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Thematic Paper

Session 1: Revitalizing Irrigation Performance: Lessons from the Asia Region

I. Introduction

1. The purpose of this paper is to consider the constraints to better performance of irrigation schemes and solutions. The paper will discuss the current situation, challenges and possible ways forward to improve performance.

2. There are a number of drivers for change in how the available water resources are allocated and used—increasing demand for food, and increasing water allocations for manufacturing, thermal electricity generation, and domestic consumption.

3. By 2030, under an average economic growth scenario and if no efficiency gains are assumed, global water requirements would grow from 4,500 billion cubic meters today to 6,900 billion cubic meters. This is 40% above current accessible, reliable supply. Estimates for the same period for Asia predict a 5% increase in agriculture use, 30% increase in domestic use and a 65% increase in industrial water use.[1]

4. With the irrigation subsector comprising about 80% of the demand for freshwater in Asia, there is a need to produce more food from the water currently available to the irrigation sector. There is also pressure to release water for other uses. Under these conditions, there is a pressing need to modernize the subsector to meet both current and future challenges.

II. What is Modernization?

5. Modernization is the process of upgrading infrastructure, operations and management of irrigation schemes to sustain the water delivery service requirements of farmers, and optimize production and water productivity.[2]This can be further defined in detail as:

> "***Process***" means that modernization of schemes is a continuous exercise. This must account for future changes in the irrigation system and service requirements of the farmers. Ideally the process will align with existing government development and budgetary timeframes and schemes;
>
> "***Upgrading***" means improving beyond what exists; not replacing or rehabilitating. It means applying design best practices to infrastructure to optimize operation requirements and maximize system performance and efficiencies;
>
> "***Infrastructure***" means all physical assets related to the irrigation system including headworks, conveyance schemes, drainage schemes, monitoring schemes, communication schemes, farm and access road networks, operation buildings, etc.;
>
> "***Operations and management***" means all human resources and management processes responsible for managing, operating and maintaining the irrigation system including ground and surface water management, and the associated physical infrastructure;

[1]Charting Our Water Future. 2030, Water Resources Group, 2009.
[2] Innovations for More Food with Less Water – Task 1 Final Report, International Water Management Institute, Colombo, 2015.

ADB
The Australian Water Partnership
Water partners for development
FAO FIAT PANIS
IWMI International Water Management Institute

"***Irrigation system***" encapsulates all physical and non-physical components that contribute to convert water and nutrients into food and fiber. This includes the infrastructure, water resources, agency staff, farmers, service providers, supply and market chains, etc.;

"***Sustain***" means that the irrigation system will continue to operate at its optimal performance. This includes managing the water resources to account for reallocations to other users, prevent adverse depletion, and enhance resilience to climate variability and adverse impacts anticipated from climate change. It also means ensuring that all costs relating to management, operation, maintenance, and asset depreciation of the system are affordable and are fully covered through either government, user (farmer), or private sector financing;

"***Water delivery service requirements of the farmers***" means ensuring reliable, adequate and flexible supply of water as agreed with farmers allowing them to maximize water and agricultural productivity. This requires farmers to be involved in planning, design and operation of the irrigation system, and in routine water management decisions;

"***To optimize production and water productivity***" means farmers must endeavor, and be supported through technology transfer and extension services, to optimize the productivity of their land with the available water.

6. Modernization is a continuous process, covering all aspects of the irrigation system. It is not limited to the modernization of only the physical infrastructure but also extends to how schemes are managed and agricultural processes undertaken. Overall it seeks to improve performance, in particular the productivity of water, with resultant benefits to the stakeholders involved.

III. Current Situation

a. What is Performance

7. The performance of an irrigation system may have differing perspectives to various stakeholders (Table 1). When modernizing irrigation schemes it is necessary to adopt an integrated approach and consider these different perspectives, particularly those of the main stakeholders, the farmers.

