Driving water-enabled growth in Karnataka

Agriculture sector

January 2012

2030 WATER RESOURCES GROUP

Contents

Preface

In November 2010, the Government of Karnataka and the 2030 Water Resources Group (WRG) entered into a collaboration with the aim of catalysing a transformative water reform process in the state. The two bodies commissioned a study with the following objectives:

- Analyse Karnataka's increased requirement for water to enable the state to meet its economic aspirations over the next 10 to 20 years.
- Identify practical options to meet this increased requirement and means to address challenges in their implementation.
- Identify policy and reform measures needed to improve efficiency of water use in the state.

Phase 1 of the study focused on Karnataka's largest water user segment – the agricultural sector. Phase 2 of the project will focus on industry and municipal sectors. This report lays out the key findings and recommendations related to Phase 1 of the study.

The report is underpinned by detailed analysis, field observations and inputs from multiple stakeholders. The analysis included estimating Karnataka's future water requirement, its current sustainable ground water and surface water supply, and the options, costs and enablers to meet that requirement. The analysis was based largely on the data provided by the Government of Karnataka; external data was used wherever appropriate. Field observations were conducted at 11 diverse irrigation projects in six sub-basins covering the Cauvery and Krishna basins. Discussions were held with stakeholders (including 120 farmers to obtain a first-hand understanding of their challenges) and workshops were conducted with over 100 officials spanning the Water Resources Department (WRD), the Department of Agriculture and the Command Area Development Authority (CADA). In addition, the report reflects insights from discussions with Hon. Minister Basavaraj Bommai; senior government officials including Dr. K.V. Raju – Economic advisor to the Chief Minister; Mr. Satyamurty – Principal Secretary, Water Resources Department; Mr. Sarvesh – Director of Agriculture; Managing Directors of the Neeravari Nigams; reputed academics from the University of Agricultural Sciences; and Mr. S.T. Patil from the Water and Land Management Institute.

Based on the diagnosis, the report suggests seven technical programmes that can support transformative water reforms:

1. WRD and Nigam transformation for excellence in project management and infrastructure maintenance
2. Strong water management focus in Nigams, WRD and CADA to improve service levels and irrigation efficiency

3. Scaling up micro-irrigation
4. Rice practices programme
5. Sugarcane practices programme
6. Crop diversification with focus on horticulture acceleration
7. Rain-fed agriculture productivity improvement.

These technical programmes need the support of a set of enablers: ramp-up of the capability building programmes and farmer education to adopt and optimally deploy the technical solutions; strong institutions to manage irrigation and drive efficiency in the state; economic incentives to drive efficiency in water use; a revitalised participatory irrigation mechanism; and additional funding to implement and incentivise the adoption of the seven technical solutions.

The report documents the effort of the study in five sections that explore the challenges faced, potential options for the state, Karnataka's water and agriculture transformation agenda and the enablers required to sustain these initiatives.

We acknowledge the guidance given by Hon. Minister Basavaraj Bommai, the Economic Advisor to the Chief Minister Dr. K.V. Raju and Principal Secretary Water Resources Mr. D. Satyamurty during the course of this project. We would like to thank the Principal Secretary and his team, Mr. Gurumurthy Hegde, Mr. Anil Kumar, Mr. Mallikarjun Gunge, Mr. Pashupathi, Mr. Shivaswamy, Mr. Ranganatha, Mr. Bangaraswamy and all the Chief Engineers who have been extremely helpful and open while sharing information and views on the water sector in Karnataka. We also thank the Department of Agriculture and the Department of Horticulture for their active participation throughout the project and for providing much needed guidance on validating assumptions to the Karnataka context. We would like to especially thank Mr. Muniyappa, Dr. Sarvesh, Dr. Dharmarajan, Dr. Vishkanta, Dr. Maheshwar and Prof. Mukund Joshi from the University of Agricultural Sciences. We would like to thank Professor S.T. Patil from WALMI for proactively sharing his views and literature gathered over years of work in this sector. We would also like to thank Mr. Basavaraj Kumbhar, the farmers' representative from Bijapur, for sharing his experience of the challenges faced by farmers and water-user associations.

We thank the following organisations: Larsen & Toubro, Hindustan Construction Company, iDECK, Jain Irrigation Systems, Netafim, Mahyco, Monsanto India, AgSri, Jalaspandana, and AME Foundation for participating in a workshop to help identify implementation challenges and potential solutions. In addition we would like to thank advisors to the Government of Karnataka Mr. Raghuram, Mr. Manu and international experts associated with the WRG who shared their experience and made the recommendations more robust. Lastly, we would like to specially thank Mr. Gurumurthy who ensured that we were able to meet different

stakeholders in the government and who helped organise the field visits and translate the field interviews.

Executive Summary

Karnataka, one of India's most water scarce states, has a major challenge at hand. Its agricultural and economic growth aspirations will lead to an estimated 60 per cent increase in water demand by 2030. Karnataka will be unable to meet this demand unless it focuses on a state-driven comprehensive transformation of its water and agriculture sectors. This report outlines seven initiatives, supported by five enablers, and an effective process leading to the implementation of this plan to drive this transformation.

The actions prescribed in this report have the potential to:

- Unlock approximately 1,400 thousand million cubic feet (TMC) in additional available water – more than the 636 TMC in projected incremental demand by 2030.
- Increase farmer income by 50 per cent on average from INR 24,000 to INR 38,000 (2004 to 2005 prices) by 2020 and double income to INR 49,000 by 2030, thereby improving the living standards of the large farmer community in the state.
- Free up 340 TMC of water by 2020 and 700 TMC by 2030, which can be used for additional irrigation or be made available for industry and domestic purposes.

Ensuring adequate water for Karnataka's growth aspirations

The state aspires to grow its agricultural gross state domestic product (GSDP) at 4 per cent, and its overall GSDP at 9 to 10 per cent over the next 10 years. Given the current levels of water-use efficiency, this growth will lead to a 60 per cent increase in water demand by 2030 (1,397 TMC compared to the current demand of 885 TMC).

Almost half of the incremental demand will likely go unmet given historical rates of improvement in water productivity, and taking into account the additional supply that the state can create in the next 18 years. In such a scenario, Karnataka's annual agriculture GSDP growth will likely be depressed to around 1.5 per cent[1] and can adversely impact average farmer income by INR 12,000 in 2020.[2] Clearly, therefore, water is an important enabler for Karnataka's growth.

[1] Assuming business-as-usual growth in irrigated area

[2] In constant 2004 to 2005 INR

Broadening the solution set to meet increasing water demand

The increasing demand for water is a natural consequence of the growing population and robust economic growth in Karnataka. Past initiatives to increase water supply can no longer suffice. Tapping all available sources of surface and ground water, as was previously done, will address less than half of Karnataka's incremental demand of 636 TMC by 2030. In addition, such irrigation projects usually have long gestation projects and require massive funding from the state.

The Government of Karnataka has to identify innovating actions to address this situation. These actions fall under four broad objectives:

1. Augment supply with new schemes and rehabilitate existing supply schemes accounting for about 20 per cent of the additional water availability.
2. Improve irrigation efficiency, which would account for 33 per cent of the additional water available.
3. Improve agriculture productivity, which accounts for 35 per cent of the additional water that could be made available.
4. Move to a more water-efficient crop mix, which accounts for 12 per cent of the additional available water.

There are also multiple challenges in effectively implementing these actions. These include moving from pilots to implementation at scale, mobilising farmers, enabling a cross-departmental effort, and changing mindsets at the WRD from perceiving itself as a "water manager" rather than an "infrastructure provider".

Ensuring a state-driven transformation effort

The first step in such a transformation is to envision the end state. Karnataka can set itself a vision of becoming the most progressive state in agriculture and irrigation in India. This will help unlock the potential to increase farmer income by 50 per cent by 2020 and by 100 per cent by 2030, and thus improve the living standards of the large farmer community in the state.

The vision and the actions to realise it should enable agriculture to grow at an annual rate of 4 per cent; ensure adequate service levels; allocate irrigation water equitably to all; and ensure sufficient water is available for basic human needs, growth of industry.

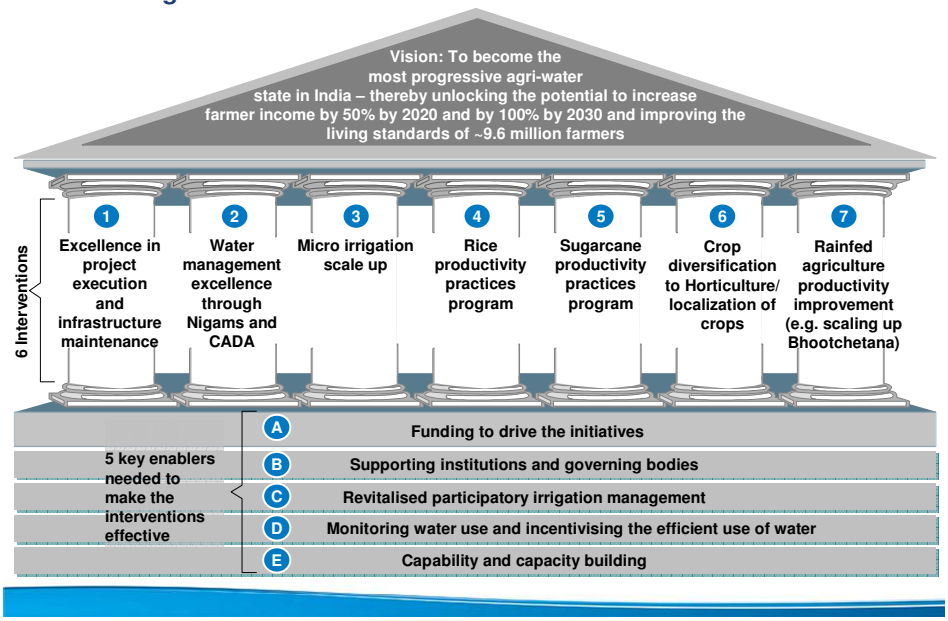
The state has already taken up several initiatives to improve irrigation and service levels. The Government of Karnataka declared 2010 to 2020 as the irrigation decade, with a focus on increasing investment in supply creation and irrigation efficiency. In addition, the state is implementing innovative projects aimed at improving water-use efficiency across Karnataka. The WRD has also successfully

completed projects on time and undertaken complex repair and maintenance works.

This study proposes seven core initiatives and five enablers for the transformation (Exhibit I).

EXHIBIT I

Water sector transformation based on 7 interventions supported by 5 cross-cutting enablers



This transformation should leverage proven technologies in project execution, water management, irrigation and agriculture, particularly focused on rice and sugarcane, in addition to existing programmes for rain-fed agriculture such as Bhoo-chetana and tank rejuvenation.

The major initiatives the state needs to undertake are:

1. Excelling at project execution and maintenance by transforming the Water Resources Department and Nigams

This initiative will improve efficiency and ensure faster and more cost-effective delivery of supply infrastructure. It has the potential to increase farmer income by INR 1,040 per annum (4 per cent of current) and additional irrigated area of 3.8 lakh hectares by 2020.

The WRD and Nigams transformation should aim to accelerate project delivery, reduce costs of projects and ensure faster availability of irrigation infrastructure to its users. The main driver for this would be creating a “design and project

management centre" which will help to implement best practices in the Nigams, advise Nigams on new technology adoption and build capability across Nigams.

This initiative should focus on improving project management systems (e.g., MIS, debottlenecking), better planning (e.g., for funding or land acquisition), adopting best practices in procurement (e.g., larger contracts, quality cum cost based approach [QCBA]-based selection) and creating a stronger system for performance management and accountability to timelines and cost.

