Analytical Framework for Irrigation Modernization India

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Water Sector Group Learning Session

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National Water Use Efficiency Improvement Support Program - Scoping Study

- NWUEISP study completed in August 2014 to support the implementation of the NWM and the 12th FYP
- NWUEISP study takes stock of water use efficiency issues in MMI in India and proposes a framework for assessing MMI performance, identify main weaknesses leading to low efficiency and propose modernization plan.
- RDTA – 7967 pilot tested the NWUEISP framework on 2 MMI in India – Dharoi in Gujarat and Sanjay Sarovar in Madhya Pradesh. Completed in June 2015

Rationale

Rationale : India Water Accounting

- MOWR estimates total utilizable water resources of 1,123 BCM with a current water demand of 710 BCM rising to 1,093 BCM by 2030 (54% increase in the next 15-20 years).

- Less optimistic estimates predict that with the current pattern of demand about half the demand will not be met by 2030 (2030 WRG, 2009)

Level of Water Scarcity

	No[a].	River basin	Total renewable water resource (TRWR)	Potentially utilizable water resource (PUWR)[b]				Water resources available per capita	
				Surface water	Ground water[c]	Total	Percentage from groundwater	TRWR	PUWR
			km^3	km^3	km^3	km^3	%	m^3	m^3
		All basins	1,887	690	343	1,033	33%	2,025	1,108
		17 basins[d]	1,253	666	308	975	32%	1,411	1,098
Westerly flowing rivers	1	Indus	73.3	46	14.3	60.3	24%	1,501	1,235
	2	Mahi	11	3.1	3.5	6.6	53%	1,649	990
	3	Narmada	45.6	35	9.4	43.9	21%	2,542	2,448
	4	Sabarmati	3.8	1.9	2.9	4.8	60%	631	797
	5	Tapi	14.9	14.5	6.7	21.2	32%	831	1,183
	6	WFR1	15.1	15	9.1	24.1	38%	257	409
	7	WFR2	200.9	36.2	15.6	51.8	30%	3,871	998
Easterly flowing rivers	8	Brahmani and Baitarni	28.5	18.3	3.4	21.7	16%	1,703	1,296
	9	Cauvery	21.4	19	8.8	27.8	32%	656	852
	10	EFR1	22.5	13.1	12.8	25.9	49%	1,169	1,346
	11	EFR2	16.5	16.7	12.7	29.4	43%	423	753
	12	Ganga	525	250	136.5	386.5	35%	1,418	1,044
	13	Godavari	110.5	76	33.5	109.8	31%	1,441	1,431
	14	Krishna	78.1	58	19.9	77.9	26%	1,133	1,130
	15	Mahanadi	66.9	50	13.6	63.6	21%	2,463	2,341
	16	Pennar	6.3	6.3	4.0	10.9	37%	440	762
	17	Subarnarekha	12.4	6.8	1.7	8.5	20%	829	568
	18	Bramhaputra	585.6	24.3	25.7	48	54%	17,661	1,448
	19	Meghna	48.4	1.7	8.5	10.2	83%	4,830	1,018

Notes:

a. Refer to map given in Figure 5.
b. Source: CWC (2002).
c. The volume of potentially utilizable groundwater resources is the volume of groundwater replenished from normal natural discharge
d. All the basins except the Brahmaputra and Meghna.

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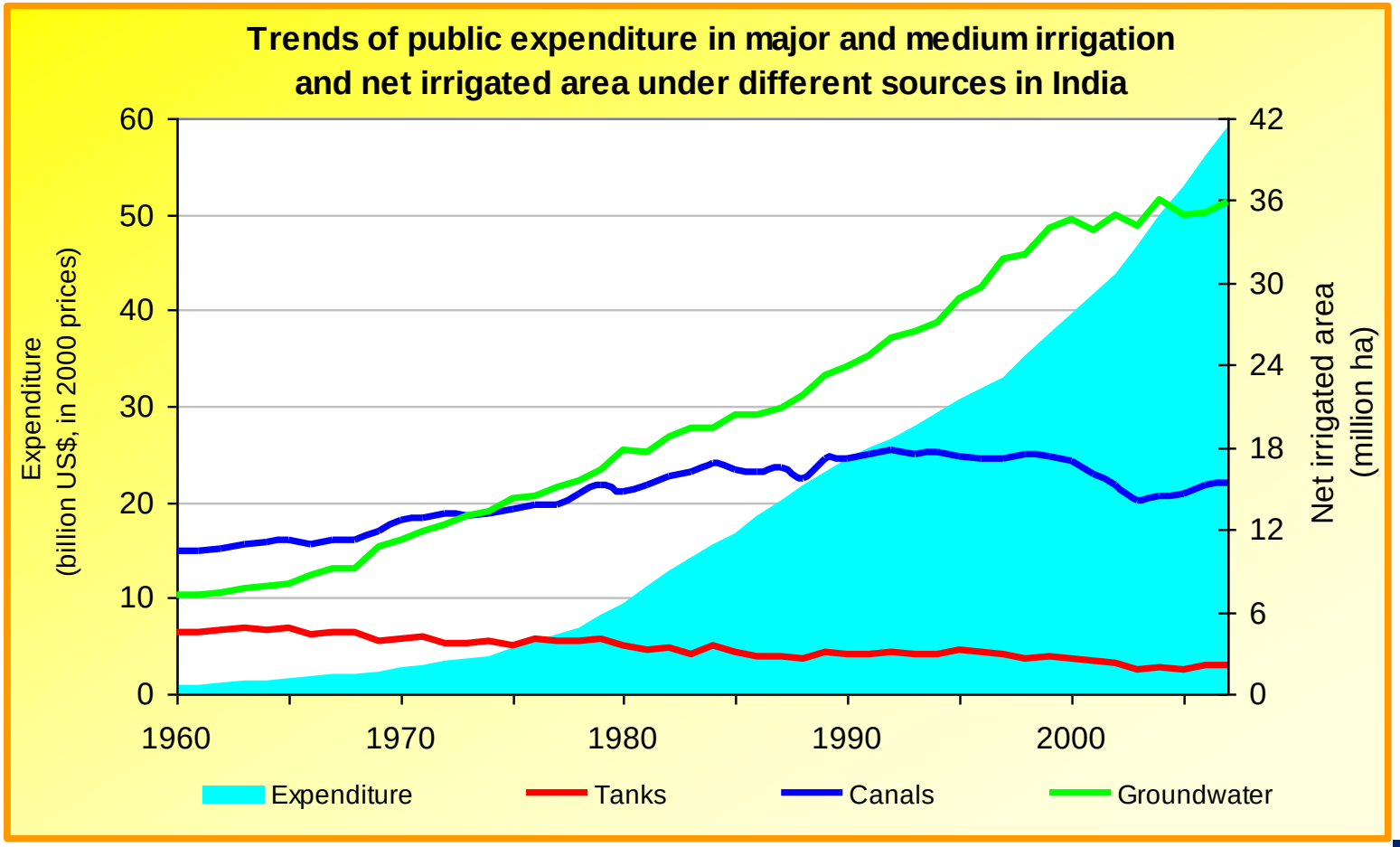
Improving Water Use Efficiency

- Agriculture estimated 80% all water withdrawal
- Irrigation Water Use Efficiency estimated at 38% (very low).
- Water Productivity?
- Major and Medium Irrigation schemes represent 80% of Government created irrigated potential.
- Focus on MMI. What to do?