Table 1. Perspectives on irrigation performance

Stakeholder	Measures of Performance
Government	• Food security • Poverty alleviation • Farmer incomes and livelihoods • Drought and famine relief
Irrigation System Manager	• Volume of water diverted at source to water delivered at outlet • Timing and quantity of water delivered • Condition of infrastructure • Cost of delivery (financial and other resources) • Fee recovery from water users
Farmer	• Agricultural production (for subsistence or cash) • Livelihood • Market opportunities • Sustainability and security of farming system

There are a number of definitions of performance; a broad definition is *"the performance of a system is represented by its measured levels of achievement in terms of one, or several, parameters which are chosen as indicators of the system's goals".*[3]

8. In this context it is important to identify the objectives of any modernization plan and to define the performance indicators that will be used to monitor progress of the plan. In seeking to improve the performance of an irrigation system it is important to look at the issues holistically and consider all factors which might influence performance. These range from the policy framework for the irrigation sub-sector to how a farmer applies water in the field, and to how the farmer markets his produce.

9. The core processes are the capture, diversion, conveyance, distribution, application and removal of water to and from the crop root zone. These are controlled at different levels in an irrigation system by physical infrastructure and components (headworks, boreholes/tubewells, main canal, secondary canals, tertiary canals, field plots, field drains, main drains, control and measurement structures) and by people (system manager, field staff, water users associations (WUAs), farmers, extension agents, traders, etc.). There are different inputs and outputs at each stage of the core processes, to which indicators can be assigned to measure performance at each level and overall.

IV. Assessing Performance

10. Performance indicators can be identified for each part of the process in order to assess the performance overall and at each level.[4,5,6] Output indicators are used to measure output performance (crop yield, crop production, farm income) but as inputs (water, land, labor, finance, energy, etc.) become constrained, the performance assessment broadens to look at how well the inputs are utilized. This is by considering efficiency and productivity of production. The productivity of water measured in weight or monetary value of agricultural produce per cubic meter of water becomes of increasing relevance, particularly within the context of competing demands for water.

11. Governments and international financing agencies are also interested in the outcomes derived from irrigation (livelihoods supported, poverty reduction, drought relief, etc.). The intermediate process indicators (e.g. conveyance efficiency, distribution efficiency) are used to assess the performance of different aspects of the process and form an important part of diagnostic studies to assess performance improvement.

12. A relatively well used approach to analyzing system performance is mapping system and services for canal operation techniques (MASSCOTE) developed by the Food and Agriculture Organization.[7]This integrates tools including rapid appraisal process (RAP) and benchmarking to provide a detailed assessment of issues influencing the management, operation and maintenance of irrigation and drainage (I&D) schemes. The process looks at the service to users, the cost of providing these services, system performance, constraints on the water resources and constraints of the physical system.

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[3]Abernethy, C.L. 1989. Performance Criteria for Irrigation Schemes. In: Irrigation Theory and Practice, International conference held at the Institute of Irrigation Studies, University of Southampton, UK.

[4]Small, L.E. and M. Svendsen. 1990. A Framework for assessing irrigation performance. Irrigation and Drainage Schemes, Kluwer, Vol.4, No.4, pp 283 - 312. Revised edition as: Working Paper on Irrigation Performance 1. Washington, D.C.: International Food Policy Research Institute.

[5] Bos, M.G., Burton, M.A. and Molden, D.J. 2005. Irrigation and drainage performance assessment: Practical guidelines. CABI Publishing, Wallingford, U.K.

[6]FAO. 1999. Modern water control and management practices in irrigation: Impact on performance, by C.M. Burt and S.W. Styles. FAO Water Report No.19, Food and Agriculture Organization, Rome, 224 pp.

[7]FAO. 2007. Modernizing irrigation management – the MASSCOTE approach. Daniel Renault, Thierry Facon and Robina Wahaj. FAO Irrigation and Drainage Paper No.63, Food and Agriculture Organization, Rome, 207 pp

13. The process makes use of RAP for assessing the opportunities impacts of modernization of irrigation schemes. This identifies the constraints and factors influencing service quality. It also assesses the level of service provided and results achieved.

