

CAPACITY BUILDING FOR MODERNIZING IRRIGATION MANAGEMENT THROUGH THE MASSCOTE APPROACH

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ABSTRACT

India has made huge public investments in providing irrigation facilities through major, medium and minor irrigation projects creating 106 Million hectares (Mha) of irrigation potential up to the year 2010. The gross water demand for multiple uses is expected to double by 2025, requiring huge capital outlays to meet the demand. Presently, India's irrigation infrastructure is expanding by 1.8 Mha per annum, which is one-third less than the maximum growth achieved in the past. This decline in creation of irrigation potential started from the 1980s due to reduced investment in the irrigation sector by the Government. Demand-supply management in water sector and efficiency in its use are very critical for sustainable water-food security to the country. It is a fact that inadequate O & M funding over the years has resulted in decrease in performance of the irrigation systems with low efficiency and low productivity entailing huge investments to bring them to higher performance levels.

It was in this context that capacity building workshops were conducted by Government of Karnataka during 2006-2009 with the cooperation of United Nations-Food and Agricultural Organization (UN-FAO) in six major irrigation projects in a hands-on training covering a vast command area of 9.8 lakh hectares. In these training workshops, the tools developed by FAO Rapid Appraisal Procedure (RAP) and Mapping System and Services for Canal Operation Techniques (MASSCOTE) were used. The MASSCOTE application was field tested in these Projects successfully. With the experience gained by FAO in assessing the performance of irrigation projects in Asia and elsewhere and the seminal work done by FAO and other world bodies; International Water Management Institute (IWMI), Irrigation Training and Research Center (ITRC), the World Bank (WB) and International Programme for Technology and Research in Irrigation and Drainage (ITPRID), irrigation and drainage paper 63 titled 'Modernizing irrigation management-the MASSCOTE approach Mapping System and Services for Canal Operation Techniques' was published by FAO in the year 2007. It illustrates a step-by-step methodology to all the Engineers involved in modernization of medium-scale to large-scale canal irrigation systems.

Modernization of irrigation systems is commonly understood as improving the water delivery service, generally by providing lining to the canal system, rehabilitation / improvement of cross drainage structures and installation of automated gate operation and use of computers. But, it is seen that in spite of spending a huge amount on these, there is no substantial improvement in performance of projects in terms of equity of water delivery service and efficiency of applied water, operation and maintenance and management. This paper attempts to overcome these by new approach called the MASSCOTE approach, which has been applied to six irrigation projects in Karnataka and its significance in capacity building of 260 Karnataka Engineers by equipping them with tools and techniques required for modernizing irrigation projects. The MASSCOTE methodology with the use of RAP, developed by FAO and field tested in Karnataka irrigation projects through training workshops has proved to be successful in capacity building of irrigation managers by addressing issues that commonly affect operation and maintenance.

The training programmes have not only made remarkable impact in capacity building of key staff in-charge of irrigation projects, but also facilitated development of strategy for modernization of irrigation projects aimed at improving performance of the projects. The strategy is broadly classified in to (i) policy issues for modernizing irrigation management, (ii) improve internal performance indicators, (iii) improve water use efficiency, (iv) capacity building at all levels (v) establishing a centre of excellence in India at Karnataka Neeravari Nigam Limited (KNNL) with FAO collaboration (vi) Plan for modernization, monitoring and evaluation.

1. INTRODUCTION

India has made huge public investments in providing irrigation facilities through major, medium and minor irrigation projects creating 106 Million hectares (Mha) of irrigation potential up to the year 2010. The gross water demand for multiple uses is expected to double by 2025, requiring huge capital outlays to meet the demand. Presently, India's irrigation infrastructure is expanding by 1.8 Mha per annum, which is one-third less than the maximum growth achieved in the past. This decline in creation of irrigation potential started from the 1980s due to reduced investment in irrigation sector by the Government. Demand-supply management in water sector and efficiency in its use are very critical for sustainable water-food security to the country. It is all the more important now that the irrigation infrastructure has to be physically and financially sustainable in terms of proper upkeep of the system, improved management and efficiency. But, it is a fact that inadequate O & M funding over the years has resulted in decrease in performance of irrigation systems with low efficiency and low productivity with attendant ill effects of over irrigation like water logging, suffering atchcut etc. entailing huge investments to bring them to higher performance levels.

In many projects in India, the performance of the projects is lower than expected. The projects are caught in vicious cycle of poor maintenance, poor water delivery service, lower productivity and lower profits. To bridge the gap between expected and actual performance, various types of interventions are undertaken like technical and managerial improvements, institutional reforms such as transfer of irrigation management to Water Users' Association (WUA). Experience shows that if these different interventions are not carried out in coordination with each other, they will not produce expected results.