Public Irrigation Investments

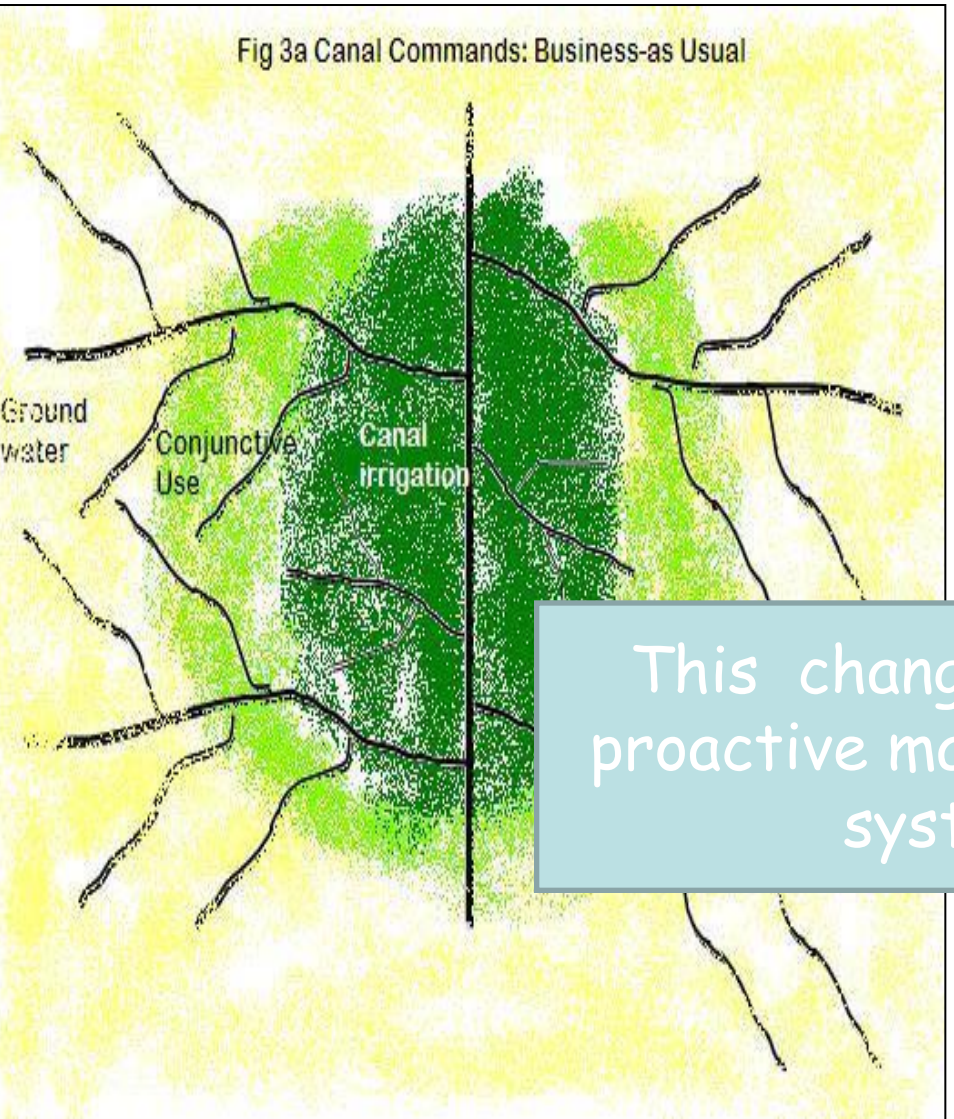


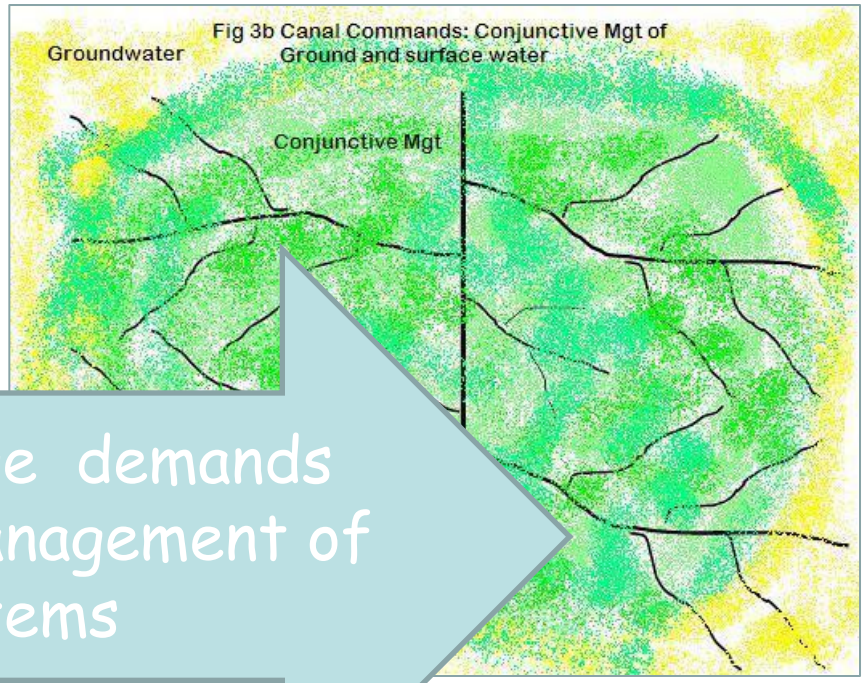
Need for a Paradigm Shift

- *IDs should: "move away from a narrow engineering-construction-centric approach to a more multi-disciplinary, participatory management approach for MMI schemes, with a focus on command area development and a sustained effort at improving water use efficiency"* (para. 5.5,12th FYP)

Key Findings and Recommendations

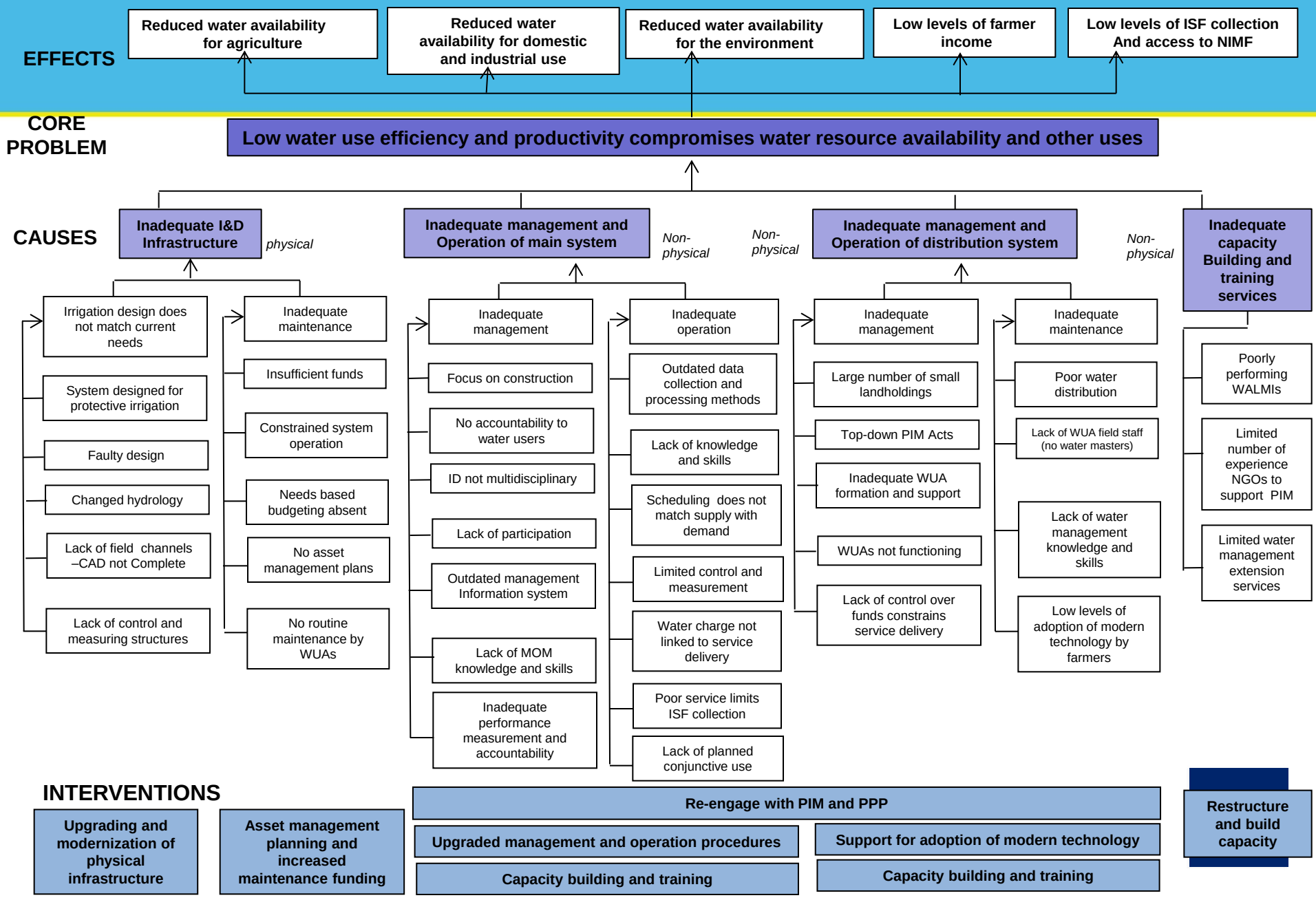
Public Irrigation Systems: Desired Future?