14. A political, economic, social, technical, legal and environmental (PESTLE) analysis can be used to look at the broader external issues affecting the performance of the organization. The example given in Table 2 shows the range of challenges typically faced by an irrigation organization aside from the more commonly discussed technical issues.

Table 2. Factors influencing irrigation system performance

Political	• Interference from politicians • Lack of political support for proper funding of I&D sector • Lack of political will to drive performance of I&D schemes
Economic	• Lack of sufficient funds for maintenance • Under-performance of the scheme • Lack of income to farmers • Distorted market pricing • Poor service fee recovery
Social	• Poor communication between water users and I&D agency • Top-tail differences in water supply • Unauthorised abstractions • Conflict over water use
Technical	• Lack of sufficient control and measurement structures • Poor condition of physical infrastructure due to lack of maintenance • Poor service delivery • Lack of expectation placed on I&D agency to improve performance • Lack of knowledge, skills and understanding for modern system management, operation and maintenance • Outdated focus on construction rather than management of I&D schemes
Legal	• Insufficient legal framework for WUAs • Outdated legal framework for I&D
Environment	• Competition from other users for water • Reducing water availability • Climate change • Degradation of irrigated soils • Increasing issues with pollution of water

V. Opportunities

15. Opportunities for enhancing scheme performance lie in the following areas:

- Adopting transparent management by government irrigation and water resources agencies;
- I&D agencies working in partnership with WUAs;
- Strengthening WUAs with greater liaison with irrigation, water resources and agriculture agencies, and support for training in water management;
- Adopting business management practices, including strategic planning, definition of scheme objectives, target setting, performance management, performance monitoring and evaluation, rewarding good performance;
- Modernizing data collection, processing, analysis and reporting procedures through development and use of modern communications and information technology (such as remote sensing, geographic and management information schemes, use of computers and mobile phones, etc.);
- Developing and adopting procedures for performance benchmarking schemes;

- Developing and adopting procedures for asset management planning, with identification of levels of maintenance funding required to provide the level of service needed by the water users;
- Discarding the perception of farmers as beneficiaries and adopting and building a service delivery ethos focusing on meeting the needs of the farmers as clients;

VI. Way Forward

16. Because of the gap between current and potential performance, there are significant opportunities for improving the performance on many irrigation schemes. One difficulty is that there is no "one size fits all" solution; each system has a unique set of characteristics, be it in relation to the climate, soil, topography, water availability, irrigation agency organization, farmer capabilities and ambitions, etc. To address this situation, an assessment is required of each scheme either by the scheme management itself, or by a separate specialist team. Several approaches have been proposed for this external assessment in a recent ADB-funded study looking at the modernization of medium and major irrigation schemes in Bangladesh, India and Nepal.[8]

17. This tested a sequence of studies for planning the modernization of schemes (see Figure 1).[9]A key element of the approach was the use of modern systems for data collection, processing and analysis, including remote sensing and geographic information systems (GIS). Preliminary GIS maps were developed which will be further developed during the implementation stage of the project. The application of state-of-the-art remote sensing was trialed in the four schemes with the aim of piloting cost-effective mechanisms for spatial assessment of agricultural production and irrigation performance, including determination of the productivity of water.

18. Extensive stakeholder consultations were held with farmers, WUA management and members, staff from line departments, and other civil society and selected private sector organizations. These consultations enabled many of the issues and constraints relating to the management, operation and maintenance of the schemes to be identified and assessed.

19. The approach makes use of performance benchmarking to assess the current levels of performance using a standard set of external and internal performance indicators.[10] The benchmarking serve the purpose of providing: (i) a baseline of relevant information for comparison against future performance after modernization; (ii) benchmarking for comparison against other similar schemes; and (iii) a basis for making scheme-specific recommendations for modernization and improvement of water delivery service, irrigation efficiencies, productivity of water. In the study, the key internal indicators covering operations and service provision were found to be low, as were external indicators of cost recovery and productivity. Through these indicators the benchmarking identified the core areas to be addressed by the modernization plans. Recommendations can include upgrading aging infrastructure, insufficient funds for regular maintenance, institutional weaknesses and management limitations.