In addition, the WRD should increase its focus on maintenance and drive a one-time programme to rehabilitate existing assets. This will entail an incremental investment of around INR 4,000 crore over the next 3 to 5 years.

2. Attaining water management excellence through Nigams and Command Area Development Authorities

This initiative will lead to a step change in service levels and improve irrigation efficiency, potentially increasing average farmer income by INR 660 per annum (3 per cent of current) by 2020.

This initiative should be driven by strengthening accountability for water management in the Nigams (e.g., by incorporating service level metrics such as Water Users Associations' (WUA) satisfaction, proportion of the canal network without water in the evaluation of chief engineers). Volumetric measurement of water flow in the main canals and distributaries will be necessary to drive greater transparency in water management.

In addition, the Government of Karnataka should consider restructuring its CADA system, letting it focus only on irrigation-related activities such as last mile infrastructure, drainage, land levelling, participatory irrigation management (PIM) and water-related extension as opposed to general infrastructure building in the command area. This is necessary to drive initiatives such as the regulated release of water based on a pre-notified water distribution schedule.

3. Scaling up micro-irrigation

This initiative will be especially relevant for water-intensive crops such as sugarcane. It has the potential to increase farmer income by INR 580 per annum (2 per cent of current) by 2020. The required investment is around INR 1,000 crore over the next 10 years and approximately 500 trained micro-irrigation extension units.

This can be achieved by enabling transparent and farmer-friendly processes at Anthar Ganga, the nodal agency created to drive drip irrigation in the state. It is important to give Anthar Ganga crop-specific targets and technology prescriptions to achieve best results for the state. For example, sugarcane is an important crop,

consuming around 27 per cent of agriculture water. It should be set a drip irrigation penetration target of around 25 per cent by 2020 (1.8 lakh hectares) across ground- and surface-water irrigated areas.

The state should invest in proof-of-concept fields for drip irrigation in surface-water irrigated sugarcane fields, helping to extend irrigation to the tail-end of the canal network.

In addition, we recommend an investment in strong extension services (through local sugar mills, water users associations, etc.) to sustain the high adoption of modern agricultural practices and technology by farmers so they can maximise the benefits (yield improvement) of the technology.

4. Scaling up rice productivity practices programme

This can increase farmer income by INR 820 per annum (3 per cent of current) and reduce water need by 130 TMC by 2020. To achieve this, we propose scaling up the System of Rice Intensification (SRI) through pilots at scale in the head reach of major canal systems; tailoring new hybrid varieties of rice for Karnataka through a consortium between the state agricultural university, international institutes and private companies; and increasing the penetration of aerobic rice to target 10.5 lakh hectares under rice cultivation by 2020.

5. Improving sugarcane productivity

This would lead to a possible increase in farmer income by INR 700 per annum (3 per cent of current) and reduce water need by 50 TMC by 2020. The state can drive this initiative by scaling up the Sustainable Sugarcane Initiative (SSI); attracting private investment to adapt global technologies for Karnataka; and providing incentives to sugar mills to adopt better practices across 3.25 lakh hectares of sugarcane by 2020.

6. Diversifying crops by accelerating the growth of horticulture

This initiative will increase farmer income by INR 2,090 per annum (9 per cent of current) by 2020, and reduce water need by 70 TMC. This would entail moving 3 lakh hectares of land under rice and sugarcane to high-value horticultural crops. A differentiated value chain strategy focusing on one or two crops per agro-climatic zone, and a cluster of targeted investments across the value chain (farm to market) from both the public and the private sector are needed to effect this transition. It also requires creating an enabling policy environment and incentives to de-risk smallholder participation.

7. Improving productivity of rain-fed agriculture

The state is already running initiatives such as Bhoo-chetana that target to improve rain-fed productivity. Bhoo-chetana has resulted in 35 per cent yield improvements in semi-dry crops across 12 lakh hectares of rain-fed land. Scaling up this effort across rain-fed areas will help reduce 85 TMC of water throughout the state.

Enabling the transformation

We propose five major enablers to successfully implement these seven initiatives:

1. **Investment of approximately INR 16,500 crore** over the next 10 years, across the Water Resources and Agriculture departments, to fund the suggested initiatives (an extra INR 10,000 crore as per the current trajectory). This is in addition to the funding needed for the construction of surface water projects[3].
2. Supporting institutions and governing bodies that drive optimal use of water. These include:
   - An **empowered ministers' group** to drive structural reforms and inter-departmental initiatives, monitor and debottleneck the implementation the of water policy and progress of transformation initiatives.
   - An **independent body** to drive the execution of inter-sector allocation once fixed, monitoring service levels that are mandated by the government, etc.
   - A **water research and strategy institute** as a public–private partnership (PPP) that can act as a think tank to shape policy, conduct research and guide policy on topics such as climate change impact on water resources.
3. **Revitalising participatory irrigation management** by making membership of WUAs mandatory, investing in the capability of the WUA boards through CADA, and making WUA development an important performance metric for CADA and chief engineers of projects.
4. **Establishing policies to monitor and incentivise the efficient use of water**, supported by volumetric metering at the distributory level and then scaling it up to the laterals. In addition, the WRD can test the possibility of using alternate signals for water price such as rewarding farmers/associations for saving water.

3 This is in addition to the Government of Karnataka's estimate of INR 50,000 crore to INR 70,000 crore required to create new supply

5. **Creating institutional capacity to drive the water sector transformation** at the grass-root level, through around 10,000 trained personnel across agri-extension, water-extension (WUA managers) and irrigation maintenance, potentially through an organisation like the National Skills Development Corporation.

Building momentum for implementation

While transforming Karnataka's agriculture water situation is a long-term plan, early momentum and quick wins are essential to build and sustain stakeholder interest in the initiatives. The following are four immediate steps that can help build momentum to implement all the initiatives:

1. **Launch the water transformation effort as a state priority** and create alignment around the vision and strategy with political, government and civil bodies.
2. **Launch pilot projects to scale-up proven technologies** and launch programmes to institutionalise project management excellence and water management excellence.
3. **Explore private participation in the scale-up of pilot projects** in agriculture and irrigation infrastructure sectors.
4. **Initiate work on the State Water Policy and Irrigation Act** and align it with the vision and strategy of the state water transformation. This is necessary to move from the pilot stage to large-scale implementation of solutions and strategies across the state.

A recent workshop prioritised areas for pilot projects on the basis of the following themes:

- **Improving irrigation efficiency of water-intensive crops:** This pilot aims to demonstrate improvement in the irrigation efficiency of rice and sugarcane, two water-intensive crops for Karnataka. The pilot would integrate the Government of Karnataka's existing pilots on volumetric metering. Two models are proposed for the pilot suitable for rice and sugarcane:
  - Model 1: Volumetric measurement with the scale-up of technologies relevant for rice dominated command areas (e.g., SRI, aerobic rice) driven by an effective CADA. This model could be piloted in the Tungabhadra region in the Bhadra command. If successful, this model, when implemented at the state level, has the potential to reduce water use in agriculture by 150 TMC by 2030 and increase farmer income by INR 5,000 per hectare at 2008 prices.
  - Model 2: Volumetric measurement with the scale-up of technologies relevant for sugarcane dominated command areas (micro-irrigation –

ground and surface water drip, SSI, etc.) driven by sugar mills. This model could be piloted in the Ghataprabha or Karanja regions in the Godavari basin. If successful, this model, when implemented at the state level, has the potential to reduce water use in agriculture by 100 TMC by 2030 and increase farmer income by INR 39,000 per hectare at 2008 prices.

Each model would be piloted at a scale of 1 lakh hectares over 3 seasons.

- **Excelling at project management for irrigation infrastructure:** This initiative focuses on creating an institution which can drive excellence in project execution, and act as a nodal agency for the water transformation of the state. This institution would be responsible in establishing a process to evaluate, rate and choose consultants based on QCBA in addition to setting up an expert body to review and approve critical Detailed Project Report (DPRs). The centre should also provide planning and project execution support by helping prepare L4 plans for projects, and define the planning and monitoring processes for WRD projects. The centre should also explore the applicability of PPP models and should scan for irrigation project and maintenance technologies globally that could be implemented in WRD projects. The centre would also be responsible for capability building at the Nigams on design tools and best practices in planning and project monitoring; this would be done by identifying change champions through a structured programme.
- **Excelling at water management in command areas**: Water management practices in the identified pilot areas will be integrated into the existing irrigation efficiency pilots. The water management programmes will focus on demonstrating and proving the utility of distributory volumetric measurement systems. In addition, driving appropriate performance metrics and planning process in the CADA and revitalising WUAs to enable them to participate actively in the improvement of the delivery system will be key areas of focus.

Workshops are being planned to facilitate the preparation of the DPR for each of these pilots by the agencies handling the DPR (e.g., ICRISAT, IWMI), the GoK and the WRG to finalise the pilot design and obtain the approval of the Hon. Minister for Water Resource, so that the pilot can be launched 2 months prior to the irrigation season.

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Delivering sufficient water to meet Karnataka's growth aspirations is a challenge, but it ***can*** be done by systematically implementing the recommended initiatives and enablers. By committing to the deep transformation of its water and agricultural sectors, Karnataka has the potential to become the most progressive

water state in India – significantly increasing farmer income, releasing water for industry and drinking water purposes and driving the sustainable use of water resources.

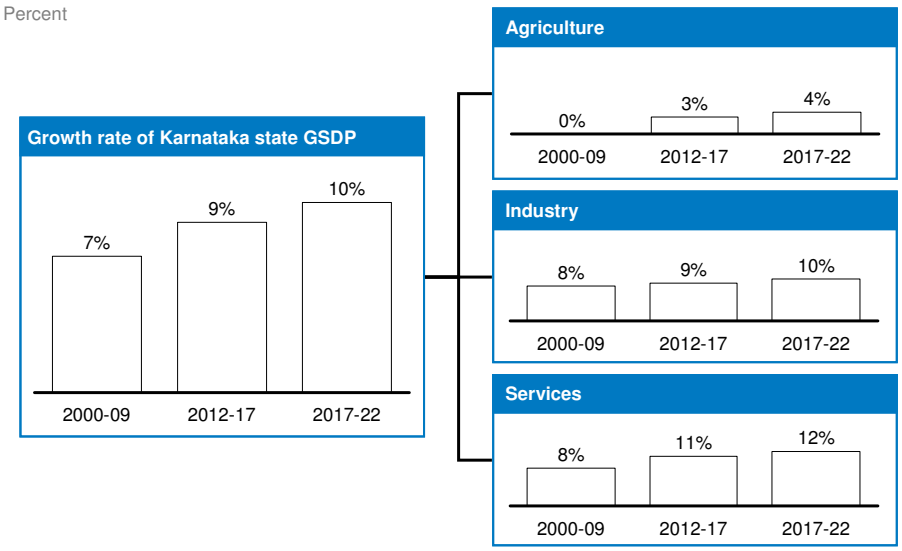
1. The challenge: Ensuring adequate water for Karnataka's growth aspirations

To shape a sustainable strategy for water security, it is critical to first understand the increased water demand implied by projected economic growth.

Karnataka's economic aspiration is to achieve 9 to 10 per cent GSDP growth by 2020. The state aspires to grow its industrial sector at about 9 per cent per annum and services at 11 to 12 per cent per annum, while it aims to step up agricultural growth from 1 per cent to 4 per cent per annum by 2020 (Exhibit 1.1).