In order to improve the performance of irrigation projects, modernization is resorted to. Modernization of irrigation systems is commonly understood as improving the water delivery service, generally by providing lining to the canal system, rehabilitation / improvement of cross drainage structures and installation of automated gate operation and use of computers. But, it is seen that in spite of spending a huge amount on these, there is no substantial improvement in performance of projects in terms of equity of water delivery service and efficiency of applied water, operation and maintenance and management.

In the state of Karnataka, it is acknowledged that irrigation projects are not performing as expected. This is due to inadequate maintenance, inadequate staff and decline in funding for O & M activities and shortcomings in Participatory Irrigation Management (PIM). The estimated ultimate irrigation potential from all sources in the state is 5.5 Mha, out of which Major and Medium Irrigation Projects could be exploited to the extent of 3.5 Mha and 2.0 Mha from minor irrigation projects and ground water.

As a part of a collaborative program between the Government of Karnataka and FAO, aimed at re-engineering/modernization of irrigation management in Karnataka, a total of six MASSCOTE training workshops were organized by FAO in Karnataka irrigation projects during 2006-2009 in a hands-on training covering a vast command area of 9.8 lakh hectares. The tools used were the RAP-MASSCOTE methodology developed by FAO. The six workshops spread in various parts of Karnataka conducted with the main thrust on capacity building of Engineers include; (i) Ghataprabha Left Bank canal (GLBC), (ii) Gandorinala-Bennethora (G-B), (iii) Bhadra, (iv) Hemavathy, (v) Alamatti Lift Systems and (vi) Narayanpur Canal System. The MASSCOTE application was field tested in these projects successfully. Based on the experiences in Karnataka, FAO published a document titled "Modernizing irrigation management - the MASSCOTE approach" as FAO No.63 document in FAO irrigation and drainage paper series. It illustrates a step-by-step methodology to all the professionals involved in the modernization of medium-scale to large-scale canal irrigation systems. This was one of the laudable outputs of FAO cooperation with Karnataka.

2. PROJECT BACKGROUND

A brief introduction of the six irrigation projects where these training workshops were conducted is given below.

Ghataprabha Left Bank Canal (GLBC)

This project is situated in north west part of Karnataka in Krishna basin bordered by the two rivers Krishna and Ghataprabha. It is designed to irrigate an area of 1.6 lakh hectares by harnessing the waters of Ghataprabha river, which is a tributary of Krishna river. The canal system was completed in 1974-75 and is in operation since then. The workshop was conducted during October 2006.

Gandorinala-Bennethora (G-B)

These two projects are contiguous with command area of Gandorinala overlapping command area on Bennethora, situated in Northern part of Karnataka in Krishna basin. The irrigable command is 28000 ha. Gandorinala project was freshly constructed compared to Bennethora and both were eager to issue water for irrigation when the workshop was conducted during December 2006.

Bhadra

The Project is situated in the central part of Karnataka in Krishna basin. The project has a command area of 1.06 lakh hectares. A dam is constructed across river Bhadra, a tributary of river Krishna to impound 2025 Mcum of water. Earlier, in the 1990s, a modernisation project under NWMP was taken up, which was based on 'structured system' of operation of canals, which was based on ungated proportional structures. However, IWMI which conducted a survey of the effectiveness of modernisation concluded that the modernisation strategy failed due to lack of participatory approach, incompatibility in the operating procedures which did not take in to account the heavy and spatial variability of rainfall across the command area, unrealistic cropping pattern which was not adhered to by the farmers and lack of adequate maintenance. Further, in the year 2007, modernisation of the project was taken up to rehabilitate the structures, line the entire canal system to save significant quantum of water by means of reduction in seepage losses and by increasing conveyance efficiency. The workshop was held in this Project during January 2007.

Hemavathi Project

The project is Cauvery basin. Hemavathy Project envisaged construction of dam near Gorur to store 1050 MCum of water to irrigate 2,65,079 hectares of land. An irrigation potential of 120882 hectares was created at the time of conducting the workshop during July 2007. The irrigation in the project area commenced in the year 1996.

Almatti lifts

The project is in Krishna basin. It comprises of Almatti lifts -left bank, right bank and Mulwad lift, all on the foreshore of Almatti dam. The total irrigation potential under these schemes is 56950ha out of which a potential of 28355 hectares was created when the workshop was conducted during May 2008.

Narayanpur Canal system :

The Narayanpur canal system has Narayanpur reservoir as source which is situated on the downstream of Almatti dam in Krishna basin. The system comprises of both flow and lift schemes with irrigation potential of 5,13,000 hectares. There are eight canal systems under different stages of implementation; (1) Right Bank Canal, (2) Left Bank Canal, (3) Rampur Lift Irrigation, (4) Indi Lift Irrigation, (5) Indi Branch Canal, (6) Shapur Branch Canal, (7) Mudbal Branch Canal & (8) Jewargi Branch Canal. The workshop was conducted during February 2009.