[8]ADB. 2015. Planning for irrigation modernization. Technical Assistance Consultant's Report prepared by Lahmeyer International in association with BETS Consulting Services, Centre for Environment and Development and Total Management Services. Regional Technical Assistance TA7967-REG: Innovations for More Food with Less Water (MFLW), Asian Development Bank, Manila, April.
[9] Technical Assistance 7967: Innovations for More Food with Less Water. ADB, 2011.
[10] Malano, H., Burton, M. and Makin, I. 2004. Benchmarking Performance in the Irrigation and Drainage Sector: A tool for change. In: Special Issue: Benchmarking in the Irrigation and Drainage Sector. Irrigation and Drainage 53 (2). New York: Wiley, June.

Figure 1. Sequence of analyses for modernization planning

Main Assessments	Supporting Analyses	
Data collection	Data, GIS and Remote Sensing (D)	Stakeholder Participation (SP)
Benchmarking	(D1) Benchmarking Data	(SP1) Focus Group Discussions
Agriculture Planning Institutional Studies Irrigation Management Strategies	(D2) Hydrology, Hydrogeology, Crop Budgets, Energy, GIS, Remote Sensing	(SP2) Sample Area Profiles, Participatory Rural Appraisals
Plans for Modernization and Reforms	(D3) Cost and Benefit Estimates	(SP3) Workshops

20. In the assessment, modernization of the agricultural components is also considered essential. FAO estimates that 80% of the projected growth in food production in developing countries will come from intensification in the form of yield increase (71%) and higher cropping intensities (8%).[11]The analysis of the agricultural aspects centers on three stages: (i) estimation of current production levels and yields based on government crop statistics (area, yields and production costs); (ii) analysis of production constraints; and (iii) preparation of plans for modernization including changing crop types and varieties, improving yields based on adaptive research, assessment of agricultural support and preparation of upgraded crop and farm budgets. Sufficient funds should be allocated to measures to modernize agriculture, with 8-10% of the total budget allocated to these activities. More innovative initiatives are required to support the (often weak and under-resourced) government agricultural extension services, with public-private partnerships being encouraged with commercial agricultural companies, non-governmental organizations and farmer-led producer groups.

21. A broad range of initiatives is required, such as: (i) improving post-harvest support and marketing schemes; (ii) improved and timely supply of inputs at fair prices; and (iii) more extensive and higher quality extension advice. Specific innovations include: (i) soil testing to assess fertilizer requirements and soil moisture; (ii) system of rice intensification, alternate wetting and drying, and direct seeding for rice to increase yields and reduce water requirements; (iii) precision land levelling; (iv) marketing support, including access to market data (such as through text message); (v) development of appropriate farm mechanization technologies and equipment; (vi) establishment of farmer producer enterprises (e.g. seeds, organic fertilizers); (vii) improved crop planning and irrigation scheduling to better suit water availabilities and allocations; (viii) diversification to more appropriate and improved return crops, including reduction of paddy rice grown in water scarce situations; and (ix) specialist agricultural support including transition support to micro irrigation, when appropriate.