EXHIBIT 1.1

Karnataka's economic aspiration over the next 10 years



SOURCE: 'Karnataka – A vision for development'; Dec 2008, prepared by Karnataka State Planning Board; Directorate of Economics and Statistics

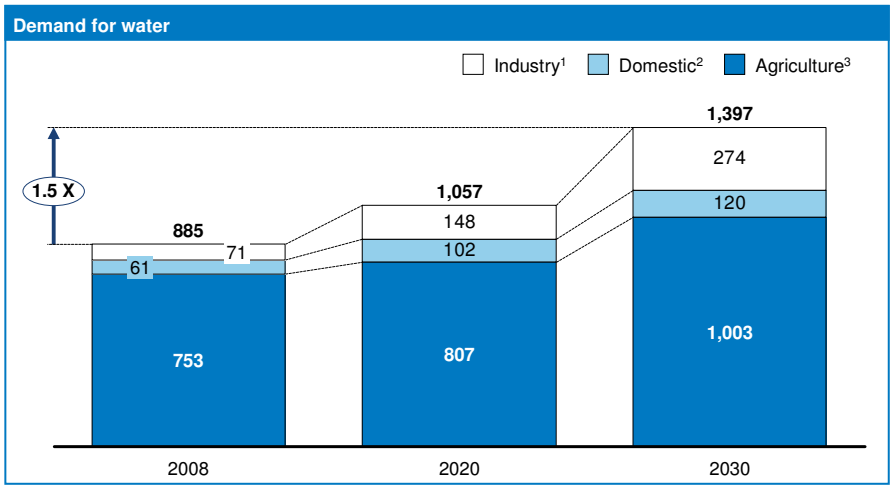
With agriculture accounting for 80 per cent of water use in the state, water efficiency in agriculture is a critical lever not just in meeting Karnataka's aspirations for agricultural growth, but also making water available for other sectors. Further, given that agriculture accounts for 61 per cent of employment in Karnataka, improving agricultural productivity will be essential to improve farmer income.

Based on the current cropping pattern and yield improvement of 1 per cent per annum based on historical trends, Karnataka's growth aspirations will result in water demand increasing from 885 TMC in 2008, to 1,057 TMC by 2020, and to 1,397 TMC by 2030. By 2030, agricultural water demand alone is projected to increase by 33 per cent to 1,003 TMC; domestic water demand to double to 120 TMC; and industrial water demand to quadruple to 274 TMC (Exhibit 1.2).

EXHIBIT 1.2

Karnataka's demand for water by 2030 at the current levels of efficiency and productivity

TMC ESTIMATED



1 and 2. Preliminary estimates. To be detailed in Phase II
3 – Based on current cropping pattern and yield improvement of 1% per annum based on historical trends

SOURCE: Directorate of Economics & Statistics records for 2006-2009; Note on domestic and industrial water requirement in the state published by WRDO

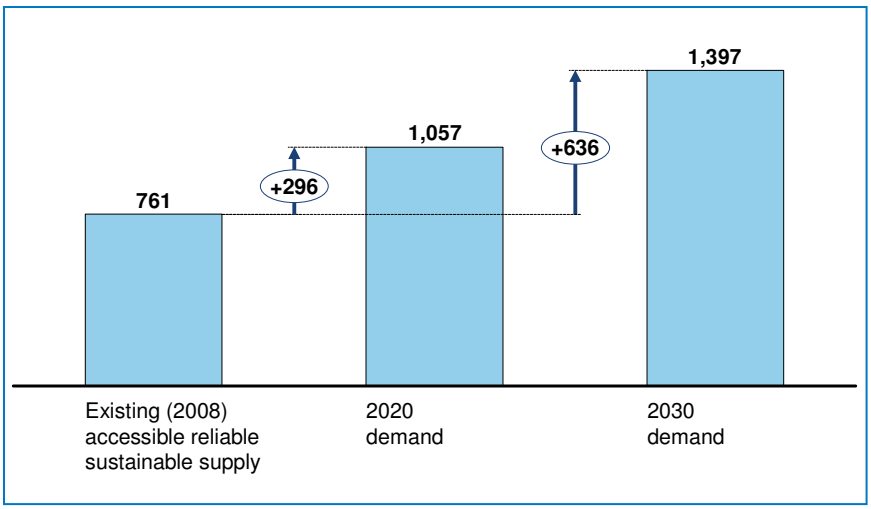
Karnataka's current sustainable water supply is estimated at 761 TMC, net of losses such as conveyance before the consumption point (i.e., the farm gate for agriculture). This is a combination of 497 TMC of net sustainable supply from surface water and 264 TMC of net sustainable supply from ground water.

With total water demand in 2030 projected at 1,397 TMC and current sustainable supply at 761 TMC, Karnataka needs to find demand- and supply-side solutions that can address the incremental demand of 636 TMC (Exhibit 1.3).

EXHIBIT 1.3

Incremental demand for water in 2030

TMC



SOURCE: Water demand model, Water resources department, Dynamic groundwater resources of Karnataka-March 2009

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With strong growth aspirations, Karnataka's demand for water is expected to grow by 50 per cent by 2030. The state needs to find solutions to address the incremental water requirement of roughly 650 TMC over the next 18 years.

2. Broadening the solution set to meet increasing water demand

Karnataka's growing population and the robust growth of its economy will naturally heighten water demand. Using past approaches alone is not sufficient to meet this increased demand and the state must innovate and explore a broader solution set.

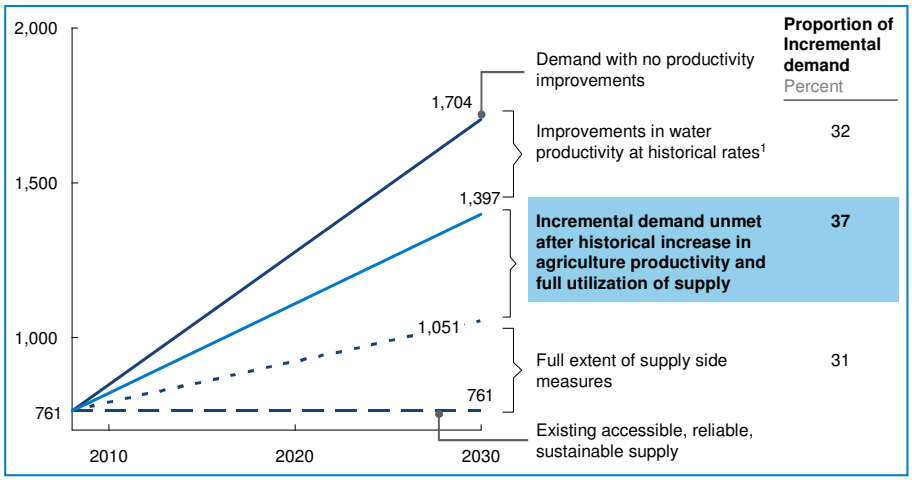
Limits to the historical approach

Historically, the state government has responded to increased water requirement by tapping additional surface and ground water sources. The study estimates that, based on the state's water resources, an additional 290 TMC of net surface and ground water supply can be added in principle, if all sources of sustainable supply are tapped and operated at current levels of efficiency. Therefore, tapping all available supply options will address less than half of Karnataka's 636 TMC of incremental water requirement by 2030 (Exhibit 2.1).

EXHIBIT 2.1

Incremental demand after historical increase in agriculture productivity and full utilization of supply

TMC



1 - Yield improvement of 1% per annum in food grains in irrigated land between 1999-00 and 2009-10

SOURCE: Water Resource Department; Directorate of Economics and Statistics

In reality, the challenge is likely to be even greater if we account for the difficulties associated with executing surface water irrigation projects – long gestation periods (it typically takes 15 to 20 years to achieve full potential) and significant state funding requirements (approximately INR 50,000 crore to INR 70,000 crore).[4]

This will strain state finances, making it difficult to contain fiscal deficit. Relying only on the historical approach is therefore not sufficient to meet future demands.

Need for innovative approaches to implementation

Analysing the full range of potential solutions shows that Karnataka *can* meet its future water requirements. Implementing all available solutions would allow Karnataka to unlock approximately 1,400 TMC of additional water – more than the 636 TMC in projected incremental demand by 2030. While the individual

[4] In 2010 to 2011 prices estimated for the additional 175 TMC net supply

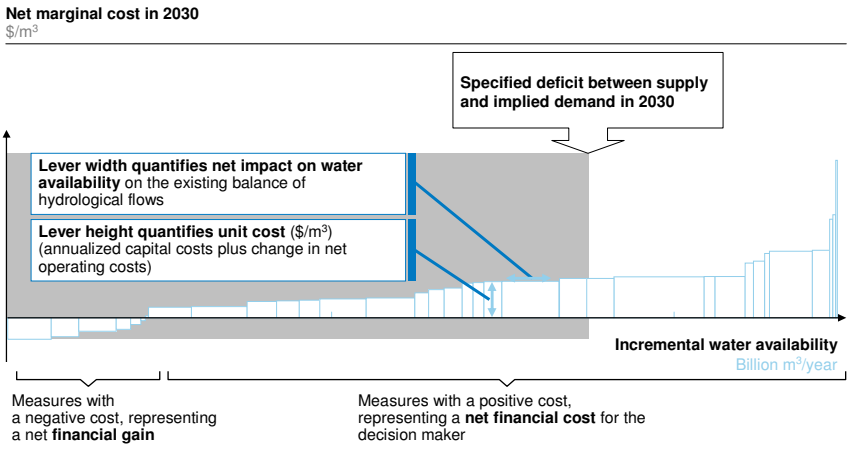
solutions are not new, considerable innovation is needed to implement them at the scale and pace necessary for the required impact.

Identifying solutions to meet water demand

The water availability cost curve can be used to prioritise available solutions. The cost curve's horizontal axis represents the amount of water made available by each solution or lever, while the vertical axis of the cost curve represents the cost per unit of water released by each solution or lever (Exhibit 2.2).

EXHIBIT 2.2

The water availability cost curve



SOURCE: 2030 Water Resources Group

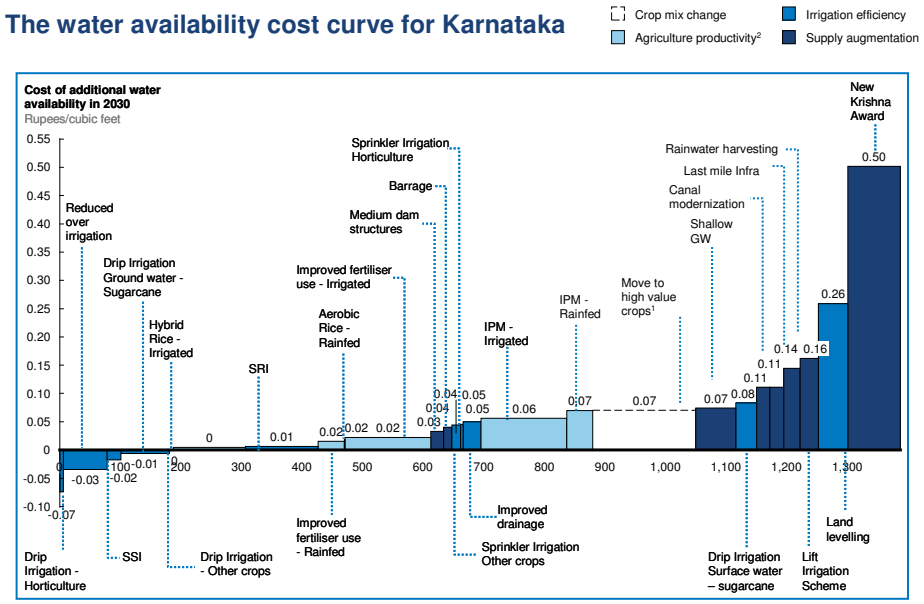
A water availability cost curve was developed for Karnataka with demand reduction solutions such as drip irrigation, sprinkler irrigation, SRI, SSI, aerobic rice, hybrid rice use, and integrated pest management; supply-side interventions included modernising canals and fully utilising the Krishna tribunal award (Exhibit 2.3). The cost curve was developed with significant inputs from personnel at the Department of Agriculture and the Water Resources Department to test the applicability of solutions to Karnataka, and tailor costs and potential to the Karnataka context.