3. CAPACITY BUILDING OBJECTIVES

The objectives of capacity building are;

1. Produce food for thought for decision-makers in Karnataka before engaging in investment plans, particularly on how to ensure that diagnosis and solutions are investigated properly in modernization projects;
2. Suggest some specific strategies to managers on how they should conceptualise the modernization of irrigation management;
3. Lay the foundations of a stepwise modernization plan
4. Introduce the MASSCOTE and RAP exercises to a large audience through real-case application.

5. CONDUCTING TRAINING WORKSHOPS

5.1 Trainings Organized

As a part of capacity building exercise, training workshops were organised aimed at training the Engineers of Water Resources Department of Government of Karnataka with the cooperation of FAO in six major irrigation projects using the RAP MASSCOTE methodology developed by FAO. They are ;(i) Ghataprabha Left Bank canal (GLBC), (ii) Gandorinala-Bennethora, (iii) Bhadra, (iv) Hemavathy, (v) Alamatti Lift Systems and (vi) Narayanpur Canal System (NLBC & NRBC). The MASSCOTE application was field tested in these Projects successfully during these training workshops.

5.2 The Participants

A total of 260 numbers of Engineers from the level of Assistant Engineer to Engineer-in-Chief were imparted training.

Sl.No.	Project area	No. of participants
1.	Ghataprabha Left Bank Canal (Oct 2006)	30
2.	Gandorinala - Bennitora (Dec 2006)	40
3.	Bhadra (Jan 2007)	45
4.	Hemavati (July 2007)	40
5.	Alamatti Lifts (May 2008)	50
6.	Narayanpur Canals (Feb 2009)	55
Total		260

5.3 Training material

The FAO document Irrigation and Drainage Paper 63 titled ‘Modernizing irrigation management-the MASSCOTE approach Mapping System and Services for Canal Operation Techniques’ was the main document distributed among all the participants. The other documents given to the participants include; (1) RAP and Benchmarking -Explanation and Tools, (2) Sensitivity analysis of irrigation structures-technical briefs. Class room lectures were arranged with international experts on irrigation management from FAO who delivered lectures on the RAP-MASSCOTE methodology, canal operation techniques and basic canal hydraulics to refresh the participants and to acquaint them with the new tools of modernization.

5.4 Training Methodology

The MASSCOTE Approach

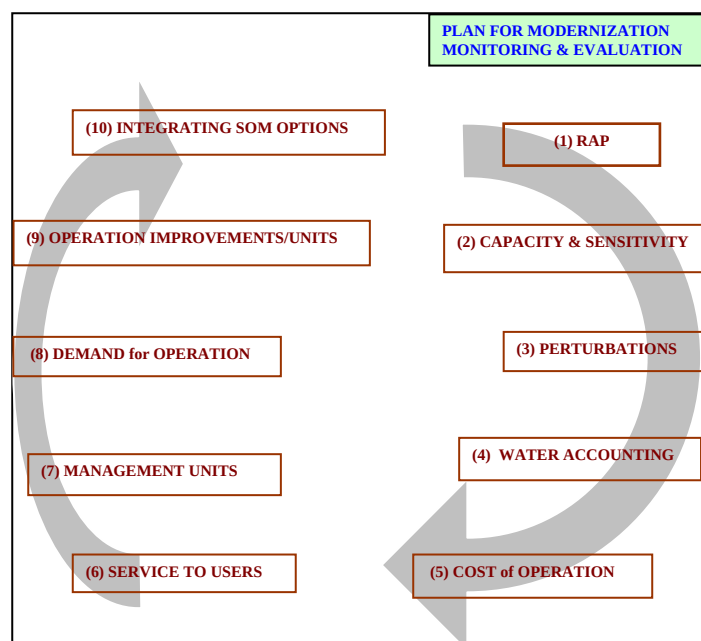
The RAP-MASSCOTE approach consists of a series of steps used in diagnosing performance and mapping the features of the irrigation system through a comprehensive methodology of analyzing canal operation in order to improve the service to users and in addition ensuring cost-effectiveness of canal operation techniques. The MASSCOTE approach is an attempt to help Managers to address modern needs, issues and challenges. The entry point of this approach is canal operation but the scope is modernization and the goal is to promote Service Oriented Management (SOM) with specific identified targets in terms of effectiveness in relation to money, to water and with regard to environment.

The MASSCOTE aims to organize the development of modernization programmes through a step by step methodology comprising of:

- Mapping various characteristics of the system,
- Delimiting institutionally and manageable sub-units,
- Defining the strategy for service and operations for each unit.