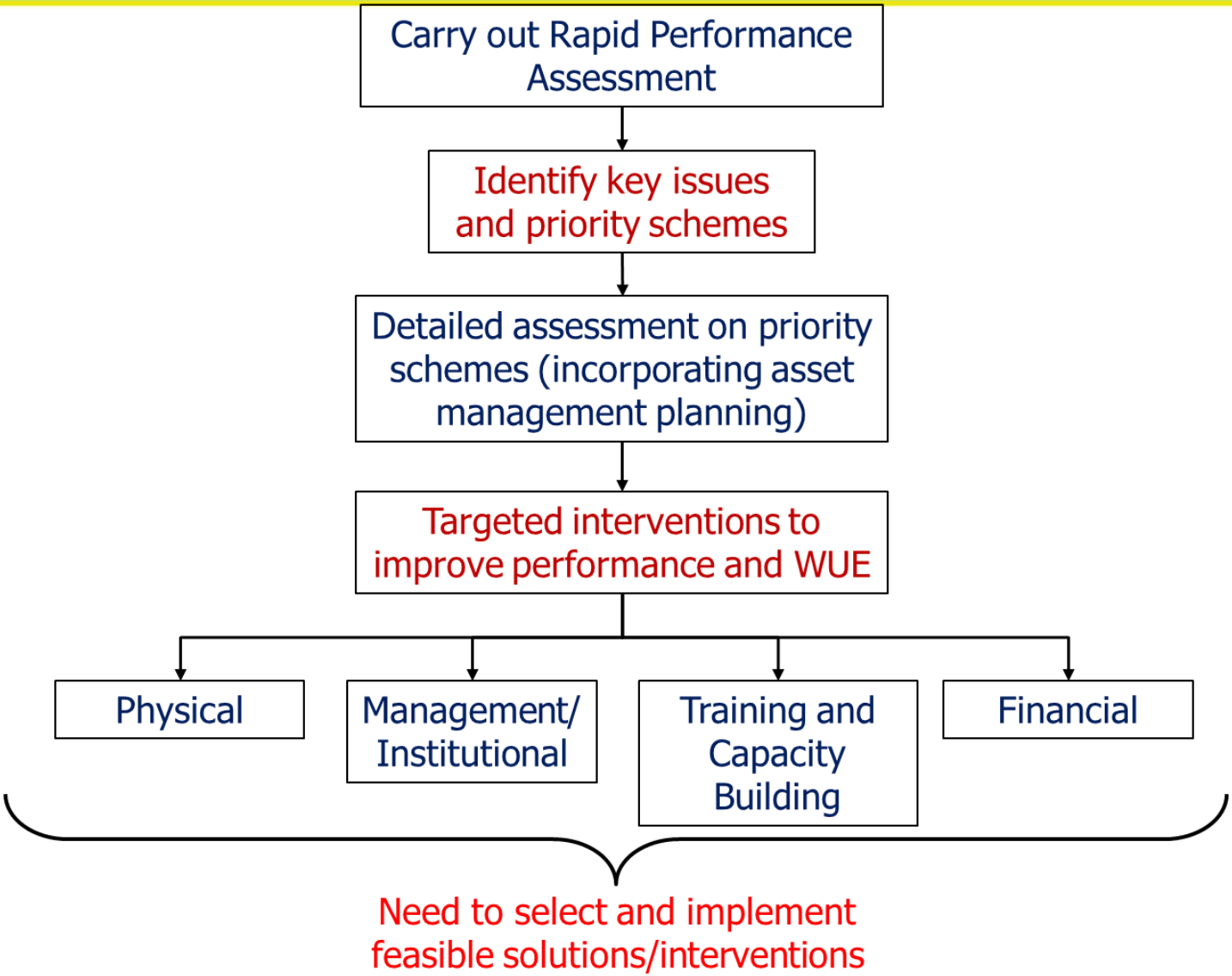


This change demands proactive management of systems

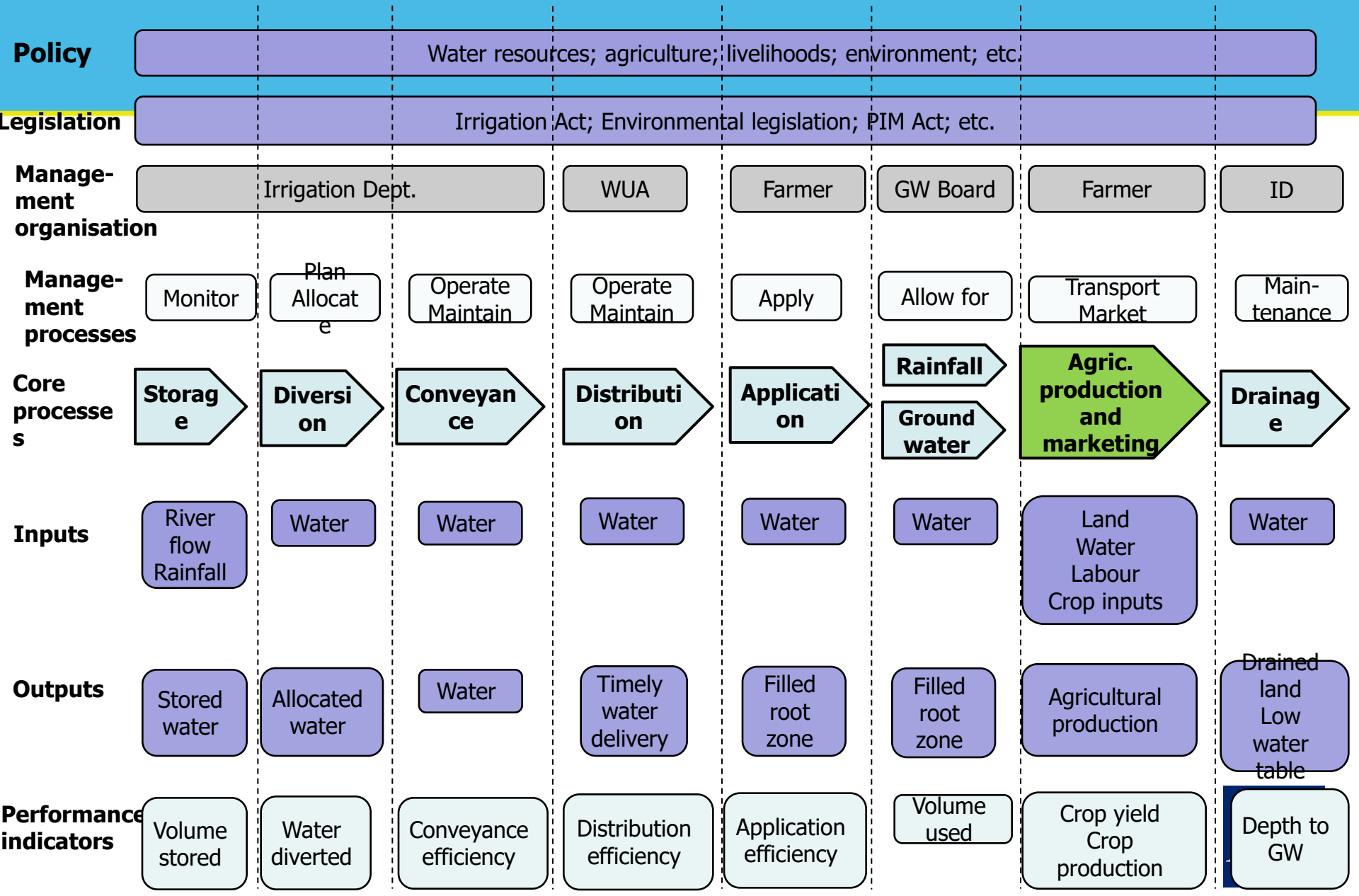
Identified Problem Tree



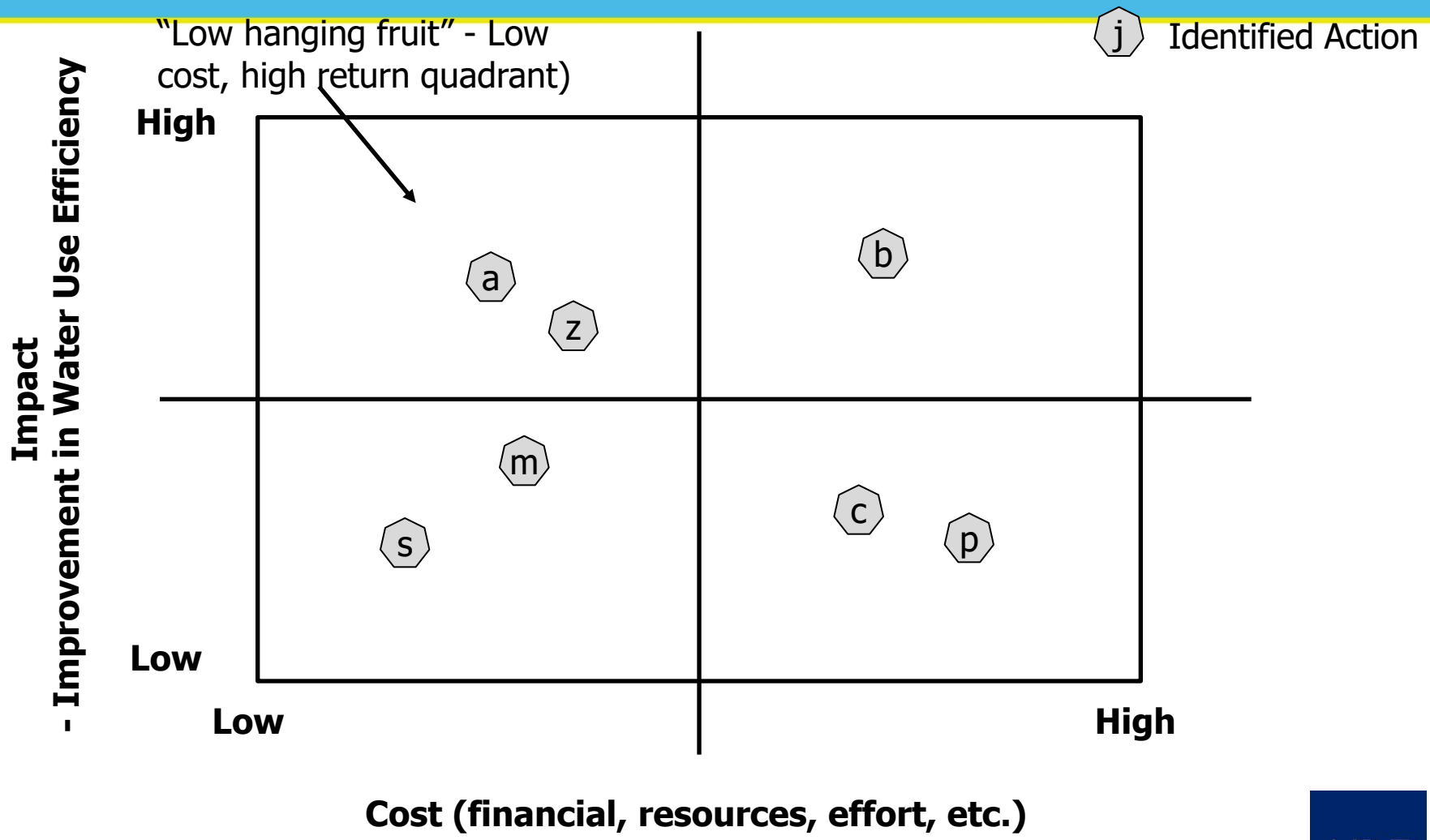
Approach for a Solution



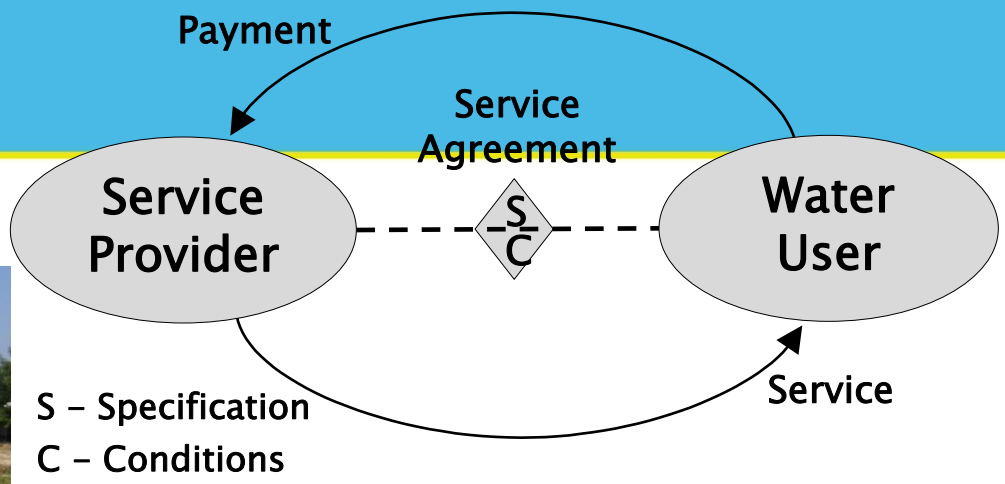
Identify core processes in MMI schemes



Identifying cost-effective measures for improving WUE



Central Concept - Improving service delivery



Central concept – Improving service delivery

Service delivery encompasses the following:

- ID staff or third party (PPP) are responsible for service delivery and scheme performance
- Focus on productive irrigated agriculture
- Improved scheduling to match supply and demand
- Linking service delivery to fee collection
- Using modern technology – Remote sensing for crop area and ET; GIS: MIS; SMS linked to web pages, etc.
- Improved control and measurement (linked to scheduling)
- Adequate maintenance budget (linked to service delivery)
- Partnership with water users (through WUAs)
- Plan and manage for conjunctive use
- Supported by effective education and training

Analytical Tools Developed for Rapid Appraisal and Planning - 1

Benchmarking	Benchmarking based on FAO RAP approach
Focus Group Discussions (FGDs)	Quick non-quantitative assessment of current farming systems, constraints and indicative responses to possible initiatives
Participatory Rural Approach (PRA)	More detailed structured and detailed surveys including some quantitative assessment of constraints, issues and responses to possible initiatives
Sample area profiling	Semi-detailed studies in a sample areas including infrastructure, agriculture and social and institution as in conjunction with FGDs
Medium and detailed level remote sensing	Quick analysis of land-use from freely available medium resolution imageries over 5 schemes Pilot analysis over a selected area using high detail analysis to assess crop productivity