The water availability cost curve for Karnataka shows that the state has the potential to save around 1,400 TMC of water towards addressing the 636 TMC of incremental demand. However, achieving full potential from any one solution

may be difficult; Karnataka will need to implement multiple solutions to meet the 2030 water demand.

EXHIBIT 2.3

The water availability cost curve for Karnataka



1 Cost for lever "Move to high value crops" is assumed to be an average of cost for demand side and supply side levers
2 Wastage reduction (post-harvest) have not been added to the cost curve as focus crops (sugarcane and rice) do not suffer from high wastage levels

The solutions can be broadly classified under four objectives:

1. **Augment supply through new schemes and rehabilitate the existing ones**, accounting for about 20 per cent of the additional water availability. The solutions include utilising the new Krishna award, constructing lift irrigation schemes and barrages, building last-mile infrastructure and modernising canals.
2. **Improving irrigation efficiency**, which would account for 33 per cent of the additional water available. These include initiatives for micro-irrigation, land levelling, reducing over-irrigation, as also the Sustainable Sugarcane Initiative, and proposals for a System of Rice Intensification and aerobic rice.
3. **Improving agriculture productivity**, which would account for 35 per cent of the additional water that could be made available. This includes the development and use of hybrid varieties, integrated pest management and balanced fertiliser use.
4. **Moving to a more water-efficient crop mix**, which would account for 12 per cent of the additional available water. This involves shifting to higher value horticulture crops without impacting food security.

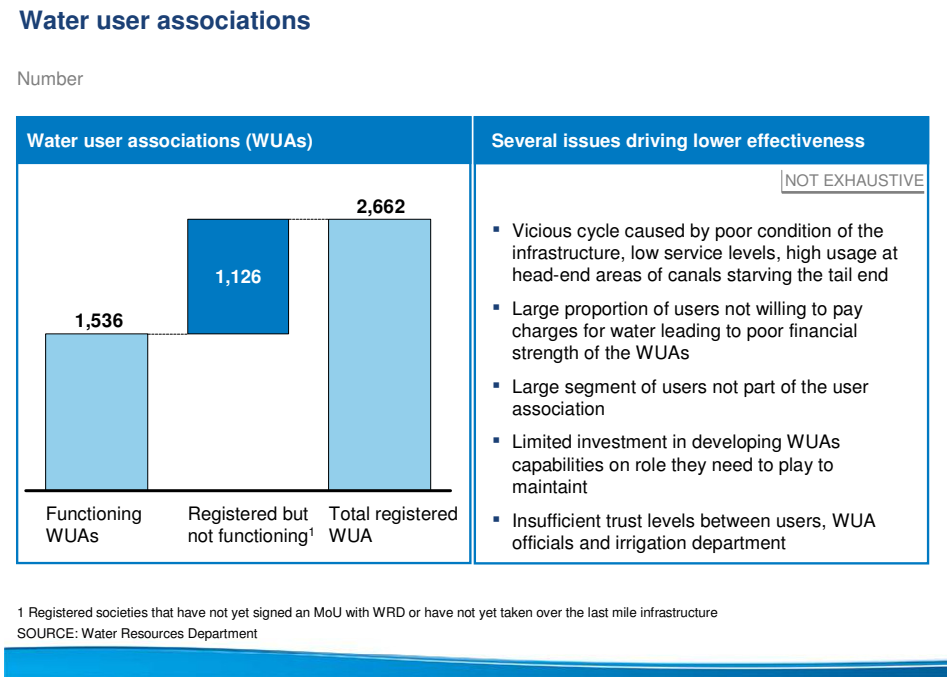
Around 70 per cent of the solutions lie in improving agricultural productivity and using efficient irrigation practices, indicating that cross-department coordination would be required for effective implementation.

Overcoming implementation challenges

The state faces four significant challenges to act on the full solution set:

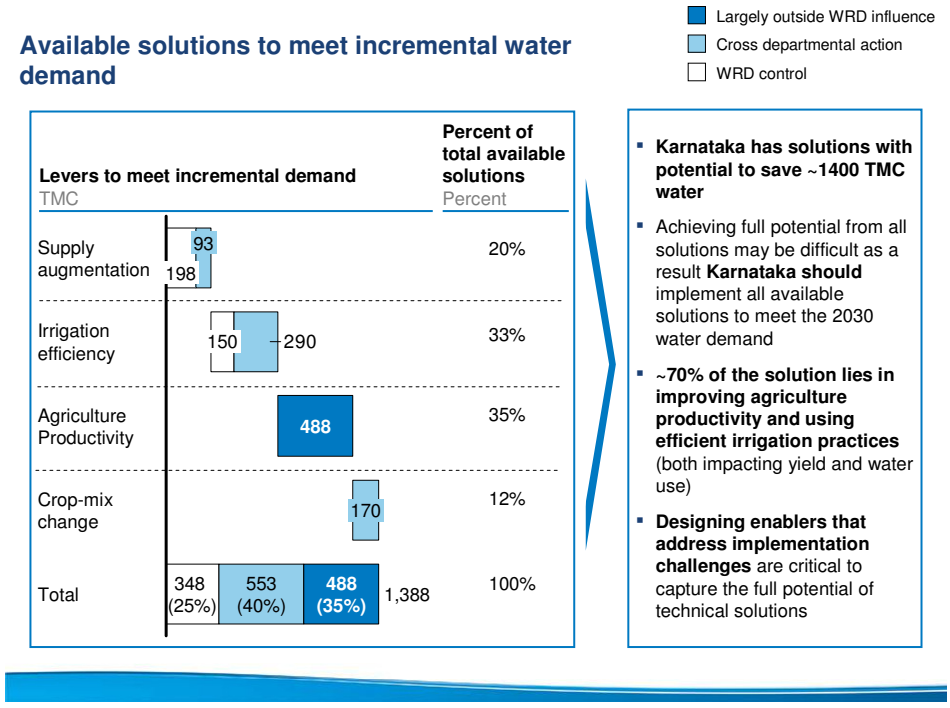
1. **Moving from pilots to implementation at scale**: While Karnataka has successfully piloted solutions and implemented solutions at the pilot stage, the state should build the delivery mechanism and ecosystem to fully gain from available technical solutions. For example, a massive scale-up of drip irrigation should be accompanied by a corresponding investment in extension services.
2. **Mobilising farmers who are currently disengaged or disillusioned due to poor water service levels**: A large number of irrigation efficiency and agricultural productivity initiatives require large-scale mobilisation, awareness and capability-building among farmers. Farmers are currently reluctant to participate due to below-par service from the irrigation department (Exhibit 2.4).

EXHIBIT 2.4



3. **Enabling cross-departmental effort, particularly across the Agriculture and Water Resources departments:** About 40 per cent of the solution set (e.g., drip irrigation scale-up) requires significant cross-departmental effort across the WRD and the Department of Agriculture (Exhibit 2.5).

EXHIBIT 2.5



4. **Changing mindsets in the WRD from being an "infrastructure provider" to a "water manager":** Currently, the WRD focuses mainly on new infrastructure development rather than maintenance and water management. For example, the performance of chief engineers is measured largely by the financial and physical progress of the projects; water management metrics or the condition of built-up infrastructure are not part of their evaluation.

□ □ □

Historical approaches alone are likely to address only half the incremental requirement for water. To fully meet future demand, the state needs to broaden and tap the full solution set – across supply, agriculture productivity, irrigation efficiency and crop shift. However, the state must address the various challenges inherent in this effort so as to tap the full potential of the solution set.

3. Ensuring a state-driven transformation effort in Karnataka

To ensure that Karnataka has the water required to meet its economic growth aspirations, the state should embark on a comprehensive transformation of its water and agriculture sectors. The first step in such a transformation is to envision the end-state. Karnataka can set itself a vision of becoming the most progressive state in India in the areas of agriculture and water use. This will help unlock the potential to increase farmer income by 50 per cent by 2020 and by 100 per cent by 2030, thus improving the living standards of the large farmer community in the state.

Achieving this vision requires a state-driven transformation in water and agriculture, with private sector involvement in select areas. The transformation should leverage innovative but proven technologies in irrigation, agriculture and project execution, particularly focused on rice and sugarcane.

The vision can encompass several focus areas: enabling agriculture to grow at an annual rate of 4 per cent; ensuring adequate service levels; allocating irrigation water equitably to all; and ensuring sufficient water is available for basic human needs, growth of industry.

The state has already taken up several initiatives to improve irrigation and service levels. The Government of Karnataka has declared 2010 to 2020 as the irrigation decade with a focus on increasing investment in supply creation and irrigation efficiency. In addition, the state is implementing innovative projects aimed at improving water-use efficiency across Karnataka (Exhibit 3.1).

EXHIBIT 3.1

Examples of innovative projects and successful execution

	Highlights	Learnings
Drinking water supply to Gulur-Hebbur	▪ **Fast and timely execution** of LIS scheme as compared to similar projects in the past ▪ Project in 2 stages. Construction started in January 2010 with planned completion in December 2011. Stage 1 is nearing completion ▪ Priority project with close monitoring from senior officials and political leadership	▪ Focus from political leadership helps improve coordination between departments ▪ Regular monitoring at all levels is essential from contractor to minister to track progress ▪ Buy in from local political leadership is essential for debottlenecking land acquisition
Shiggaon lift irrigation scheme	▪ First project in Karnataka for **promoting micro irrigation** through sprinkler systems over 9,900 ha and a water utilization of 0.9 TMC ▪ Partnership with L&T for construction of main pipelines and pumping station and with Jain Irrigation for last mile connectivity and installation of sprinkler systems and maintenance for 2 years	▪ Micro-irrigation based systems can be used to irrigate a large area with low water utilization ▪ Partnership with private companies can be used to reduce the burden of execution and maintenance on the state
Change of gates at KRS	▪ **Challenging repairs** of replacing 16 gates at a height of 80 ft successfully completed between Jan 2010 till date ▪ In 2010 a temporary gate crashed during replacement. Since all gates have been replaced	▪ Close monitoring and supervision of project execution is required for successful project completion
Ghataprabha	▪ **Use of technology** like telemetry for monitoring spanning an area of 157,000 hectares ▪ Enables centralized monitoring. 2 TMC has been saved by making appropriate flow corrections	▪ Technology can be used to ease monitoring which helps reduce wastage

This study proposes seven core initiatives for the transformation:

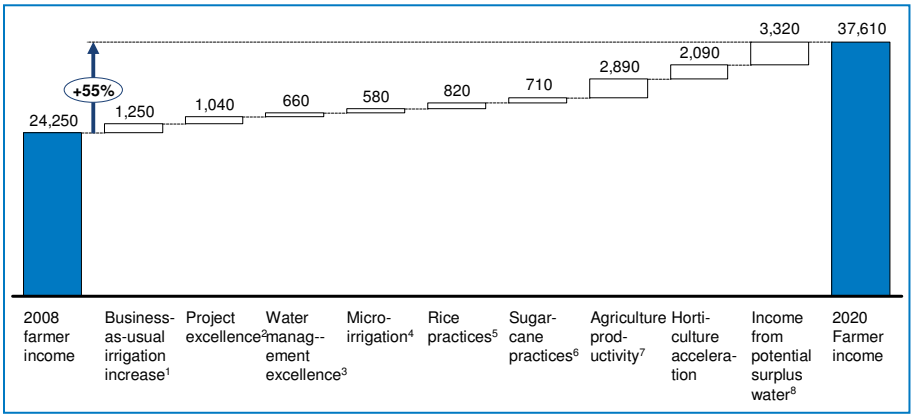
1. Excelling at project execution and maintenance of irrigation infrastructure by transforming the Water Resources Department and Nigams
2. Achieving excellence in water management by focusing activities of the Nigams and CADAs
3. Scaling up micro-irrigation especially in water-intensive crops such as sugarcane
4. Scaling up the rice productivity practices programme
5. Implementing the sugarcane productivity practices programme
6. Accelerating crop diversification in horticulture
7. Scaling up existing initiatives such as Bhoo-Chetana and the revitalisation of tanks to improve the productivity of rain-fed agriculture

Implementing these initiatives could help increase farmer income by 50 per cent by 2020 and create 340 TMC of surplus water after catering to the future requirements of industry and domestic sectors (Exhibit 3.2).