The steps involved in MASSCOTE approach leading to vision and plan for modernization, monitoring and evaluation is illustrated in fig 1.

Fig 1 Steps of MASSCOTE



The steps in MASSCOTE approach

The mapping steps in MASSCOTE approach principally run under two phases;

Phase A – Collection of base line information

Phase B – Development of vision for Service Oriented Management (SOM) and modernization of Canal Operation.

The various mapping steps comprised in each of the above two phases are illustrated in the table 1.

Table 1 The MASSCOTE framework

Mapping Phase A – baseline information	
1. The performance (RAP)	Initial rapid system diagnosis and performance assessment through the RAP. The primary objective of the RAP is to allow qualified personnel to determine systematically and quickly key indicators of the system in order to identify and prioritize modernization improvements. The second objective is to start mobilizing the energy of the actors (managers and users) for modernization. The third objective is to generate a baseline assessment, against which progress can be measured.
2..The capacity & sensitivity of the system	The assessment of the physical capacity of irrigation structures to perform their function of conveyance, control, measurement, etc. The assessment of the sensitivity of irrigation structures (offtakes and cross-regulators), identification of singular points. Mapping the sensitivity of the system.
3. The perturbations	Perturbations analysis: causes, magnitudes, frequency and options for coping.
4. The networks & water balances	This step consists of assessing the hierarchical structure and the main features of the irrigation and drainage networks, on the basis of which water balances at system and subsystem levels can be determined. Surface water and groundwater mapping of the opportunities and constraints.
5. The cost of O&M	Mapping the costs associated with current operational techniques and resulting services, disaggregating the different cost elements; cost analysis of options for various levels of services with current techniques and with improved techniques.
Mapping Phase B – Vision of SOM & modernization of canal operation	
6. The service to users	Mapping and economic analysis of the potential range of services to be provided to users. Mapping a vision of the irrigation scheme.
7. The management units	The irrigation system and the service area should be divided into subunits (subsystems and/or unit areas for service) that are uniform and /or separate from one another with well-defined boundaries.
8.The demand for operation	Assessing the resources, opportunities and demand for improved canal operation. A spatial analysis of the entire service area, with preliminary identification of subsystem units (management, service, O&M, etc.).
9. The options for canal operation improvements / units	Identifying improvement options (service and economic feasibility) for each management unit for: (i) water management, (ii) water control, and (iii) canal operation.
10. The integration of SOM options	Integration of the preferred options at the system level, and functional cohesiveness check. Consolidation and design of an overall information management system for supporting operation.
11. A consolidated vision & a plan for modernization and M&E	Consolidating the vision for the Irrigation scheme. Finalizing a modernization strategy and progressive capacity development. Selecting/choosing/deciding/phasing the options for improvements. A plan for M&E of the project inputs and outcomes.

6. IMPACT OF TRAINING WORKSHOPS

The impact of the training workshops is manifold. Listed below are the benefits and outcome of capacity building workshops which establish that the objectives of workshop have been fulfilled to a great extent.

1. The MASSCOTE methodology which was in the development stage was further refined after field testing in the training workshops and lead to the publication of Irrigation and Drainage Paper 63 titled 'Modernizing irrigation management-the MASSCOTE approach Mapping System and Services for Canal Operation Techniques' which was published by FAO in the year 2007.
2. Five policy issues emerged from the GLBC MASSCOTE workshop which are taken up appropriately at Government level. They are :
 - A revised approach to hydraulic equity
 - Accept the need for flexible Cropping patterns
 - Shift from protective to productive irrigation
 - Service oriented management (SOM) and explicit Integrated Service Oriented Management (IWRM)
 - Revisiting the concept and practices of "Payment for water services"
3. A typology of all the systems under various stages of implementation by KNNL (30) emerged to allow each system being referred to some of the key features/aspects identified in the 3 systems where workshops were conducted.
4. Follow up actions on the recommendations of the workshop were initiated on all the three projects to evolve a modernisation plan. In case of G-B project, the challenging task of carrying out implementation of MASSCOTE findings was taken up by the core team of engineers who had undergone the training. In case of Bennethora project, though the rehabilitation system package had already been planned which was about to be implemented, the workshop lead to the reengineering of operation and management at no additional cost by merely refocusing the planned investments on critical items to ensure good services to the users. Whereas, in Gandorinala project which was still under construction phase, the workshop lead to the implementation of the appropriate techniques of canal operation with capital investment by merely redesigning the canal offtakes and regulators.
5. The six workshops on the application of MASSCOTE methodology conducted in Karnataka resulted in capacity building by way of training 260 Engineers of key staff of WRD. Some of the trained Engineers of KNNL, in turn participated as resource persons in two workshops on Irrigation Modernisation of Jaunpur Branch System of Sarada Sahayak Project (December 2007) and Upper Ganga Canal System (September 2008) as a part of capacity building of Uttar Pradesh Irrigation Department (UPID) Engineers and in a training workshop of Engineers of Central Asian Countries at Tashkent, Uzbekistan (July-August 2009).