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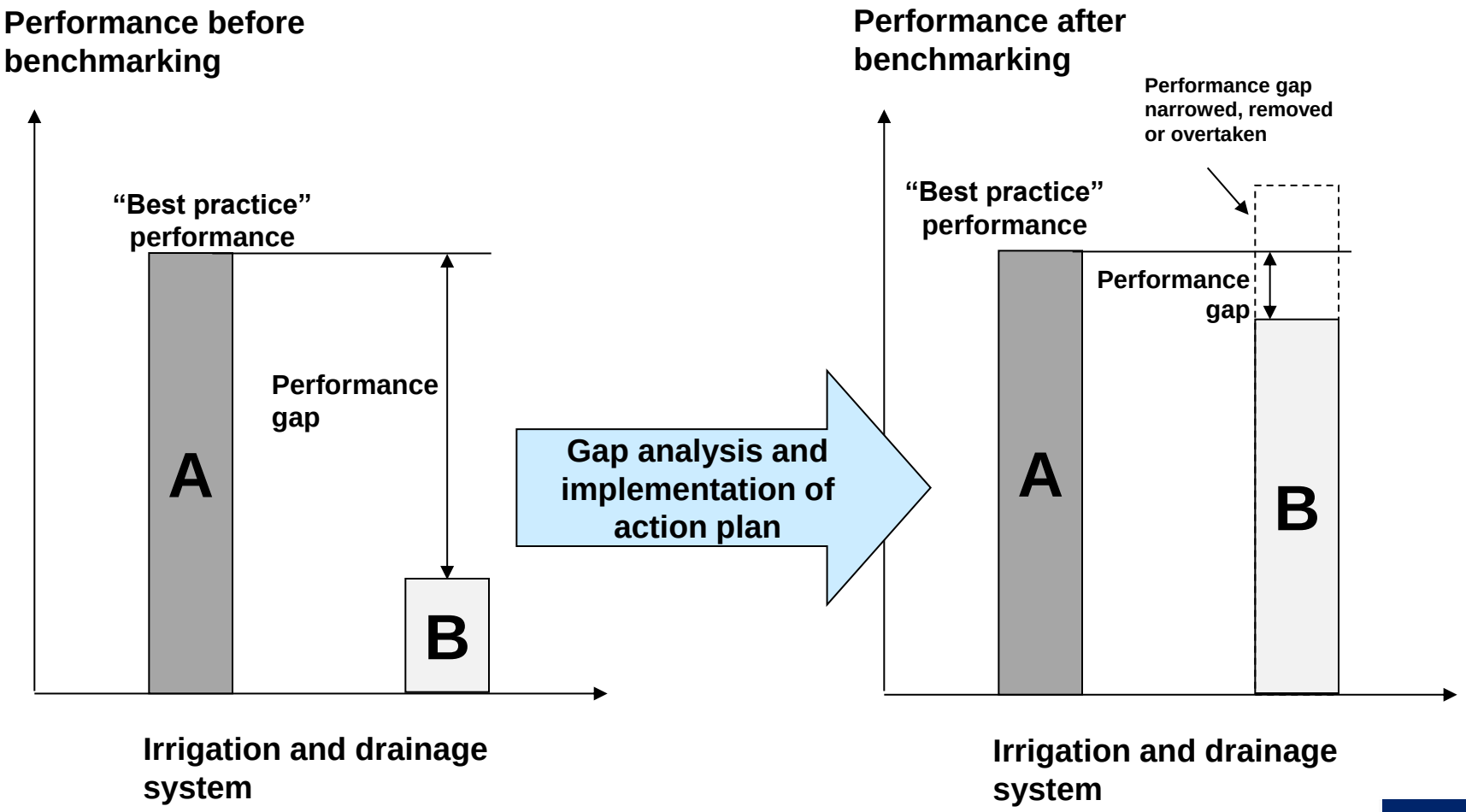
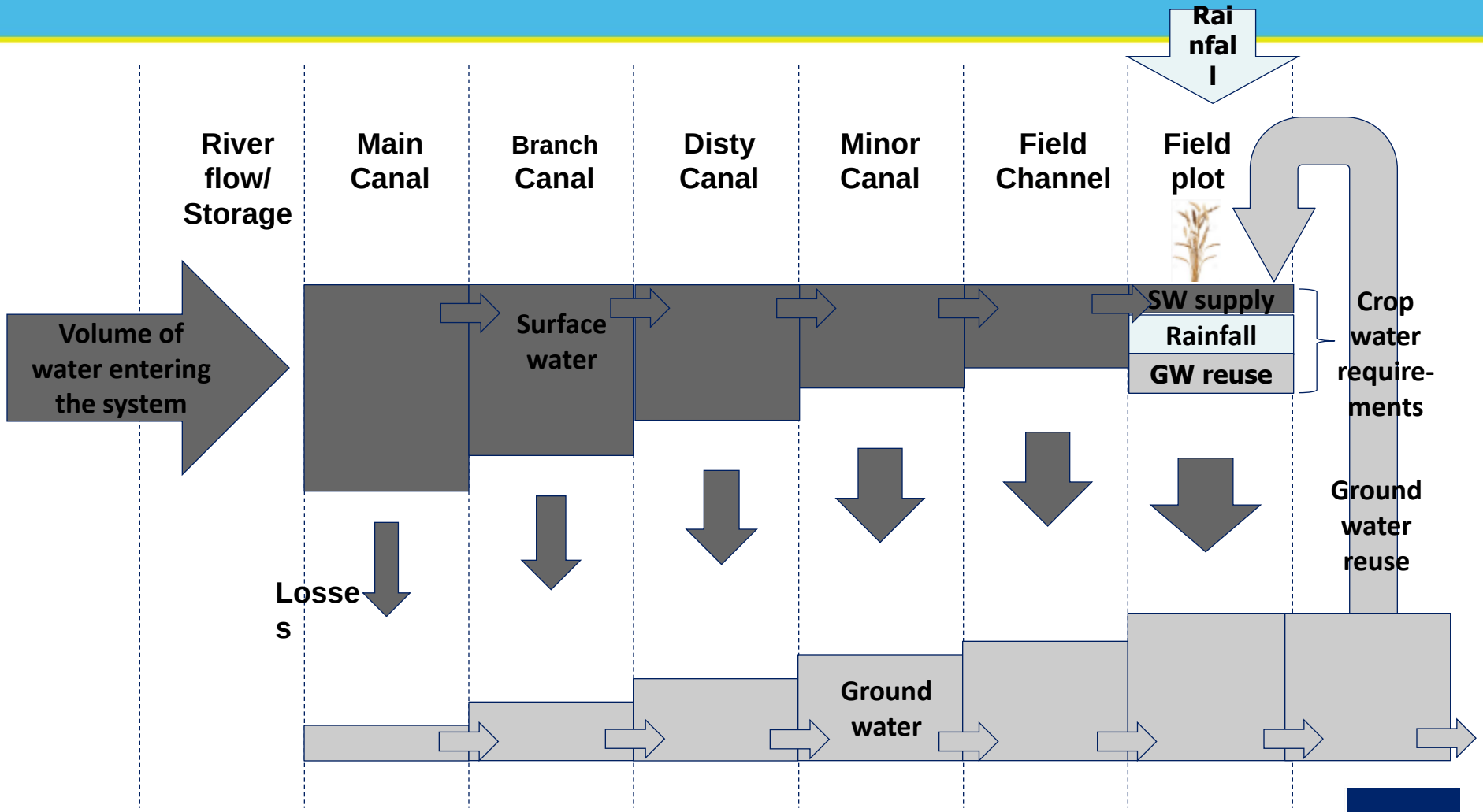
Analytical Tools Developed for Rapid Appraisal and Planning - 2

Sub-basin water balance	Scheme water balance of both surface and sub-surface systems
Institutional and technical analysis	Compiling and integrating the outputs of RAP and PRA including costs
Improved water management	Prefeasibility plans to assess options and present proposals to improve water management and agriculture
Preliminary plans for water management	Preliminary plans for scheme modernization and increase efficiencies; Report

Benchmarking – A way forward to improving performance



Solutions: Identify water balance in MMI schemes



NWUEISP Summary - 1

- Require a “paradigm shift” in the way irrigation schemes are managed
- Upgrade and modernize control and measurement in canal systems, with associated step-changes in O&M procedures
- IDs need to adopt a service delivery approach using modern technology (remote sensing, GIS, etc.)
- Focus on service delivery and performance management, including rapid appraisal and benchmarking
- Re-engage with PIM – provide support and leadership, strengthen WALMIs and NGOs

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NWUEISP Summary - 2

- Develop approaches and procedures for conjunctive use of surface and ground water
- Quantify MOM costs using asset management planning and provide adequate funds, either from users or government. Properly maintained I&D systems should become the norm, not the exception.
- Strengthen CAD&WM and agricultural support programmes
- Piloting of modern approaches to MOM – it's time to move forward in changing the basic approach, processes and expectations.
- Involve the private sector in innovative ways – introduction of modern technology, management contracts, etc.

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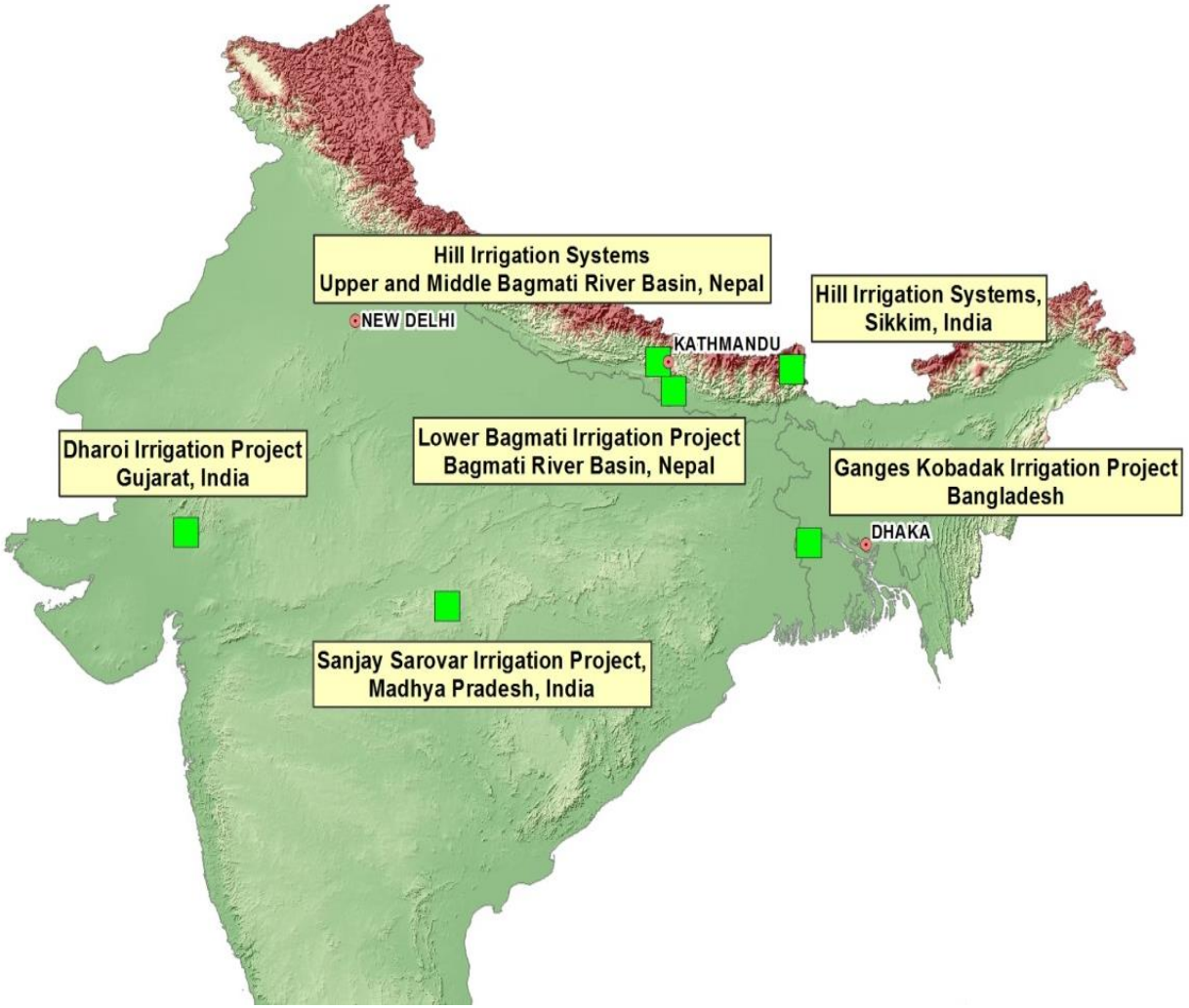
RDTA 7967 : Innovations for more food with less water