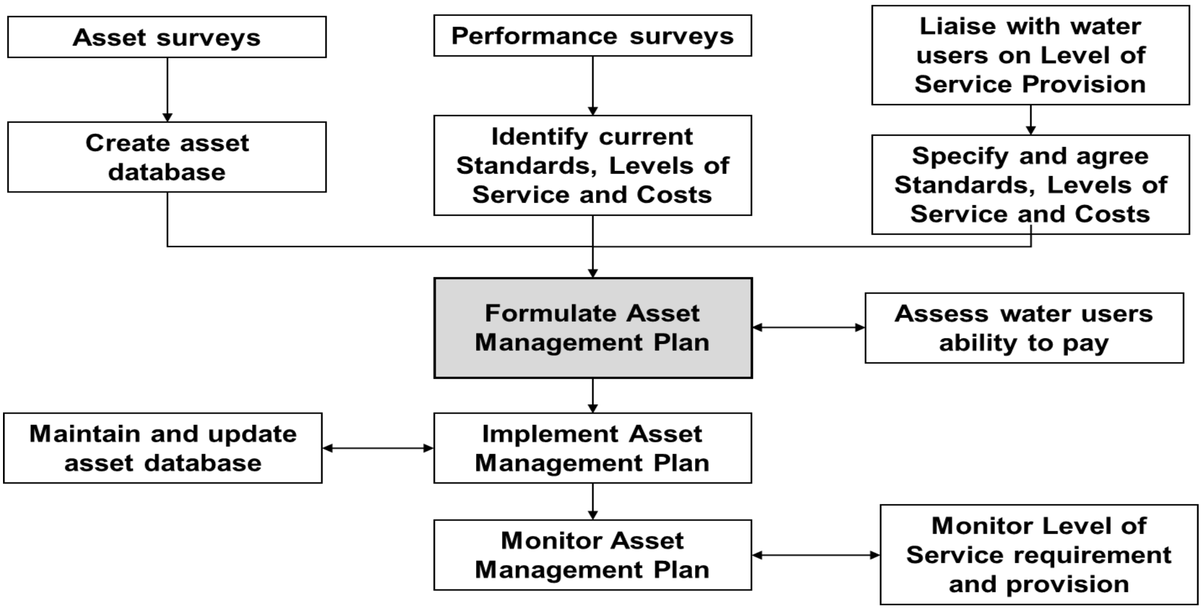
22. Institutional and management issues need to be addressed if the irrigation sector is to be modernized. These include: (i) broaden the current remit of irrigation managers to focus on overall scheme performance and conjunctive management of surface and groundwater resources (including action to minimize energy usage for pumping); (ii) the

[11]FAO. 2009. The Resource Outlook to 2050: By How Much do Land, Water and Crop Yields need to Increase by 2050. Expert Meeting on How to Feed the World in 2050. Food and Agriculture Organization of the UN. June 24-26, 2009.

introduction of modern irrigation technologies including decision support systems, micro irrigation (where appropriate), and pre-paid metering (on tubewell schemes); (iii) modernization of working practices and work force in irrigation departments; (iv) outsourcing relevant management and operations functions to the private sector; (v) review and upgrade policies and legal and institutional frameworks for WUAs, including changes within the irrigation departments; (vi) encourage commercial agricultural support systems; (vii) asset management planning to identify short, medium and long-term funding and investment required for productive and sustainable I&D schemes (viii) establishing financial sustainability through viable mechanisms of cost recovery.

23. Costs and benefits of irrigation schemes need to be far better understood than at present. Physical infrastructure is the major asset and main cost component associated with irrigation, asset management planning (Figure 2). It has a valuable role to play in providing a structured approach to establishing the true costs of operating and sustaining I&D schemes. It combines surveys of the condition and performance of the physical assets, with assessment of the scheme overall. In consultation with water users, the levels of service required and willingness and ability to pay service fees can be established.[12] The plan can be prepared for any timeframe, usually 20-30 years, broken down into shorter term (5 year) implementation plans.

Figure 2. Framework for asset management planning and strategic investment planning for I&D schemes



24. ADB studies have found that (for sample schemes) the average annual management, operation and maintenance costs was $50/ha with an average contribution from farmers of only US$2/ha.[9] The costs of the on-farm systems managed by the water users were around US$60/ha. The study concluded that an increase of 70% in the funding levels from US$50/ha/annum to US$85/ha/annum, with an increased contribution from water users of around US$30/ha/annum, is needed to ensure sustainable operation of a modernized irrigation system. To improve the link between service delivery and fee recovery, the study proposed semi-volumetric charging, with irrigation allocations measured at the heads of secondary canals with users below this level sharing the costs based on estimates

[12] This can be assessed through crop and farm budget analyses.

of volumes used calculated from the crop type, estimated irrigation water requirements and crop area.

25. For more transparent and accountable irrigation service delivery, the study proposed a series of operation procedures. These include flow measurement and data collection, with real-time information about flows and water levels at key points being collected by decision support and supervisory control and data acquisition systems. Linked to these would be modernized approaches to planning irrigation water demand, water allocations and irrigation scheduling.