7. IMPLEMENTATION STRATEGY FOR MODERNIZATION

With the outcome of the six MASSCOTE workshops available indicating the level of performance of the projects vis-a-vis the expected performance initially formulated while evolving the project, the strategy to improve the performance of the projects has been derived. The derived strategy takes in to account the capability and strength of technical staff, the progress made in participatory irrigation management, the condition of the infrastructure, the policies on water distribution and collection of water rates and the availability of finance for carrying out modernization programme. The strategy is broadly classified in to (i) the policy issues for modernizing the irrigation management, (ii) improve the internal performance indicators, (iii) improve the water use efficiency, (iv) capacity building at all levels (v) establishing a centre of excellence in India at KNNL with FAO collaboration (vi) Plan for modernization, monitoring and evaluation

(i) The policy issues for modernizing the irrigation management

Five policy issues emerged from the GLBC MASSCOTE workshop :

- (a) A revised approach to hydraulic equity
- (b) Accept the need for flexible Cropping patterns.
- (c) Shift from protective to productive irrigation
- (d) Service oriented management (SOM) and explicit IWRM
- (e) Revisiting the concept and practices of "Payment for water services"

(a) A revised approach to hydraulic equity

Equity is always an issue in any irrigation project, especially where there is non-uniform availability of groundwater in the command area and the socio-economic condition of the farmers is varying in the command area. Farmers having access to groundwater and recirculation invariably tend to grow high water consuming crops like sugarcane supplementing canal water with groundwater whereas the farmers with no access to groundwater depend mainly on canal water growing semi-dry crops with low economic returns. There is a need

to recognize all components of the system water balance and use canal supplies to compensate under-served sectors of the command to raise system cropping intensity/productivity. Such a policy shift would represent an opening of operational and investment opportunities. The possible way forward is to establish a principle of equitable access based on recognition of complementary supply to other secured alternative sources of water.

(b) Accept the need for flexible cropping patterns

In all the irrigation projects, an official cropping pattern is prescribed restricting the farmers to grow as per official cropping pattern and imposing penalty, if they fail to do so. In practice, the farmers violate the cropping pattern in view of opportunity of conjunctive use, recirculation and very low tariff for electrical power consumption. Another reason is unreliability of canal water supplies, more in the tail end reaches of distributaries and tail end of main canal. Considering that flexibility in growing cash crops generates high wealth in the command areas which deserves to be encouraged, imposing restriction on cropping pattern is proposed to be dispensed with. The possible way forward is that service to farmers should be based on needs of actual cropping pattern, with due considerations to the principle of equity and to surface water availability.

(c) Shift from protective irrigation to productive irrigation

Hitherto, the policy of distribution of water has been based on equity for surface water and the adoption of

a dictated cropping pattern with crops mainly of semi-dry type requiring low water needs. With this policy, it was felt that the water could be distributed to a large area and the farmers could grow at least one crop for sustenance. But, with the development of pumping technology and availability of electrical power at low tariffs, farmers have been resorting to conjunctive use and growing cash crops driven by market demand. As a result, the productivity of irrigation has grown dramatically. It has been estimated for GLBC project that the productive approach is 4 times more productive in terms of economical value than the protective one.

In the case of GLBC project, the productivity of surface water as additional supply to others sources of water has been found to be as high as Rs.10 per m³ (0.23 US \$/ m³), which places this system as one of the best among the Asian systems. Therefore, the operational policy is proposed to be relaxed to permit actual practices to flourish within the overall resource limits of the irrigation systems.

(d) Service oriented management (SOM) and explicit IWRM

The concept of SOM is central in modernization, but it is not restricted solely to the delivery of water to crops. The water service supplier/agency of irrigation systems is the main operator for a set of water services in their command area, including potable supply, livestock watering, orchards and shelter belts. The multiple use and function of water services across irrigation commands is becoming increasingly apparent and recognized by users and managers alike. Here, services are domestic water to some villages, environment, or the non crop-evapotranspiration (trees, natural vegetation) in the GCA, which might account for 10 to 20% or more of the water from irrigation supply.

Therefore, the need to recognize the multi-functionality of water services explicitly in water management planning and operation is felt. The implications for an operational policy and regulatory liability of both users and service suppliers are manifold and will require detailed specification. The opportunity in this policy is consideration of multiple uses of water in CA for sharing the cost of O&M among a larger section of users and uses. This can certainly help the management agency being more effective while reducing the cost borne by farmers. The possible way forward is water services beyond crops explicitly recognized for irrigation agency.

