurement devices and long-crested weirs. Long-crested weirs need promotion as they reduce response time and keep water levels more constant. Canal breaks, lining damage and spills can be reduced.Therefore the correct question to ask is not “Why automate canal operations?” but “What level of canal automation are appropriate for a particular project?”

Levels of canal automation implementation

Level 1: Remote and manual monitoring using SCADA system.

Limitations:

- Rely on operator judgment.
- Wait-and-see approach.
- Hard to control large network.
- Transient flows are hard to control.

Level 2: Independent, automated control of individual gates based on local water levels. Here centralcontrol is executed through SCADA and remote control through programmable logic controllers (PLC) or remote terminal units (RTU).

Limitations:

- No coordination among control structures
- Failures not recorded or observed
- Tailender problems and spills
- Wrong level controlled?

Level 3:Centralized automated control, using SCADA and computer-driven logic.

Limitations:

- Accurate flow measurement or significant in-canal storage required.
- Controls average water level rather than downstream water level.

Automation of the gates at farm level allows water to be delivered without irrigators needing to be present to manually operate the gate. It also provides the ability to interact with on-farm automation equipment, thereby enabling best practice irrigation methods to be employed on-farm. If numerous structures are to function automatically in series (that is, a whole canal), proper simultaneous modeling of the canal pools and gates with the appropriate algorithms must be done by experienced persons who can give the correct and complete information to integrators for the PLC programming.

Canal modernization entails new water through reduction in delivery system losses and an improved level of service for irrigators. Installation of structures like long-crested weir would reduce response time i.e. there is a reduction in the amount of lead time that is required when an order is placed for water. This means closer to an ‘on-demand’ supply of water, with orders being confirmed at the time they are placed and water being received as ordered.

Computerised gate operations have following prerequisites:

• Dedicated well-trained local staff with excellent mobility in all weather, night and day
• Protection from vandalism
• Availability of high-quality sensors, actuators, industrial grade PLCs
• Existence of a permanent, well-trained staff that can troubleshoot and repair all components
• Availability of an experienced company to integrate various electronic equipments for measurements, communication networking equipments with advanced hydraulic algorithms etc.
• Excellent electricity availability
• An adequate, guaranteed long-term maintenance budget for labor and parts

(d) Flow Measurement:

Ideally, all water deliveries should be measured and continuously monitored. This is cost prohibitive for most irrigation projects. However, it is difficult to develop effective management controls without appropriate feedback on operational performance. Water measurement is a keycomponent of water control.

Good water measurement is also essential for improving water control. In general, check structures do not give accurate water measurement. Over the last several decades, modern flumes and weirs have provided simple, accurate, and inexpensive means for measuring water flow at all bifurcation or division points. In places where such measurement is difficult, acoustic flow meters are now becoming common. The ability to tie remote water measurement information into SCADA software allows continuous monitoring of flows within the system. This has also proven useful for water accounting and documentation of annual water uses.

Our ability to measure irrigation water has improved dramatically in the last several decades. Computer design and calibration of as-built dimensionshas made long-throated flumes and weirs, the device of choice for irrigation flowmeasurement because of cost and simplicity. Flumes and weirs are very simple and extremely cost effective. There are no valid excuses for not providinggood water measurement at key locations within a distribution network, for example at canal and offtake headings.

TRAINING:

Canal managers are accustomed to the age-old practices of canal operations. They show apprehension for modern technology for its feasibility on Indian conditions and situations. It is highly imperative that this mindset of various stakeholders be altered and they need to be convinced that with some smart application of technology in existing projects, more water can be made available for users. The need has been felt due to various reasons like, updating of systems objectives and purposes, aging of irrigation systems, changes in demand patterns, increased costs of operation and maintenance, the need for reduced operational spillage and growing gap between demand and delivery.

Draft proposal of national Water Policy – 2012 has been laying emphasis on “the need of the skilled manpower in the water sector, regular training and academic courses in water management” and “continuing research and advancement in technology to address the issues in water sector in a scientific manner”. CWPRS has been organizing short courses on “Modern Methods in Canal Control and Operations”. The targeted audience for this course is canal operators, irrigation district managers, engineers research personnels and other technical personnel who manage, operate, and design canal projects.

Key to success of such courses not the subject matter, but rather how this subject matter is taught. In general, the students in these classes are experienced adults who work with operating canal systems and real-world issues. Most of them work under field conditions and are not accustomed to sitting through long classroom lectures. Majority of them have a formal education in science and engineering, so they have developed their knowledge of water project operations through experience “in the field”. These students learn much more effectively by first-hand experience than by listening to a technical explanation. Therefore, the course emphasizes learning via experience with a real (albeit small) canal and flowing water, where cause and effect are demonstrated with physical reality.

The course’s general objectives are to present the issues of operational management of open-channel hydraulic systems such as irrigation canals, bring awareness to the problem complexity, in terms of hydraulic and control engineering aspects and present a clear framework of solutions adapted to this issue. The courses cover modern methods to upgrade the operations of existing canals, including canal automation techniques and equipment.The curriculum includes a combination of classroom discussions, equipment demonstrations and laboratory demonstrations that target canal operators, engineers and other technical staff. Major emphasis during the course is on following topics:

- Canal hydraulics - How does water naturally behave and why?
- Canal operations and modernization and automation - What are the various operating techniques that can be used by canal operators to deliver water effectively and efficiently? What are the limitations and requirements for implementing these different techniques?
- SCADA in canal operations – application of IT, communication, instrumentation and advanced hydraulics in canal management
- Various canal control techniques and control algorithms
- Flow measurements through hydraulic and acoustic techniques etc.