EXHIBIT 3.2

Potential for farmer income increase enabled by the water sector transformation

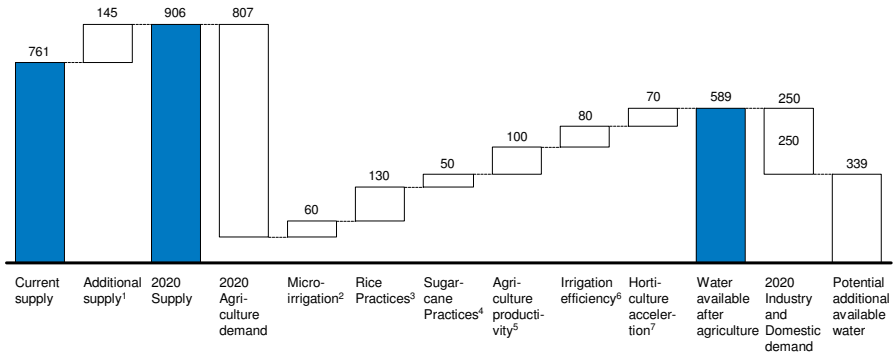
Average Rupees per farmer in 2020, 2004-05 prices



1 Business-as-usual calculated assuming future increase in irrigated area at the average rate between FY07-09 (0.7 lakh ha per annum)
2 Additional income driven by additional 3.8 lakh ha irrigated due to Project excellence and holistic maintenance
3 Irrigation efficiency includes land levelling, improved drainage, reduced over-irrigation and rainwater harvesting
4 Micro-irrigation includes Rs. 340 from drip irrigation in sugarcane (1.8 lakh ha) & balance Rs. 320 from drip and sprinkler in all other crops (5.5 lakh ha)
5 Includes SRI (3 lakh ha), hybrid rice development, aerobic rice in rainfed, agriculture productivity improvements through fertilizer balance & pest control
6 Includes SSI (~75,000 ha) and agriculture productivity improvements through fertilizer balance and pest control
7 Includes agriculture productivity improvement for 27 foodgrain, oilseed and horticulture crops other than rice and sugarcane in rainfed and irrigated areas. This potential is not covered under the 6 proposed initiatives.
8 Assuming all water released after implementing all solutions is used in agriculture

Potential for release of water to other sectors by implementing all solutions

TMC freed up for other sectors, 2020



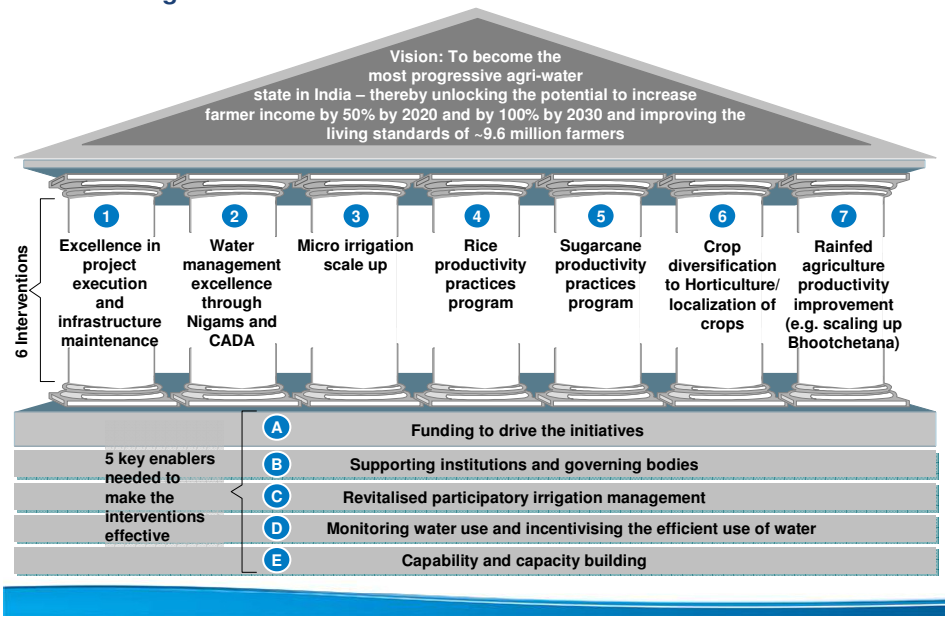
1 Additional supply calculated assuming 50% completion of planned schemes like New Krishna Award, lift irrigation schemes, etc. Also assumes increase in supply through rainwater harvesting (27 TMC)
2 Micro-irrigation includes 53 TMC from Drip Irrigation and 7 TMC from spinkler irrigation
3 Includes savings from SRI (45 TMC), hybrid rice development (45 TMC) and remaining from improved productivity practices like IPM, land levelling, etc
4 Includes SSI (10 TMC) and agriculture productivity improvements through fertilizer balance, land leveling and pest control (40 TMC)
5 Includes agriculture productivity improvement for 27 foodgrain, oilseed and horticulture crops other than rice and sugarcane in rainfed and irrigated areas. This potential is not covered under the 6 proposed initiatives.
6 Includes water saved due to irrigation efficiency improvement in 27 foodgrain, oilseed and horticulture crops other than rice and sugarcane in rainfed and irrigated areas. This potential is not covered under the 6 proposed initiatives.
7 Assumed water saving by converting 3 lakh ha under rice, suagarcane and wheat to horticulture crops

While most of the programmes leverage proven technology, the real challenge is in implementing these at a scale (minimum of 1 lakh hectares) that can make a material difference to the water balance in the state.

Five enablers can ensure that the state implements these initiatives and captures their full potential: mobilising funding for implementation; scaling up institutional capability building; setting up governing bodies to help drive water use efficiency; participatory irrigation management; and incentives at the farm-level for water use efficiency (Exhibit 3.3).

EXHIBIT 3.3

Water sector transformation based on 7 interventions supported by 5 cross-cutting enablers



1. Excelling at project execution and maintenance

Transforming the WRD and Nigams will enable the state to achieve excellence in project management and reduce project execution time and costs. This can increase farmer income by INR 1,040 (4 per cent of current) by 2020. Nine sub-initiatives can help achieve such a transformation (Exhibit 3.4).

EXHIBIT 3.4

Excellence in project management & maintenance to accelerate delivery and improve asset efficiency

1	Strengthen design and project management capability by creating and leveraging the design and project management centre to implement best practices
2	Follow best practices in packaging and contractor selection to reduce costs and improve quality of output. (e.g., larger packages, engineer selection using QCBA, improved norms and rates for technology adoption)
3	Create a comprehensive long-term projects plan (10 year plan) to help prioritize projects and plan funding
4	Adopt practices that can help reduce land acquisition time (e.g., increased accountability, advance planning, regular benchmarking of land rates)
5	Introduce robust project management system and processes (e.g. independent third party observers and quality control, Robust MIS)
6	Consider a separate irrigation cadre, broaden board member profiles and increase MD tenures to increase accountability
7	Launch a large scale program focusing on modernization and rehabilitation of the canal network
8	Increase focus on maintenance of canal network and dam and strengthen maintenance systems and processes. (standardized spend norms, early release of spend, maintenance beyond weeding & de-silting, increased accountability)
9	Drive the entire Water Resources Department transformation and capability development through the design and project management centre

Strengthen design capability and accelerate project execution

The state should set up a new design and project acceleration centre to implement best practices. This centre should be responsible for:

- Advising Nigams on new technology adoption and standardising designs for common irrigation structures to improve the turnaround time of engineering
- Designing a process for evaluating, rating and choosing consultants using a quality cum cost based approach
- Monitoring planning and execution of projects periodically and removing bottlenecks from any execution issues that can cause delays
- Building capability across the Nigams on key areas of design and project management.

Implement best practices in packaging and contractor selection

This will help reduce costs and improve output quality. It is best to apply and refine these practices on a few select projects before a broader roll-out. The identified best practices are:

- **Increasing sizes of contracts that are bid out,** especially in main canals, to attract larger EPC and construction companies that can bring in better practices to help save time and cost. The department can enable this by considering larger contracts at the estimation stage itself. In addition, the

department can consider continuing the turnkey model for lift irrigation schemes (LIS) headworks and for future dams.

- **Structuring contracts to align project progress with last mile infrastructure,** e.g., bundle creation of main canal along with distributaries and laterals for a given area.
- **Setting norms and exploring a revision in the schedule of rates** so as to use the latest technology and materials in relevant sections of projects (e.g., using cement stronger than M30, using pumping equipment for cement).
- **Adopting QCBA in contractor/consultant selection** by giving weightage to technical parameters besides using cost as a selection parameter in the final stage.

Create comprehensive long-term (10 years) projects plan

Creating a 5- to 10-year project progress plan based on priority metrics (such as cost per hectare of irrigation created and nearness to completion) is critical to achieving greater impact with the funds available. This can help prioritise projects and plan funding. One reason for time over-runs in irrigation projects is that available funding is spread thin over a large number of ongoing and new irrigation projects. Funding fewer but more impactful projects end to end can help create larger pieces of irrigated land at a lower cost.

Adopt practices for faster land acquisition

Land acquisition is one of the key bottlenecks in project completion and should therefore be a focus area. All major project zones should have appointed Special Land Acquisition Officers (SLAO) whose performance is measured against a 2- to 3-year land acquisition plan. The process should be frequently reviewed through initiatives such as the benchmarking of rates paid for land acquisition for irrigation purposes against the prevailing market rate of land every year.

Introduce robust project management systems and review processes

The following steps can ensure systematic project tracking and timely completion:

- **Establishing a comprehensive review mechanism** with periodic reviews at different levels, e.g., Executive Engineer (weekly), Chief Engineer (monthly) and Secretary/Minister (quarterly).
- **Monitoring project progress using simple project management software** with standardised action-oriented report formats to increase visibility across stakeholders. It has been seen that easy-to-use project management software is sufficient to monitor the progress of irrigation projects. The department can

choose from several software options, ranging from complex packages like Primavera and Suretrack to simple packages like Microsoft Project.

- **Developing detailed project planning templates** that facilitate clarity on project status, completion targets and resource mobilisation. Creating a daily activity plan can increase transparency in contractor management and enable debottlenecking issues on the ground.
- **Appointing independent third party observers** to check violations of contractor practices, such as unauthorised sub-contracting.
- **Allowing quality control divisions greater independence for increased effectiveness** by having them report directly to a senior administrator in the WRD rather than to chief engineers.