(e) Revisiting the concept and practices of “Payment for water services”

The principle of payment for water services on a volumetric basis is widely recognized as fundamental in good management practices. The tariff that should be associated with this principle should be set in such a way that when aggregated for all services of the command area, the total remuneration to the agency should at least cover the cost of Operation and Maintenance of the entire system. However, experience has shown that payment for water services has not been implemented to a degree where the O & M costs are recovered fully due to practical difficulties and irrigation sector continues to be heavily subsidized by the Government.

In conjunctive use systems, farmers are combining two main sources of water: canal water and groundwater. The treatment for one service cannot be independent of the other one.

A consistent approach of the different sources of services (surface and groundwater) vis-a-vis of cost and quality is fundamental in that regard. The cost for service to farmers should somehow reflect the level of service in terms of reliability and flexibility. But it should be clear that there exists a gap between the full economic cost of service provision and the level of water service charges.

(ii) Improve the internal performance indicators

The key findings of the workshop are reflected in the internal performance indicators from RAP field visits. These are very low in comparison with similar systems in Asia and the world. The urgent need to improve these indicators thereby the level of service delivery in terms of equity, reliability and flexibility has been felt. Focusing on this aspect of service delivery, measures have been initiated in the three projects to improve the performance. Some of the measures included, in case of GLBC;

1. Entire canal system lining is taken up in a phased manner to reduce seepage losses in canals, improve canal operation by reducing response time and reduce tail end shortage.
2. Remote controlled level monitoring systems are installed which provide real time data of canal operation and reduce wastage of water apart from providing better service to farmers.
3. Proposals have been initiated to regularize the actual cropping pattern consisting of high percentage of sugarcane to enable allocation and utilization of adequate water.
4. Steps have been initiated to form more WUAs so that the entire command area is brought under the purview of WUAs for water delivery management. Further, the already formed WUAs are being strengthened financially by creating suitable finance and credit mechanism under Command Area Development Authority (CADA) programme and also by transferring technical know-how in managing canals and distributions.
5. Investigations are taken up for creating buffer storage in Km.102 of main canal to mitigate the shortage.
6. Proposals are initiated to improve and widen the canal service roads along the entire canal system to facilitate smooth communication.
7. Additional data are collected ; climatic data for the past 5 years, mapping the actual cropping pattern, analyzing the capacity of canals & structures, assessing the sensitivity of structures (offtakes and cross regulators), mapping of the drainage network, mapping the demand for operation, groundwater levels and assessment of groundwater extraction.

In case of Bhadra project, canal operations improvements are taken up;

1. Modernization of canal system - CC lining, reconstruction and rehabilitation of structures and construction of measuring devices are taken up and significant progress is made. The works when completed would result in savings in use of water estimated as 184 MCum.
2. The savings in water use would increase water use efficiency and increase productivity.
3. Action is initiated for formation of WUAs and federation of WUAs at project level.

In case of G-B project, canal operation improvements are taken up and are in advanced stage of completion.

1. Head works and structures are rehabilitated. Weirs constructed for water level control in the main canal.
2. Measuring devices (flumes) installed in main canal and secondary canals.
3. Five barrages are taken up for recycling in view of very long canals leading to tail-end shortages. One balancing reservoir in km 10 of right bank canal is constructed.
4. Infrastructure improvements ;
 - Service roads are made motorable.
 - Communication facility provided to key locations.
 - Computers provided for data processing
 - Wireless computer networking provided to all offices for data transmission and sharing.
 - Residential quarters constructed for operators of headworks.
 - Manual Supervisory Control and Data Acquisition (SCADA) is introduced.
 - Existing cross regulators are rehabilitated and mixed cross regulators (with gates and a side weir) are proposed. Mixed Cross Regulators will reduce cost of operation while maintaining water level upstream effectively.
 - Sensitivity of offtakes is brought down by increasing the depth of water in the main canal by construction of weirs.
 - Water balance studies are taken up by collecting reliable data.
 - Operation cost is brought down by 26% by shifting one division office and three sub-division offices to other project area. Finally, there will be a single management agency for two projects (G-B) after completion of the modernization works.

These measures and other proposed measures which are on the anvil aimed at improving the water delivery service will bring about an improvement in the internal performance indicators. It is proposed to conduct RAP again in these projects to assess the impact of modernization programme on these systems.

(iii) Improve the water use efficiency

Improvement in water use efficiency is very critical to effective management. The water balance studies are vital for assessing the water use efficiency. There have been gaps in the assessment of water balance and what is arrived at is the first proxy. It indicates there is potential for saving of water and thereby increase water use efficiency. Thrust will be given to accurately determine the water balance by measurement of all the flows and then use the results to find out where and how the water savings could be effected.