System level pilot studies

RDTA 7967 System-Level pilot Studies



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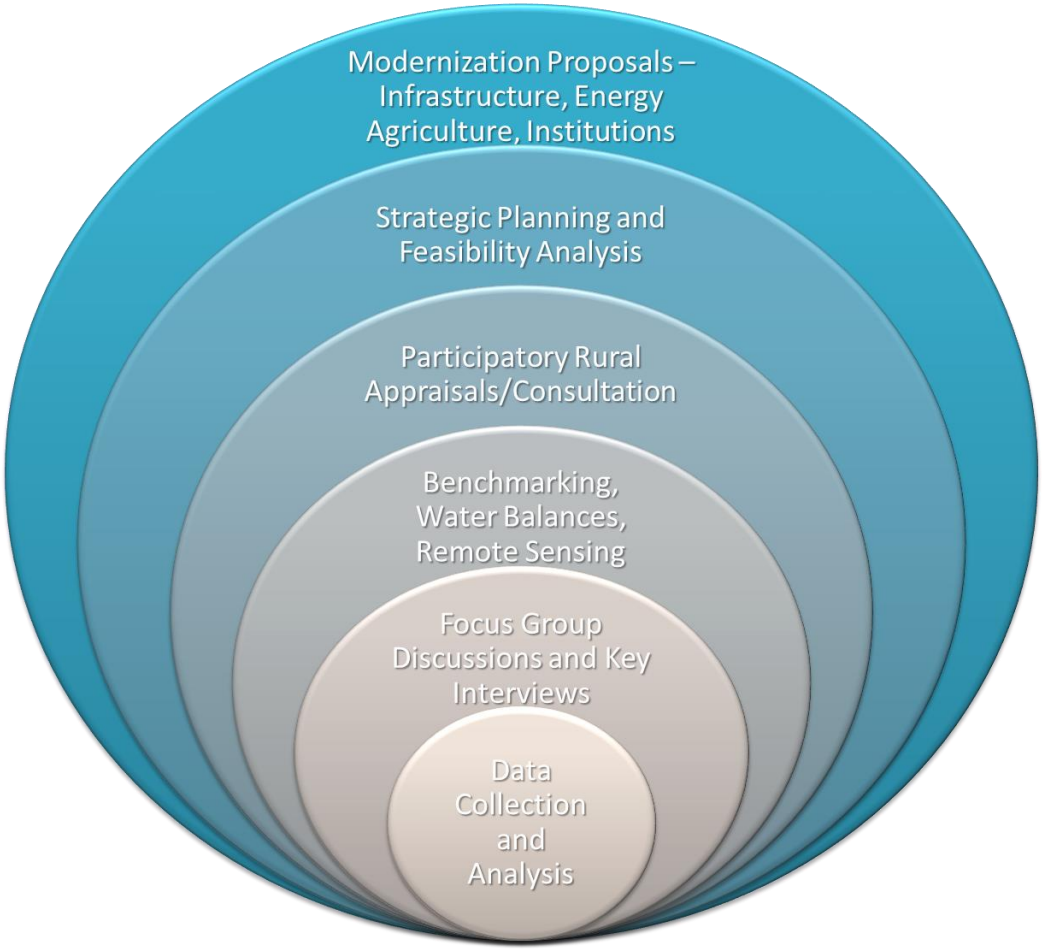
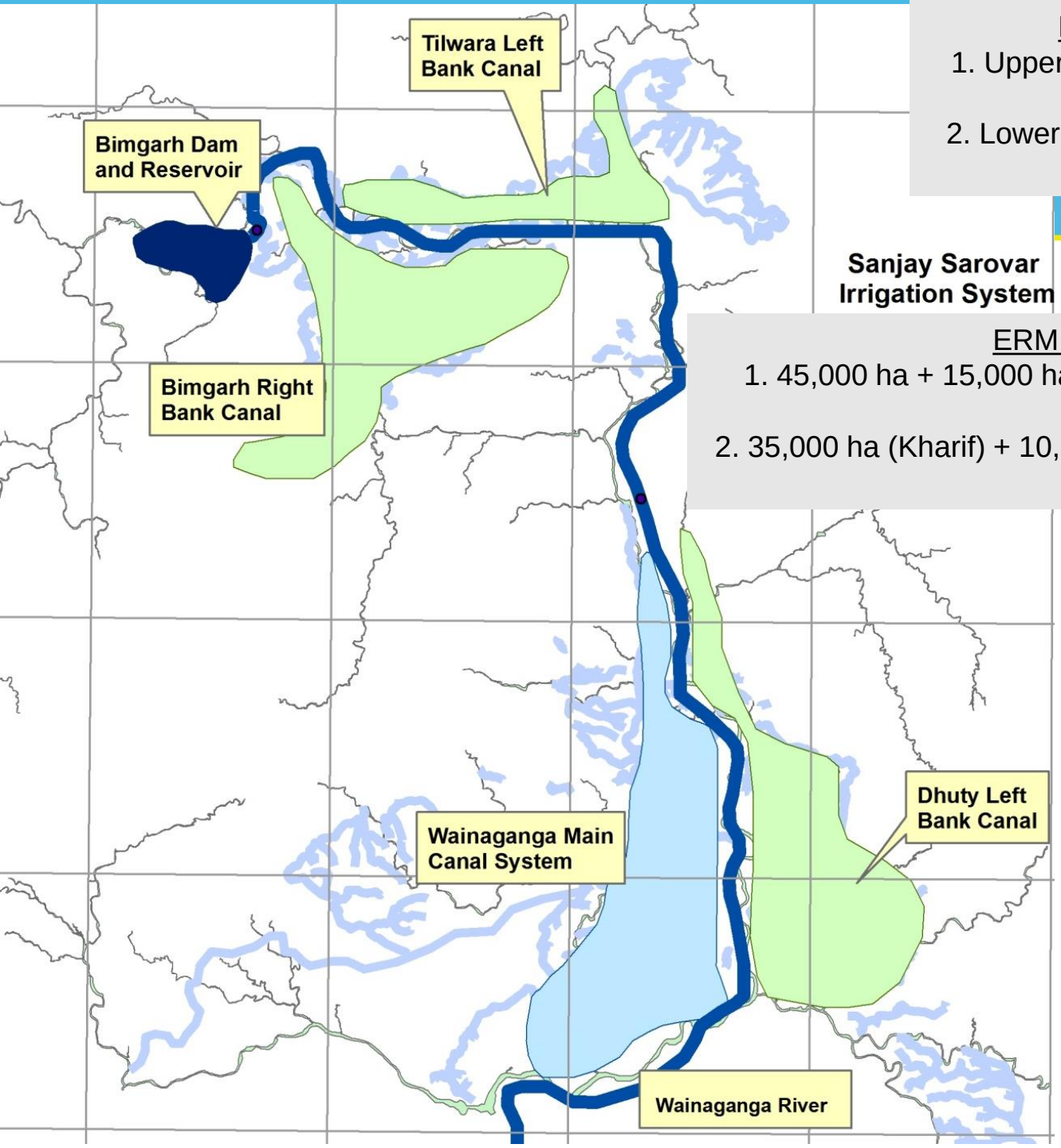
Study Approach: Comprehensive, Integrated and Efficient