Change staffing process for the Water Resources Department and Nigam personnel

The department should focus on developing an experienced and committed team that delivers long-term results. Towards this, it should focus on:

- **Creating a separate irrigation cadre to strengthen the core team:** The Nigams currently recruit a large part of their staff from the Public Works Department (PWD). These personnel may not have sufficient exposure to irrigation. To help create a strong core team of irrigation engineers, we propose forming a separate irrigation cadre and recruiting, training and developing people for it.
- **Broadening profiles of Nigam board members and increasing the tenure of the Nigam MD:** A longer MD tenure (4 to 5 years, compared to the current average of around 2 years) will enable the MD to drive long-term strategic reforms more effectively. In addition, independent external experts on the board will help bring in new ideas.

Launch a large-scale programme by modernising and rehabilitating the canal network

Apart from the 4 to 5 currently identified projects, others should also be taken up for modernisation and rehabilitation over the next 10 years to improve the condition of canal infrastructure. The currently identified projects require around INR 3,800 crore for modernisation; an equal amount should be allocated for future projects. The state should also set stringent targets for contractors to reduce execution time to ensure completion during the off season.

Improve maintenance of irrigation infrastructure

Apart from one-time rehabilitation, it is critical to adopt practices that ensure the maintenance of the structures over time. These practices are:

- **Standardising norms for regular maintenance spend** across the three Nigams based on age of project, length of canal network, complexity and buffer for usage as emergency funds by chief engineer. The release of funds should also be aligned with the irrigation season to ensure their effective use.
- **Create a maintenance plan at the start of each year** to prioritise and schedule maintenance activities beyond desilting and removing weeds. It is important that a suitable time window be created in the year to carry out and inspect maintenance activities without affecting the release of water to farmers.
- **Increase accountability for maintenance** by evaluating chief engineers on maintenance-related KPIs like conveyance efficiency of canals. To apportion the work better, the department can create the post of an O&M engineer responsible only for the maintenance of the network throughout the year, especially in projects under construction. In addition, given its critical position, the main canal should be maintained by one dedicated team rather than dividing its responsibility among several teams.

Drive the transformation and capability development of the WRD through the design and project management centre

The state should pick two to three pilot projects over the next year to implement the new systems, processes and practices in engineering best practices, packaging and contractor selection, land acquisition, project management and maintenance. The state should identify change champions within pilot projects to drive the transformation. The learning and insights gained should be documented and will form the basis for the scale-up of all projects within Karnataka over the next 2 to 3 years**.**

2. Attaining water management excellence through Nigams and CADA

The following initiatives could increase average farmer income by INR 660 per annum (3 per cent of current) by 2020.

Make Water Resources Department Organisation (WRD) accountable for water management

The performance metrics of this department should include water management aspects such as water delivery versus a pre-notified water distribution schedule, number of active WUAs, WUA/customer satisfaction, and tariff recovery rate.

These metrics should also extend to the Nigam MD and chief engineers, with fixed, specific performance indicators and incentives linked to performance.

Introduce volumetric measurement in main canal and distributaries and improve data transparency

This is an important first step in monitoring and promoting the efficient use of water. The state should also leverage technology to facilitate easy monitoring (e.g., the use of telemetry in Ghataprabha) but with a focus on striking a balance between cost and convenience to enable scaling up systems in the state. Data regarding availability and release of water should be made transparent and easily accessible to users.

Improve the planning process of scheduling and release of water

The decision-making process of the Irrigation Consultative Council (ICC) should be made more transparent. Once the ICC takes a broad decision for a season, weekly/monthly micro plans should be created regarding the release of water. Tracking these plans is critical as it builds users' confidence in the system and eventually leads to a stronger irrigation network.

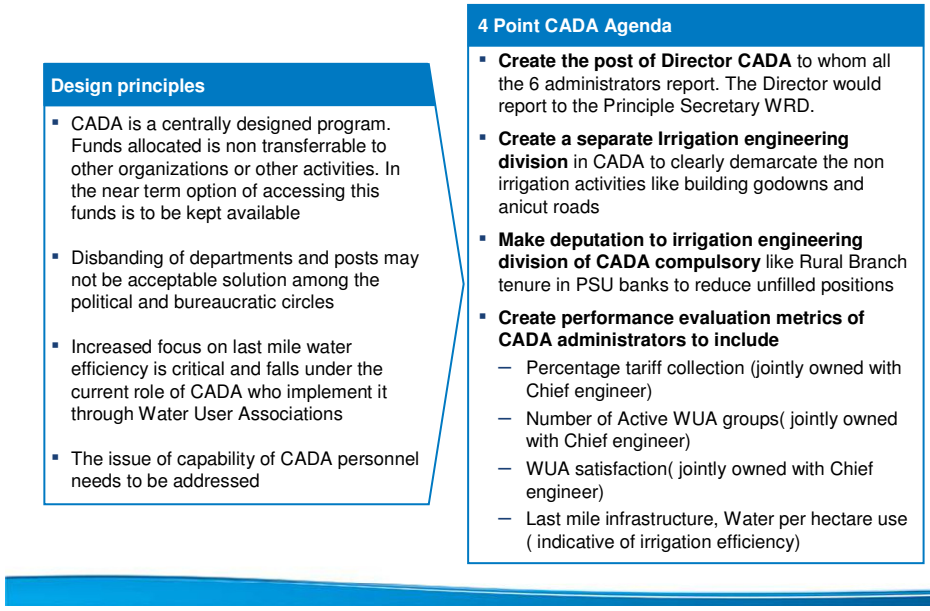
Restructure CADA to focus solely on irrigation-related activities

This will promote efficient water use by farmers. Restructuring CADA involves the following suggestions:

- Creating the post of Director CADA reporting to the Principal Secretary, WRD to monitor activities of all CADAs.
- Setting up a dedicated irrigation engineering division to focus on irrigation-related activities such as creating last mile infrastructure, reclaiming water-logged lands, driving conjunctive use of water, developing WUAs, and water-related extension services. Activities such as building roads and warehouses should be de-prioritised.
- Mandating deputations to this division for all WRD officials, similar to rural bank stints in public sector banks.
- Defining performance evaluation metrics of CADA administrators to evaluate performance on tariff collection, active WUAs, last mile infrastructure creation and irrigation efficiency.

EXHIBIT 3.5

Restructuring CADA to focus on promoting efficient water use and last mile management



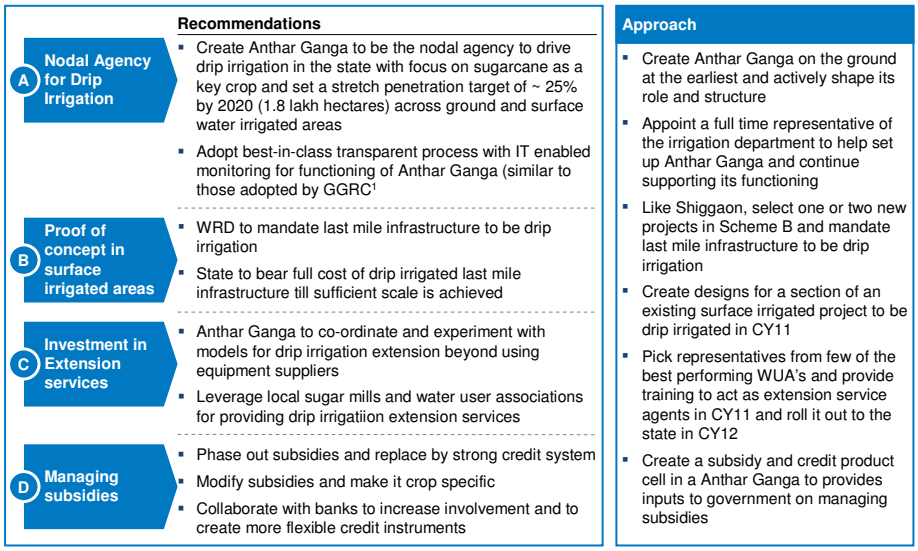
3. Scaling up micro-irrigation

Sugarcane consumes 27 per cent of agriculture water in the state. Farmers are already relying on proven drip irrigation technology for sugarcane, with 6,000 hectares of sugarcane largely irrigated by ground water. However, adoption has been slow due to low awareness of the benefits of drip irrigation and the perceived difficulties in accessing capital subsidy for the equipment. In addition, there is little incentive for farmers in surface irrigated areas to move to drip irrigation since they can access adequate water at low costs.

We suggest a four-point programme (Exhibit 3.6) to accelerate adoption and broaden coverage to sugarcane in surface irrigated lands. This can reduce water demand by 60 TMC and unlock average farmer income of INR 580 per annum (2 per cent of current) by 2020.

EXHIBIT 3.6

4 point program for scale-up of drip irrigation



1 GGRC: Gujarat Green Revolution Company

Set crop-specific targets for drip irrigation

Anthar Ganga, which is already being set up as the nodal agency, should be given long-term, crop-specific targets and technology prescriptions. Sugarcane should be a focus crop with a stretch aspiration of 25 per cent penetration by 2020 (1.8 lakh hectare) across ground and surface water irrigated areas.

Best practices, similar to those adopted by the Gujarat Green Revolution Company, should be adopted by Anthar Ganga in setting up transparent, farmer-friendly processes and introducing effective monitoring mechanisms. The latter include third-party audit of equipment quality to ensure effective delivery.

Introduce proof-of-concept in surface irrigated areas

Anthar Ganga and the WRD should jointly establish proof-of-concept drip irrigation projects for sugarcane in surface irrigation projects. For this, the WRD could mandate drip irrigation in two to three upcoming projects and the state should bear the full cost of the drip-irrigated last mile infrastructure till sufficient scale is achieved.

Invest in extension services

Anthar Ganga should ensure that extension services are available to farmers who adopt drip irrigation – this will help them sustain the initiative despite challenges in usage and maintenance. It should create training modules specific to drip

irrigation and manage various extension services providers including equipment providers and WUAs in surface irrigated areas. In addition, new models for drip irrigation extension like leveraging local sugar mills should be explored.

Manage subsidies

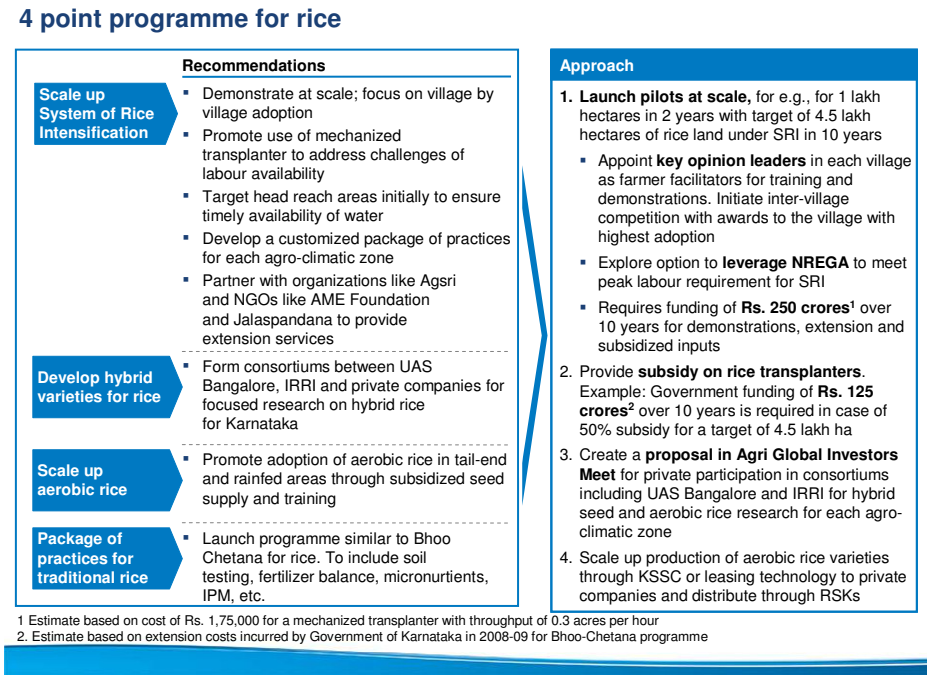
A credit products and subsidy cell should be set up within Anthar Ganga with the long-term objective of phasing out subsidies. It should provide inputs to the state government on the modification of subsidy policies, e.g., crop-based subsidies to promote adoption of drip irrigation in water-intensive crops. In addition, the cell should collaborate with banks to develop products targeted at micro-irrigation and work with sugarcane mills on innovative pricing contracts to drive adoption. The following steps can help to kick-start the programme:

- Define Anthar Ganga's mandate and long-term targets at the earliest. A full-time representative of the WRD should be a part of Anthar Ganga to co-ordinate across the WRD and Department of Agriculture.
- Select one or two projects in the Upper Krishna Project Scheme B and draw up a plan for mandating drip irrigation in these projects.
- Create designs and a funding plan for drip irrigating a section of an existing surface irrigated project
- Select representatives from a few of the best performing WUAs and train them to act as extension service agents

4. Scaling up rice productivity

Rice is Karnataka's largest consumer of agriculture water, using 47 per cent of the state's water for agriculture. Finding a water-efficient method for rice production is critical to achieve the state's food security requirements. We suggest launching a comprehensive, four-point rice practices programme. This has the potential to reduce water demand for rice cultivation by 130 TMC and unlock average farmer income of INR 820 per annum (3 per cent of current) by 2020. Exhibit 3.7 outlines the elements of the programme:

EXHIBIT 3.7



Implement alternate methods of cultivation at scale, such as the System of Rice Intensification

While pilot projects in Karnataka have established that the System of Rice Intensification (SRI) method of cultivation offers benefits of up to 30 per cent in yield and 15 per cent in water consumption, it needs to be proven at scale. SRI also throws up three key challenges: increased labour requirement to transplant saplings; the need for greater guarantees on the timing of water availability to ensure yield increases; and a major mindset shift among farmers to move to a new method of rice cultivation.

To overcome these challenges, the department should consider:

- Encouraging adoption by launching pilots at scale that target the head reach of major canal systems (such as Narayanpur of Tungabhadra). Aggressive targets should be set, such as adopting over 1 lakh hectares in 2 years and 4.5 lakh hectares by 2020. Adoption can be planned village by village, working with key opinion leaders and influencers in the village.
- Addressing SRI-related labour challenges through a greater focus on mechanisation for large farmers. Offering subsidies for rice transplanters is also a potential option. Further, it can explore the option of leveraging the Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) to meet peak labour requirements.

- Involving agricultural universities to develop a customised package of practices for each agro-climatic zone. The department can consider partnership opportunities with organisations like AgSri for capacity building of department personnel, and with NGOs like AME Foundation and Jalaspandana for providing extension services.

Develop hybrid seed varieties for rice

Karnataka currently has hybrid rice varieties (KRH-1, KRH-2, PA6444, etc.) that improve yields by 15 to 20 per cent as compared to high yield varieties. However, adoption has been poor (less than 5 per cent) because the grain is perceived as inferior in taste and quality since the current varieties do not suit Karnataka's agro-climatic zone.

We suggest forming a consortium among the University of Agricultural Sciences, Bangalore, International Rice Research Institute (IRRI) and private companies for Karnataka-focused research to develop a tailored hybrid seed solution for Karnataka. The state should use events such as the Agri-Global Investors Meet to attract private players through incentives like land for trials and foundation seed production, exclusive commercial rights, etc.

Scale-up use of aerobic rice

Aerobic rice allows cultivation of rice with no transplantation and consumes around 60 per cent less water. The University of Agricultural Sciences has already developed this rice and the state should scale up its production and commercialisation through the Karnataka State Seed Corporation (KSSC) or by leasing technology to private players.

Design a package of practices to boost yield of conventional high yield variety rice cultivated using flood irrigation

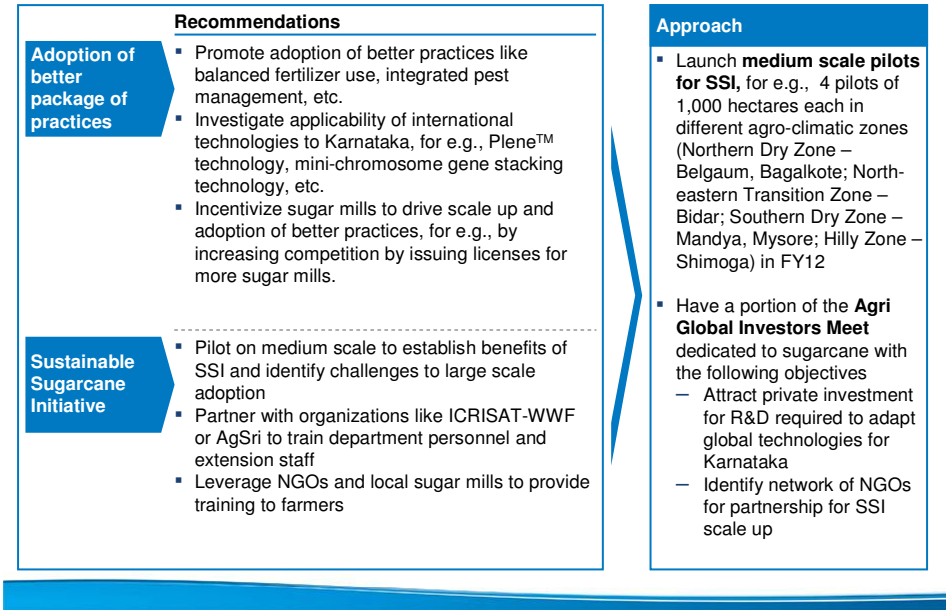
Rice productivity in Karnataka is 30 per cent lower than neighbouring states such as Andhra Pradesh. The state must bridge this gap through a package of practices involving the right set of seeds, fertiliser and pest control measures. It should launch a programme on the lines of Bhoo-Chetana that includes soil testing, fertiliser balance, micronutrients, integrated pest management, etc.

5. Improving sugarcane productivity

It is critical to design focused initiatives to boost production of sugarcane, given that this crop is the second-largest consumer of water in the state (consuming 27 per cent of agriculture water). We suggest two initiatives that can reduce water demand for sugarcane cultivation by 50 TMC and unlock average farmer income of INR 700 per annum (3 per cent of current) by 2020 (Exhibit 3.8):

EXHIBIT 3.8

Improved practices programme for sugarcane



Scale-up Sustainable Sugarcane Initiative

Sustainable Sugarcane Initiative (SSI) has been proved to improve yield by up to 20 per cent while consuming up to 30 per cent less water. Tamil Nadu and Orissa now have programmes on SSI and demonstrations have been conducted in Belgaum. Karnataka should launch medium-scale pilots, e.g., four pilots of 1,000 hectares each in different agro-climatic zones, to establish the benefits of SSI and identify challenges to large-scale adoption. The state can consider partnering with organisations such as International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) or AgSri to train department personnel and extension staff on SSI. Karnataka can also leverage NGOs like NIRMAN and local sugar mills to train farmers on these techniques.

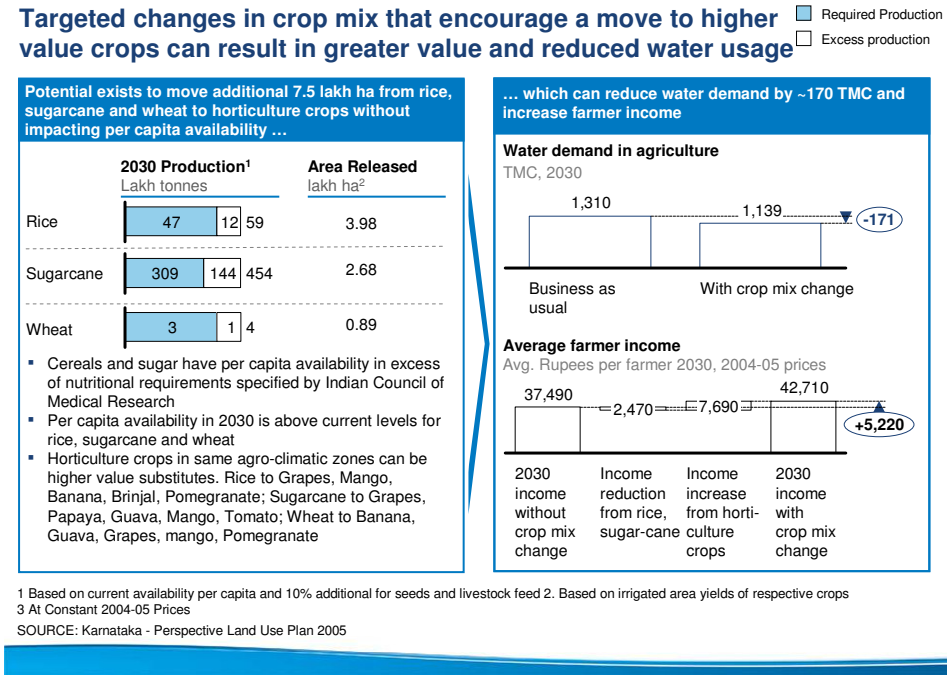
Design and adopt better package of practices

It is possible to increase sugarcane productivity through better practices like balanced fertiliser use, integrated pest management and technologies such as gene stacking, marker technology which have been used successfully in countries such as Brazil. The state should incentivise sugar mills to improve the productivity of sugarcane farms in their command area.

6. Driving crop diversification by accelerating the growth of horticulture

The state should consider shifting the crop mix to high-value horticulture crops. This move has the potential to increase average farmer income by INR 2,090 per annum (9 per cent of current) by 2020 and reduce water consumption by 70 TMC. Many horticulture crops consume less water yet yield higher returns for the farmer than conventional crops. For example, mango gives INR 1.09 per cubic foot of water used, as against INR 0.06 for rice. There is potential to move 3 lakh hectares and 7.5 lakh hectares under rice, sugarcane and wheat to high-value horticulture crops by 2020 and 2030, respectively, without compromising on food grain availability for the state (Exhibit 3.9).

EXHIBIT 3.9

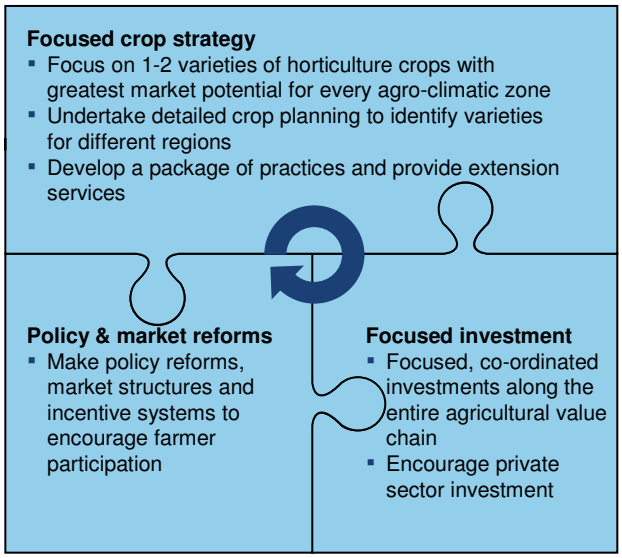


Other countries have successfully implemented programmes to accelerate horticulture. Morocco launched “La Maroc Vert”, under which land is leased to private players who invest their resources and know-how to promote higher value agriculture and also aggregate the produce of small holders. This has tripled the annual income of small holders from 2008 to 2010.