(iv) Capacity building at all levels

It is widely perceived that if technical improvement and management transfer are implemented without adequate capacity building across different management levels involved, the sustainability of the return on the investment (financial and human) is limited. Capacity building is needed in order to provide technical staff and managers with new skills and tools modernization requires. Modernization will assuredly bring about improvements in water delivery efficiencies and water supply reliability. These technical changes lead to beneficial changes in water management service (flexibility, reliability, equity).

KNNL realised that the capacity building of the Engineers is essential to achieve meaningful progress in the modernization of the irrigation systems on par with any other South-East Asian countries. The UN-FAO India Office had come forward to help KNNL in its modernization efforts by extending help of international experts of UN-FAO and as well as to organize a study tour of irrigation systems in Malaysia and Thailand where FAO have considerable work. The study tour was organised for 15 Engineers and 1 representative of WUA during September 2006.

The objective of the study tour was to another capacity building exercise to familiarize KNNL core team as well as key staff of its large irrigation systems which were selected for training, appraisal and preparation of modernization plans, with the implementation of an irrigation modernization training programme and the use of RAP for irrigation systems, as well as to review and analyze the irrigation modernization policies, strategies and programmes implemented by these countries in the region, which have benefited from technical support from FAO.

In addition, the study tour exposed the core team to the on-going experiences relevant to the problems and issues of irrigation projects. Thailand (Royal Irrigation Department – RID) and Malaysia (Department of Irrigation and Drainage – DID) were visited by the study team, as both countries had an on-going irrigation modernization programme, initiated with the support of FAO and based on the FAO training materials, which targeted the training of all staff of large-scale irrigation systems in both countries.

The visit of KNNL Engineers was further followed up with visit of hon'ble Minister for Water Resources, Government of Karnataka (GOK) at the invitation of FAO to the FAO projects in China and Thailand for exchanging our experience with the projects with those countries and also to participate in the MASSCOTE training workshop in Shanxi Province of China for accelerating irrigation development in Karnataka. One of the objectives of the visit of hon'ble minister was to develop KNNL in Karnataka, India as a centre of excellence for irrigation modernization in Asia along with Shanxi Water Resources Development (SWRD), Shanxi, China and DAID, Malaysia in the near future and network them to mutually harness the benefits of newly developed expertise by all the countries. Further, hon'ble Minister for Water Resources, GOK participated in the high level panel discussions on multiple uses of water at the World Water Forum – 5 held at Istanbul, Turkey in March 2009. At this conference, hon'ble Minister presented a paper on multiple use and functions of water service (MUFS). Thus, KNNL has been in the forefront in Irrigation Management issues both at the Engineers' level as well as at policy making level.

Other than KNNL Projects, workshops on irrigation modernization have been held with FAO co-operation wherein KNNL Engineers participated as resource persons and faculty in Hemavathy Project (June 2007) of Cauvery Neeravari Nigam Limited (CNNL), Jaunpur Branch Canal of Sarda Sahayak Project in Uttar Pradesh (December 2007), in Almatti Lifts of KBJNL (May 2008), Lower Ganga canal in UP (Sept 2008), Narayanpur canal system (Feb 2009) of Krishna Bhagya Jala Nigam Limited (KBJNL) and imparting training to Engineers of Central Asian Countries at Tashkent, Uzbekistan (July – Aug 2009).

Capacity building at the level of the farmers through trainings on land and water use, participatory approach in management is taken up by WALMI (Water and Land Management Institute, Dharwad). It is proposed to continue the capacity building exercise at all levels of management with more thrust.

(v) Establishing a centre of excellence in India at KNNL with FAO collaboration

It is proposed to develop KNNL, Karnataka, India as a centre of excellence for irrigation modernization in Asia along with SWRD, Shanxi, China and DAID, Malaysia in the near future and net work them to mutually harness the benefits of newly developed expertise by all the countries.

As a follow-up of the 1st Asia Pacific Water Summit held at Japan during December 2007, the FAO, Regional Office in Bangkok has prepared a proposal for reinventing irrigation governance in Asia which covers irrigation agencies in China, Thailand, Indonesia, Malaysia, India, Pakistan and Vietnam. The proposal aims at improving water governance at the level of irrigation systems and river basins as well as ground water and also capacity building at all levels. For this purpose, FAO have proposed setting up of Centres of Excellence in irrigation in at least three countries. Keeping in view the substantial and rapid progress that FAO have achieved in partnership with KNNL in modernization of irrigation system in the last five years, KNNL has been recognized as the agency for the proposed Centre of Excellence to be established in India.

The establishment of such a centre is in tune with the recommendation of the Planning Commission of India in the 11th Plan for improving the water use efficiency by 20% through improvement in the performance of irrigations systems.