Flow measurement allows canal operators to more easily understand and control a water delivery system. Flow measurement is a topic of emphasis, taught via classroom explanation of flow measurement devices and equations, followed by hands-on laboratory workshops and demonstration of equipments.

CWPRS has established a model canal facility for demonstration of various flow control and measurement techniques practices in operation of canal system. A schematic diagram of facility is shown in figure 1.

Model canal in CWPRS is an indoor facility, with total length of rectangular model canal being approximately 190 m. Approximately 120 m long, 2.44 m wide and 2.44 m deep underground tank or sump is situated beneath the model canal for storage and recirculation of water supply into the model canal. The model canal consists of two limbs, which are 120 m and 60 m long and connected through nearly 6 m long MS siphon pipe. The model canal has sluice gate, simple weir, long crested weir and composite flow control regulator consisting of sluice gate and weir. The model canal has a long throated flume for flow measurement at its end. Suitable pipes equipped with control valves simulate four turnouts from the model canal. The water released from the turnouts eventually finds its way into the sump through a pipe for recirculation.

We, at CWPRS intend to upgrade this facility to demonstrate latest technological advancements in the field of canal operation and management. Ideally a training program should allow people to actively participate. The facility being developed in CWPRS should enable people to take theoretical as well as hands on experience on wide variety of modern water control techniques.

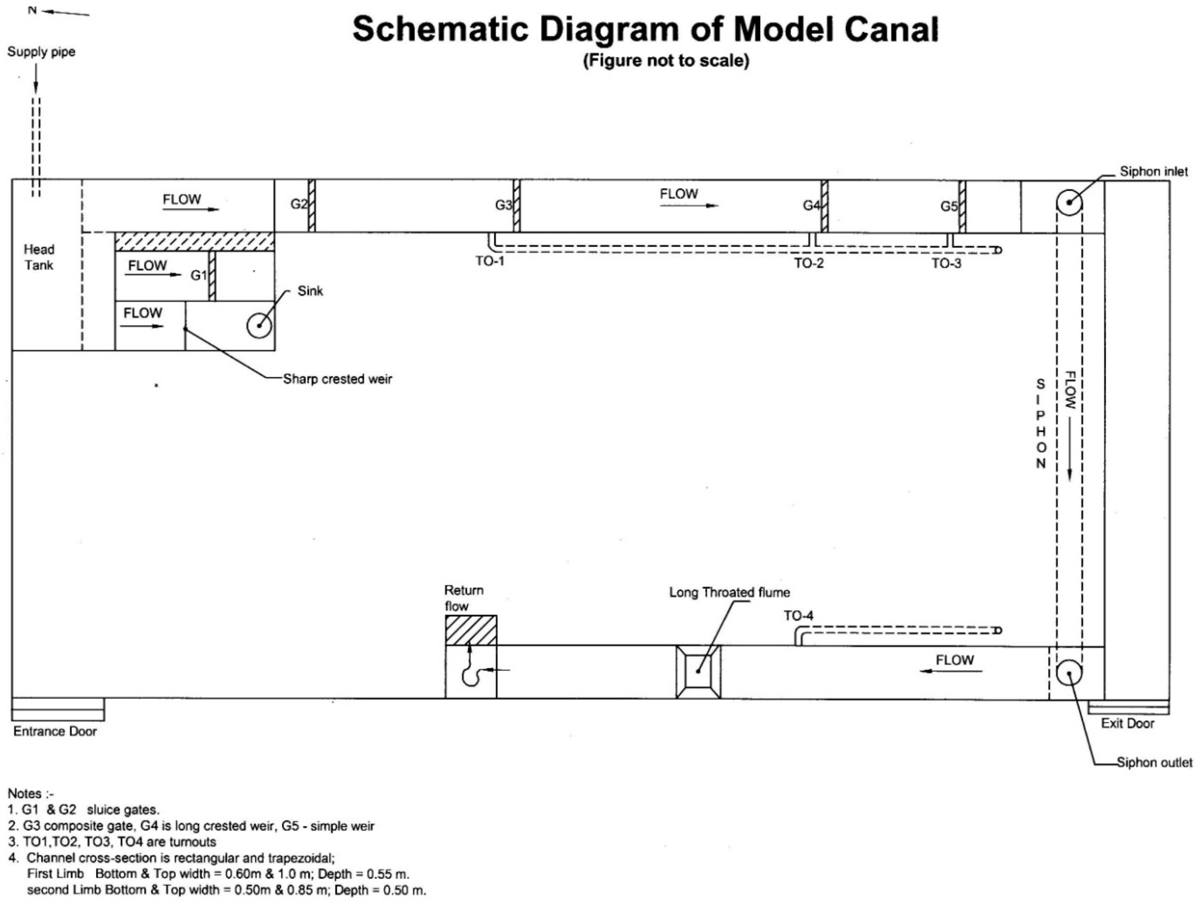

Figure 1. : Schematic diagram of model canal in CWPRS

Figure 2. : Panoramic view of model canal in CWPRS

Figure 3 and 4. : Long-throated flume and Long-crested weir in CWPRS model canal

CONCLUSION:

Limited water resources with growing demand, the only option is to make efficient use of scarce so that "new" water could be generated. The approach for finding solutions for efficient operation of network of canal system has to be holistic in nature, which demands comprehensive understanding of entire canal systems. Technological advances in hardware and software the field of hydraulics, flow measurement, information technology, communication and sensors have opened many opportunities for devisinginnovative techniques for undertaking operation of networks of canals. The challenge lies in operational integration of technologies.

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