DESIGN CCA 80,000 ha

1. Upper Area in Seoni District 45,000 ha

2. Lower Area Balaghat District 35,000 ha

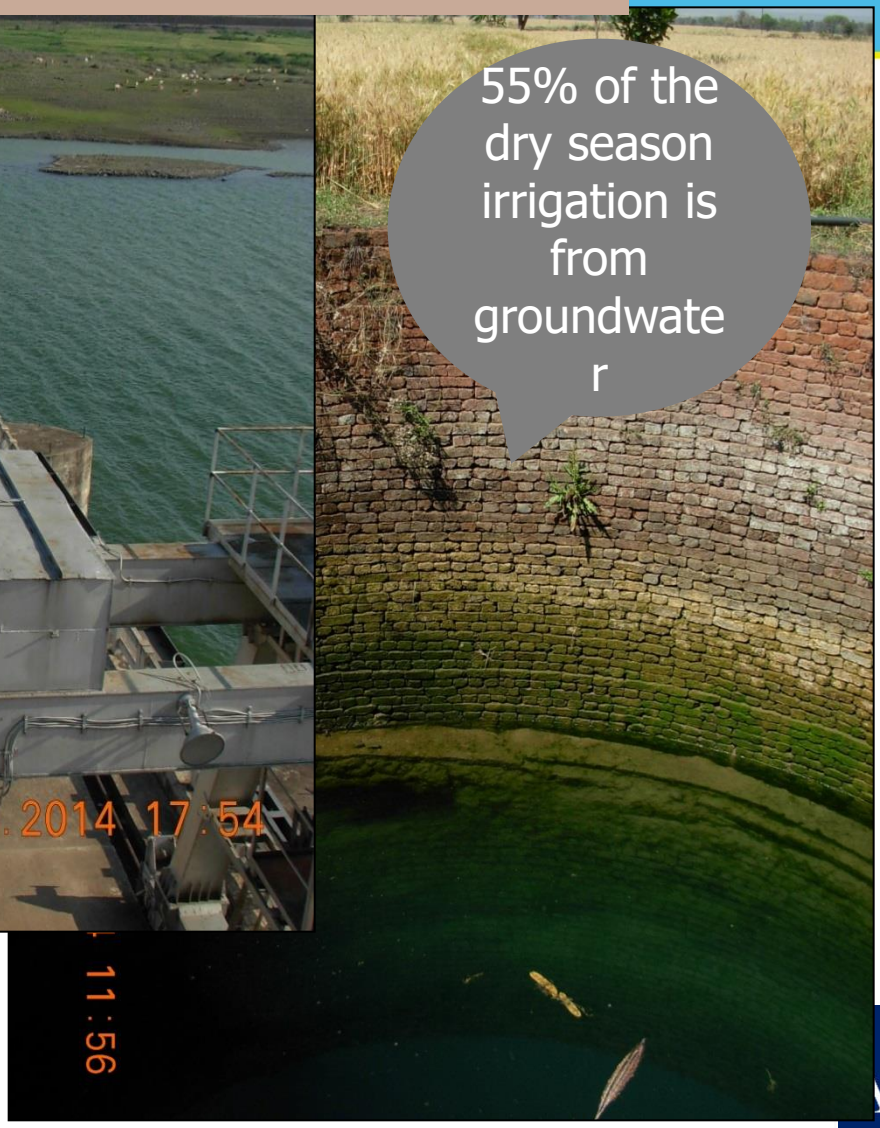
ERM - PLANNED

1. 45,000 ha + 15,000 ha (LLP) + 8,000 (Upper Tilwara)

2. 35,000 ha (Kharif) + 10,000 ha (Spring) + 4,000 ha (Rabi)

MULTIPLE AND INTEGRATED WATER SOURCES

Major dam and storage reservoir



55% of the dry season irrigation is from groundwater

$80 million in annual production

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Bhimgarh Main Canal at Tilwara Canal

Main Canal Operations

- **Adjusted daily or 2/3 days**
- **±10-15% measurement accuracy**
- **Gated cross regulators (manual)**
- **Unlined (5% is lined)**
- **No re-regulation storage**

Tilwara LBC Headworks

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Distributary Canal – Upper Area

Minor Canal

Distributary Canal – Lower Area

Field Outlet

Benchmarking Results : External Indicators – Sanjay Sarovar

External Indicators - Service Delivery Performance	Value
Annual project irrigation efficiency (%)	41%
Annual field irrigation efficiency (%)	51%
Total annual volume of irrigation water delivery (Mm^3/year)	391
Annual irrigation water delivery per unit command area (m^3/ha)	5,521
Annual irrigation water delivery per unit irrigated area (m^3/ha)	5,111
Main system water delivery efficiency	75%
Annual relative water supply	5.01
Annual relative irrigation supply	2.79
Water delivery capacity	2.31
Cropping intensity	108%
Security of entitlement supply (%)	100%

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Benchmarking results : canal indicators
Sanjay Sarovar

Main Canal	Value
Cross regulator hardware (main canal)	0.9
Turnouts from the main canal	1.5
Regulating reservoirs in the main canal	0.0
Communications for the main canal	2.5
General conditions for the main canal	1.2
Operation of the main canal	1.9
Second-level Canals	
Cross regulator hardware (second-level canals)	1.4
Turnouts from the second-level canals	1.3
Regulating reservoirs in the second-level canals	0.0
Communications for the second-level canal	2.6
General conditions for the second-level canals	1.2
Operation of the second-level canals	1.6
Third-level Canals	
Cross regulator hardware (third-level canals)	---
Turnouts from the third-level canals	1.0
Regulating reservoirs in the third-level canals	0.0
Communications for the third-level canals	2.5
General conditions for the third-level canals	1.3
Operation of the third-level canals	1.0