The objectives of the proposed centre of excellence are;

1. To focus on development, assimilation and dissemination of techniques and systems for the efficient use of water for irrigation.
2. Promotion of RAP – MASSCOTE approach developed by the FAO across the country in all the states for improving the irrigation management.
3. Pilot the initiative for better land and water management practices.
4. Assist the policy makers in matters relating to irrigation and water management.
5. Facilitate exchange of knowledge on irrigation systems and management within the state and across the country with special emphasis on imparting knowledge to empower all the stake holders who manage irrigation systems to improve effectiveness, efficiency and productivity .
6. To promote coaching culture in the organizations and to develop internationally certified coaches to unleash the potential of engineers both professionally and personally.
7. Co-ordinate with the Ministry of Water Resources, GOI, Central Water Commission and other state level agencies including NGOs in sustaining improvement in irrigation systems and management as an ongoing process.
8. The proposed Centre of Excellence will focus on enhanced regional co-operation on a number of key issues. Priority areas include:
9. Improving water governance at the level of irrigation systems and river basins, as well a ground water and trans boundary levels;
10. Adopting a multi-sectoral strategic planning and management approach to revision of food security, agriculture, water and environment policies and investment strategies;
11. Adopting demand driven and service oriented irrigation development and management strategies;
12. Modernizing irrigation systems;
13. Enhancing water productivity for both rain-fed and irrigated production;

The Centre will adopt an action oriented approach in its functioning by taking up pilot projects on irrigation modernization and governance on the field and after expected results are confirmed, the projects will be replicated across the country.

1. The centre will engage the services of a group of experts in the fields of engineering design, hydrology, geology as consultants to study and evaluate the construction methods both existing as well as future irrigation structures for improving the quality of construction and maintenance.
1. Facilitate imparting of technical expertise in the field of irrigation management available in different nations to irrigation engineers in the country through workshops, case studies and exchange programmes.
2. Tie up with major institutions involved in water management both within the country and abroad to draw upon and improve the expertise available in the management of irrigation systems viz., canal management, dam maintenance, automation, flood management, security systems etc.,

3. Involve NGOs for effective implementation of participatory irrigation management through Water User Societies by imparting necessary training to the members of the societies in cropping pattern, micro irrigation systems etc., besides making the societies as viable and self sustaining units so that they are in a position to collect and pay the water rates.

(vi) Plan for Modernization, Monitoring and Evaluation

Monitoring and Evaluation of modernization programme is very important to assess the impact made on the water delivery service (reliability, flexibility, equity). Monitoring is systematic collection of information and its use to help managers make decisions on day-to-day operation and management, asset management and plan for medium-term to long term improvements.

Monitoring at key points of the system is proposed which will be selected based on sensitivity of the structure, vulnerable points within the system, service definition and criteria. Evaluation of water delivery service is done to assess the realization of targets and objectives set in the modernization plan. The information collected in M & E is also useful in determining water balance which is a must in good water management.

As a typology of all the systems under implementation by KNNL (30) has emerged to allow each system being referred to some of the key features/aspects identified in the systems where workshops were conducted,

it would be possible to modernize all the systems with the emerging strategy.

CONCLUSION

The MASSCOTE methodology which was in the development stage prior to 2006, was further refined after field testing in the capacity building training workshops conducted in Karnataka irrigation projects and lead to the publication of irrigation and drainage paper 63 titled 'Modernizing irrigation management-the MASSCOTE approach Mapping System and Services for Canal Operation Techniques' by UN-FAO in the year 2007.

As a fallout of the capacity building workshops wherein 260 Engineers of key staff of Water Resources Department of Government of Karnataka were trained in modernization methodology, follow up actions on the recommendations of the workshops were initiated in the projects to evolve modernization plans. The challenging task of carrying out implementation of MASSCOTE findings was taken up by core team of trained engineers. The workshops lead to reengineering of operation and management by refocusing the planned investments on critical items to ensure good service to users.

Few trained Engineers, in turn participated as resource persons in capacity building modernization workshops of UPID Engineers in Sarada Sahayak Project, Upper Ganga Canal System in UP, India and in Tashkent, Uzbekistan aimed at capacity building of Engineers of Central Asian countries.

A significant fallout of capacity building training workshops is the emergence of a strategy for modernizing irrigation management of large irrigation systems in Karnataka.

References

1. **Daniel Renault, Thierry Facon & Robina Wahaj** 2007 "Modernizing irrigation management-the MASSCOTE approach" FAO Irrigation and Drainage Paper 63, Rome
2. **Daniel Renault, Thierry Facon with inputs from J.Burke** 2008 " Mapping the policy issues for modernization of irrigation management-Karnataka Neeravari Nigam Limited"

BRIEF PROFILE OF THE AUTHORS

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