26. Measures are also proposed for improved groundwater management. This included its integration into planning surface water supplies (conjunctive management). A plan was also prepared to optimize the use of surface and ground water resources and reduce the year-on-year drawdown of groundwater resources. Of the interventions assessed, the following are considered to have particular potential:

Policy/Institutional interventions

- Revision of policy on recurrent funding budget for I&D schemes based on asset management plans with a commitment to adequately fund I&D system maintenance, repair and capital replacement needs.
- Revise charters for irrigation agencies to create modern organizations with multidisciplinary staff focused on outputs and outcomes, service delivery, customer satisfaction and performance management. To facilitate the required change in organisational culture, use should be made of the significant experience in the business sector with change management (e.g. Kotter[13], Carnall[14]).
- Enhance support for participatory irrigation management (PIM) and irrigation management transfer (IMT).

Management interventions

- Adoption of modern organizational management practices of target setting, staff motivation, performance monitoring, performance evaluation and rewarding staff (Appendix A).
- Adoption of information technology-enabled systems including web-based management, assessment of crop areas and irrigation needs using remote sensing, use of mobile phone messaging for data collection and transmission, GIS for data processing, analysis and presentation.
- Cultural change in organizational approach from top-down to working in partnership with water users with a focus on service delivery and customer satisfaction.
- Adoption of asset management planning to identify maintenance, repair, and replacement funding to ensure I&D schemes can provide the level of service required for optimized water productivity in agriculture.

Technical interventions

- Rehabilitation, upgrading and/or modernization of physical infrastructure to include automated systems, construction of on-farm works, storage reservoirs, etc.

[13] Kotter, John P. 1995. Leading change: Why transformation efforts fail. Harvard Business Review, March-April.
[14] Carnall, Colin A 1999. Managing change in organizations. Third Edition. FT /Prentice Hall, Harlow, UK.

- Land levelling to improve application uniformity and efficiency.
- Use of sprinkler and micro-irrigation (drip, trickle).
- Farmer education and training in improved agricultural and water management techniques.

Financial interventions

- Thorough asset management planning, proper quantification of actual costs for management, operation and maintenance of I&D schemes, followed by adequate annual MOM budgets.
- Assessment of the financial benefits accruing to water users from the services provided and comparison with the costs for management, operation and maintenance.
- Setting of affordable irrigation service fees for farmers and quantification of subsidies (if required) to ensure full funding for MOM. A matter of governance with sufficient political will to allow farmers to pay. How to address this is a major key to unlocking the perpetual problem cycle of infrastructure decay and rebuild.
- Linking service fee payment to service delivery and greater involvement of water users in identification and execution of maintenance needs.

VII. Conclusions

27. There is a wide range of factors influencing performance. Central to improving performance is the acceptance that it is not simply about technical interventions — a holistic view and set of technical interventions in the context of the political, institutional, social and economic environment.

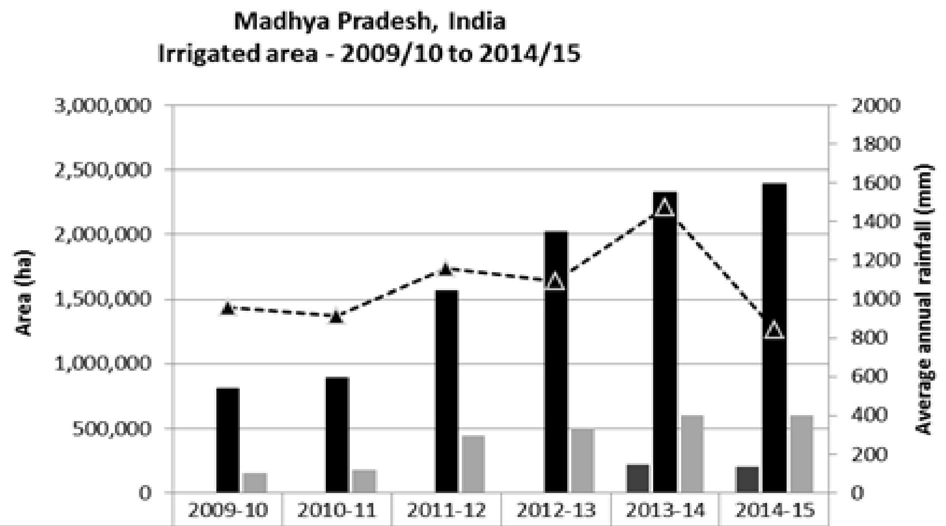
28. Significant opportunities exist for improving irrigation performance through better management. These include the adoption of business management approaches for managing irrigation and techniques developed in the business sector for problem analysis and change management. Each irrigation scheme requires a comprehensive assessment to find solutions for improving performance. In this context rapid performance assessment and benchmarking are important tools which require mainstreaming in irrigation projects.