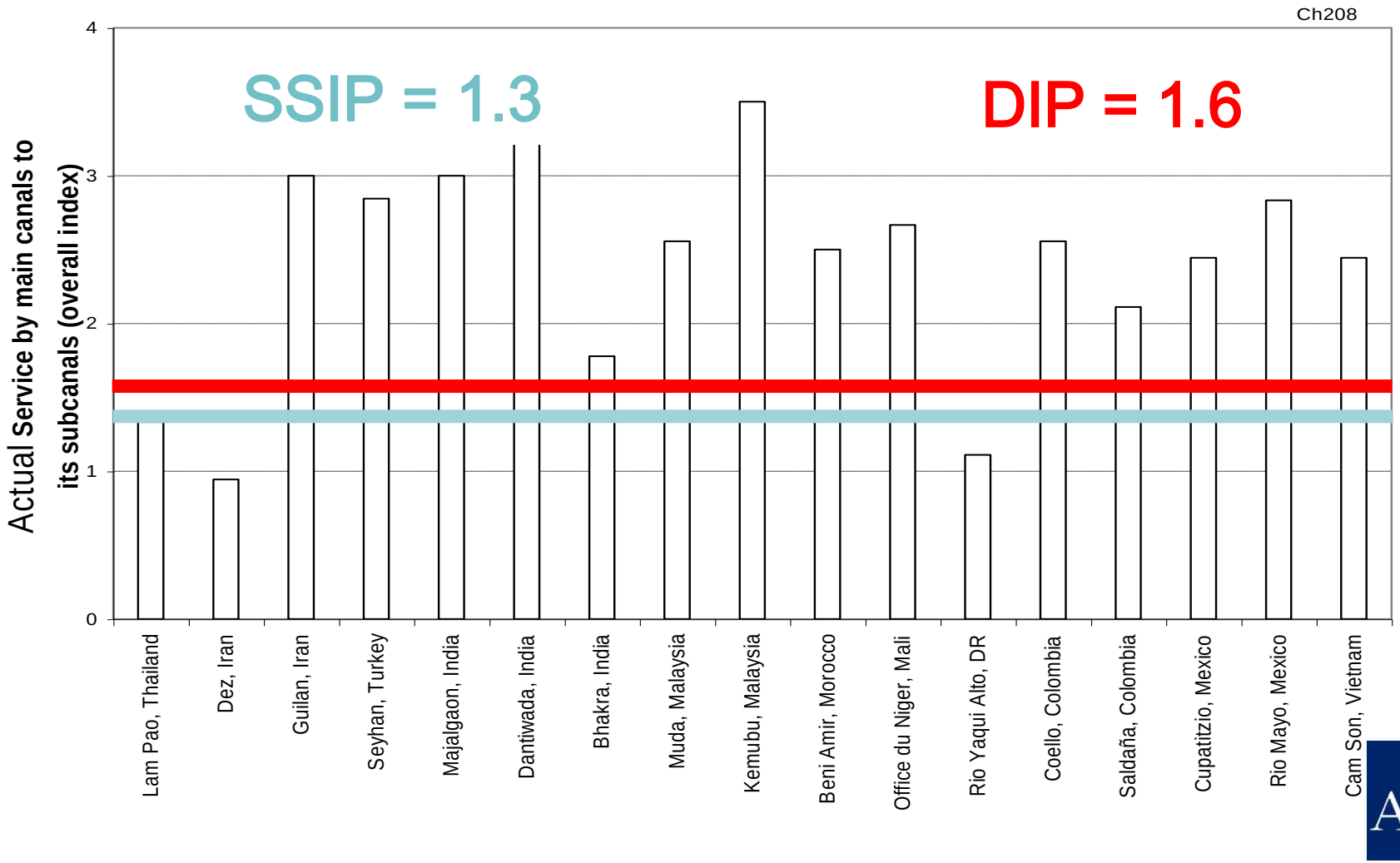
Canal Indicators (2) Sanjay Sarovar

I-5	Actual Water Delivery Service by the Main Canals to the Second Level Canals	1.3
I-5A	Flexibility	1.5
I-5B	Reliability	2.0
I-5C	Equity	1.0
I-5D	Control of flow rates to the submain as stated	1.0

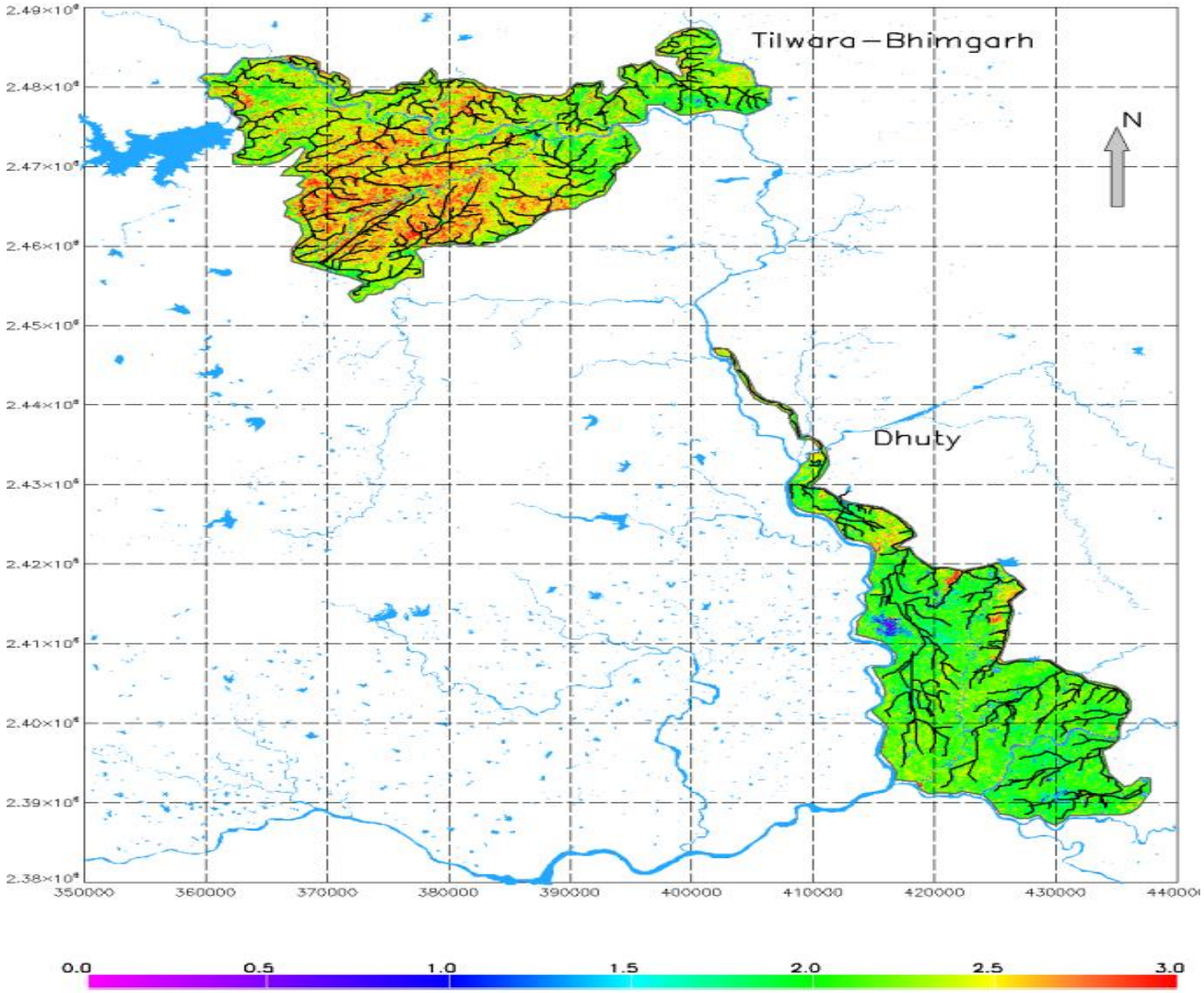
Water Delivery Service Indicators – Sanjay Sarovar

Water Delivery Service (Actual vs Stated)	Value
Actual water delivery service to individual ownership units (eg, field or farm)	1.1
Stated water delivery service to individual ownership units (eg, field or farm)	1.8
Actual water delivery service at most downstream point operated by a paid employee	0.8
Stated water delivery service at most downstream point operated by a paid employee	1.6
Actual water delivery service by the main canals to the second level canals	1.3
Stated water delivery service by the main canals to the second level canals	1.7
Social "order" in the canal system operated by paid employees	1.0

Benchmark Results - 4



Remote Sensing



Stakeholder consultations selected points

1. less than 20% farmers were generally satisfied in the agricultural sector.

- women especially reported problems
- the younger generation was generally not interested in agriculture.
- limited contact with Agriculture Department
- farmers wanted new initiatives for agriculture

Stakeholder Consultations

2. Farmers and the WUA representatives felt they were under resourced to effectively manage the complex surface and ground water irrigation and agriculture issues. WUAs were fully dependent on the government allocation which is insufficient.

There was some interest in farmer enterprises parallel to the WUA to support supply of inputs and support marketing of produce.

Recommendations

- **Modernized infrastructure**
  - Long crested weirs, balancing reservoirs, low pressure pipes, precise application methods,
  - Flow measurement, SCADA, pre-paid smartcard operated pumps
  - Improved energy management and electricity supply
  - Improved efficiencies and conjunctive management

- **Strategies for improved management**
  - Structured system management comprising Agency operation of headworks, Irrigation Coordination Committees, Independent Management Operators (IMO) operating main and branch systems, joint WUA service contracts for tertiary systems and groundwater management
  - Sustainable cost recovery with alternative income generation
  - Surface and groundwater conjunctive management

- **Agriculture improvements**
  - IMO and private sector support to WUAs for improve agriculture and water management practices, value chain enhancements, and crop diversification

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Old and New Innovations

Investment Options

- **Option 1 – Upgrading Surface Water Systems**
  - Upgrades of physical infrastructure
  - Adds re-regulation reservoirs
  - Improves flow control, measurement and decision support systems
  - Strengthens existing institutions (WRD and WUA) and introduces an independent management operator

- **Option 2 – Integrated Approach**
  - Includes Option 1 activities.
  - Adds micro-irrigation
  - Improves conjunctive management of surface and groundwater
  - Improves energy management
  - Includes agricultural support initiatives

Investment & Benefits – Sanjay Sarovar

	Unit	Current	Option 1	Option 2
1. Economics				
Investment cost	$ million		131	252
Cost per hectare	$/ha		1,482	2,844
Net Present Value	$ million		37.6	88.1
EIRR	%		17.0	17.9
B/C Ratio			1.6	1.7
2. Irrigated Cropping Intensities		134%	168%	185%
3. Total Annual Production				
Gross value of production	Rs. million	2,878	6,981	10,736
Gross value of production	$ million	48	116	179
4. Production per unit of irrigation supply	kg/m^3	0.41	1.11	1.25
% change from current			167%	200%
5. Output per unit of irrigation supply	$\$/m^3$	0.08	0.19	0.22
% change from current			134%	175%

Thank You

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