29. Preparation of asset management plans for individual I&D schemes is essential. This will determine the actual costs of operating the system and the service fee levels to be charged. Part of the process is to determine the benefits arising from each system, and the willingness and ability of water users to pay for the levels of service they require. Where water users' financial margins are tight, the process allows quantification of subsidies that government or others might need to provide over and above the contribution from water users.

30. Champions are essential. This includes political will and commitment from senior irrigation agency management for proposed interventions. Piecemeal interventions are unsuccessful and cannot address the scale of the problem. Simplifying messages to reach highest level remains an area of failure. The irrigation sub-sector is weak in presenting its constraints and opportunities simplistically. Messages remain embedded in technical complexities – media and communications support is vital to reach decision makers.

Appendix A: Adoption of Modern Management Practices in Madhya Pradesh, India

The irrigated area in Madhya Pradesh has increased 3-fold since 2010-11 due largely to dynamic leadership and the adoption of modern management methods. In 2009-10 and 2010-11 the rabi (dry season) irrigated areas were 803, 488 ha and 890,226 ha respectively, by 2013-14 and 2014-5 the area had increased to 2.33 million ha and 2.39 million ha respectively (see figure below). Though there was higher rainfall during the 2011-2013 monsoons the very low rainfall in 2014 contributing to stored water for the 2014-15 rabi season demonstrated that the increase in cropped area was not due to higher rainfall alone but rather to modernized management interventions.



	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
MP Kharif	-	-	-	-	216,006	200,514
MP Rabi	803,488	890,226	1,559,617	2,020,661	2,330,436	2,392,032
MPWRSP Rabi	150,329	177,225	444,701	501,607	599,759	596,750
Average annual rainfall (mm)	960	916	1160	1092	1472	845

MP Kharif MP Rabi MPWRSP Rabi Average annual rainfall (mm)

In 2010-11 modernized management procedures were adopted by the WRD. These measures included:

- Gate keepers sending daily reservoir water level gauge readings by SMS to the central web-based MIS where the depth readings are converted into stored volume based on reservoir specific depth-volume curves;
- Based on these readings the senior management set reservoir-specific irrigated crop area targets for the coming rabi season at the end of the monsoon (mid-September). These figures are based on a rule of thumb figure of 1 million cubic meters being sufficient to irrigate 200 ha;
- Prior to the rabi irrigation season the District office staff inspect all schemes and report back on repairs required and costs to ensure the system can function in the coming season. Senior management delegate authority for Executive Engineers (EEs) to execute the work they determine is required to achieve the required performance targets;
- Weekly data entry by EEs of cumulative area irrigated on the MIS;
- Weekly video conference with EEs and basin office Chief Engineers and the Superintending Engineers chaired by the Principal Secretary and Engineer-in-Chief to monitor and discuss the ongoing situation during the irrigation season.

At the end of the season the actual irrigated area is compared with the target area and deviations from the target values discussed during the video conference. Staffs with well-performing schemes are rewarded with cash payments, and certificates recognizing their contribution. Schemes where targets have not been met are discussed and causes identified, and where possible action taken to remedy identified causes.