Facilitating a rapid shift to high-value horticulture crops requires a differentiated value chain strategy supported by focused investment and enabling incentives and regulatory reforms (Exhibit 3.10).

EXHIBIT 3.10

Virtuous cycle of horticulture acceleration



Identify focus crops

We propose that the state adopt agro-climatic zone-based crop planning. The state should undertake a detailed crop-planning exercise to identify focus crops for each zone based on the crop's market potential, availability of water and accessibility to markets. It should also ensure that the produce is staggered over time. Each crop requires the state to develop a package of practices that can be communicated through focused extension programmes in each region.

Create a virtuous cycle of focused investment

The state needs to attract a consortium of investors for focused investment across the value chain for each of the focus crops. We propose that the state invest in enabling infrastructure like roads, railways, etc., by aligning existing infrastructure development plans to the requirements of the focus crops. The state can use the Agri Global Investors Meet to attract private investments in private markets, cold chain infrastructure and local food processing facilities.

Create an enabling environment through policy reforms and incentives

Towards this we have the following suggestions for the state:

- Encouraging contract farming by creating a standard PPP model that provides the right to procure produce at pre-determined prices in return for high-

quality inputs and extension services. We propose that the government oversees such arrangements to protect the interests of farmers.

- Offering tax incentives for setting up processing units and post-harvest infrastructure like cold chains for the focus crops in the region.
- Strengthening the Karnataka State Horticulture Co-operative Federation as the integrating agency for HOPCOMS and district horticulture co-operatives to allow for scale benefits in food processing and distribution.

7. Improving productivity of rain-fed agriculture

The state is already running initiatives such as Bhoo-chetana that aim to improve rain-fed productivity. Bhoo-chetana has improved yields by 35 per cent across several semi-dry crops (Exhibit 3.11).

EXHIBIT 3.11

Bhoo Chetana (Rainfed agriculture productivity improvement program) is being implemented successfully across the state

Bhoo Chetana is a package of initiatives ...

- Objective: To increase average crop productivity by 20% in four years in rainfed areas
- Targeted at 1-2 major rainfed crops in district
- Includes
  - Integrated Nutrient Management based on soil testing
  - Soil moisture conservation techniques
  - Use of high yielding short duration varieties
  - Integrated pest management, etc.

... that has resulted in significant yield improvements in its first year

Districts	Yield improvement
Maize	44%
Ragi	35 to 65%
Groundnut	32 to 41%
Soybean	39%

The programme is being implemented in a phased manner over a period of 4 years

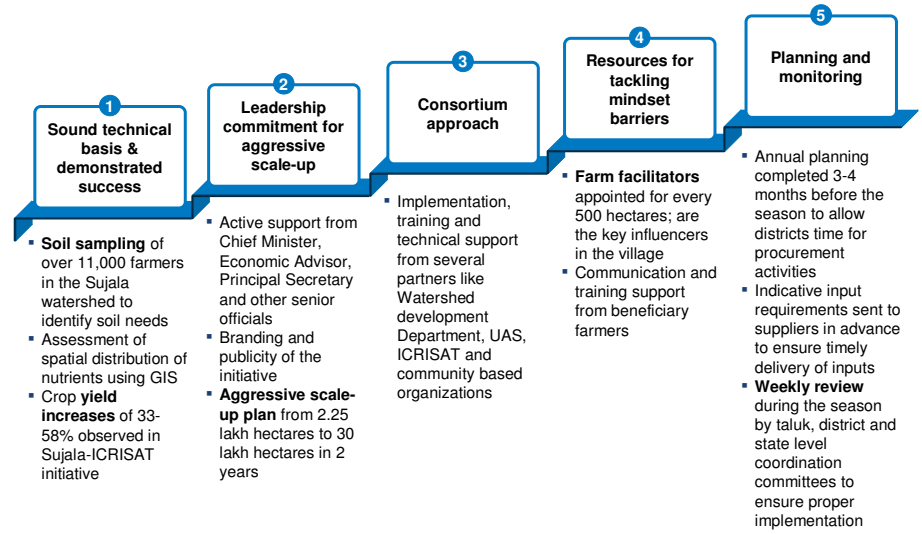
	Sujala-ICRISAT initiative	Phase I (2009-10)	Phase II (2010-11)	Phase III (2011-13)
Districts	6	6 (25% coverage p.a.)	16 (10 additional) (33% coverage p.a.)	25 (9 additional) (50% coverage p.a.)
Area	3,500 ha.	2.25 lakh ha.	12 lakh ha.	30 lakh ha.
Farmers benefited	11,000 .	2 lakh	8.7 lakh	-

SOURCE: Interviews with Department of Agriculture personnel; Bhoo Chetana brochure

Scaling up this effort across rain-fed areas will help reduce 85 TMC of water demand throughout the state. There are significant learnings from scaling up Bhoo-chetana in the state (Exhibit 3.12). This knowledge can be leveraged while designing scale-up efforts/pilots across other initiatives.

EXHIBIT 3.12

5 pronged approach adopted by Bhoochetana can be replicated for implementation of other packages



SOURCE: Interviews with Department of Agriculture personnel; Bhoo Chetana brochure

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The study recommends initiatives that have the potential to increase farmer income by 50 per cent by 2020 and free up 340 TMC of water by 2020 beyond what is required to meet the state's vision. The next chapter outlines the enablers that will ensure implementation and capture the full potential of these initiatives.

4. Enabling the transformation

Bringing about this transformation requires mobilisation at an unprecedented scale and pace. Five key enablers are necessary to implement the suggested initiatives for maximum impact. Apart from funding to the tune of INR 16,500 crore over and above new project expenditure in the next 10 years, the transformation requires stronger institutions such as an independent regulator, revitalised participatory irrigation management, economic signals to incentivise efficiency in water use and a strong capability-building programme for both users and officials.

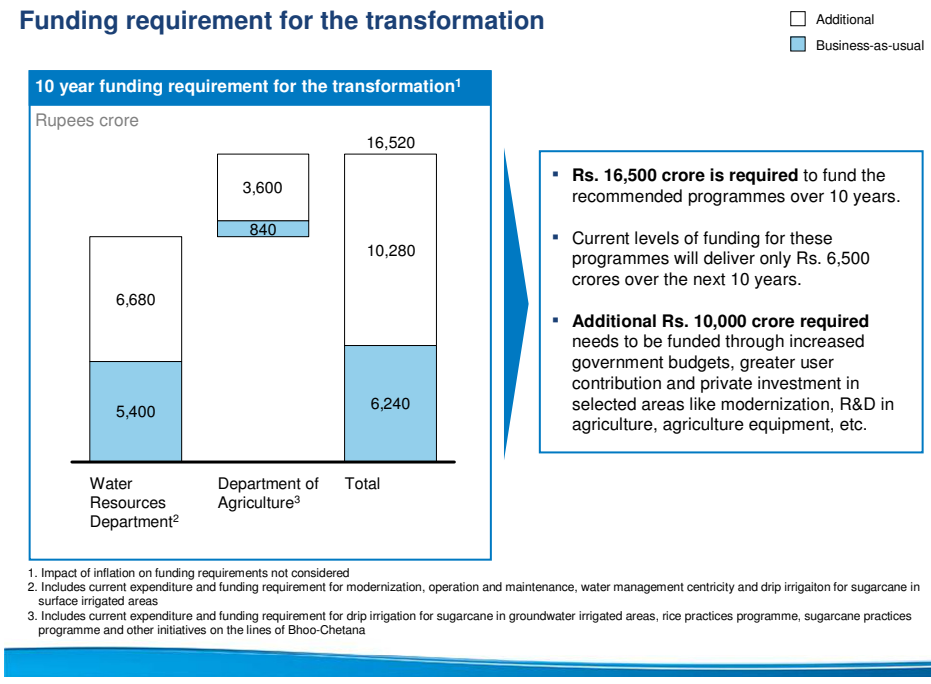
Increased Funding

The necessary funding for this transformation is estimated at INR 16,500 crore over the next 10 years. This is in addition to the INR 50,000 crore to INR 70,000 crore needed to execute surface irrigation projects.

The WRD will need to double its expenditure on modernisation, operations, maintenance, etc., and raise INR 12,000 crore over the next 10 years. The Department of Agriculture would need to raise INR 4,500 crore and focus on a 10-fold increase in expenditure on rice and sugarcane, its key crops.

Current levels of funding for the proposed programmes will deliver only INR 6,500 crore over the next 10 years. Further, farmer contributions of up to INR 1,400 crore may be expected if current subsidy levels are to continue in future. The WRD should create a framework to draw investment from the private sector in selected areas like modernisation, R&D in agriculture, and agriculture equipment, in order to fund the balance INR 8,500 crore to INR 10,000 crore (Exhibit 4.1).

EXHIBIT 4.1



Supporting institutions and governing bodies

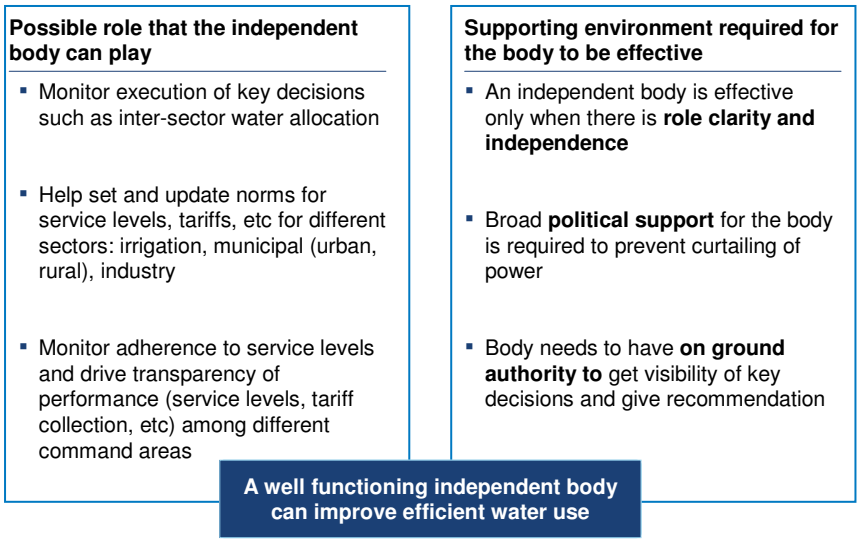
The WRD can ensure effective water management by setting up multiple roles along the water value chain to look into monitoring and driving reforms, strategic planning, regulatory requirements, infrastructure creation and maintenance, water management, farmer interaction and participations. The scope of these roles extends even beyond the WRD. Supporting institutions and governing bodies are thus necessary to strengthen these roles:

- An **empowered ministers' group,** comprising ministers from relevant departments such as Water Resources, Agriculture, Rural Development and Panchayati Raj, Industries, and Municipalities among others. This group should drive structural and legislative reforms, kick-start the transformation agenda, drive inter-departmental initiatives, monitor and debottleneck implementation of the water policy and progress of transformation initiatives. An equivalent arrangement at the Principal Secretary and Secretary level can support the group, with inputs from a technical group and respective departments.

- An **independent body** responsible for monitoring inter-sector allocation, service levels and transparency of performance. This body can succeed only with absolute role clarity and broad support from the political class (Exhibit 4.2)
- A **"water research and strategy institute"** as a public-private partnership. This would act as a think tank to shape policy, conduct research on economic topics, channel funds into promising water-related technologies, support the government in policy implementation as needed and facilitate dialogue between various stakeholders. The institute should be set up to have an independent board of government representatives, NGOs, private companies and academics. Its membership should also be diverse, including former government officials, graduates from various eminent universities and academics on secondment who will also develop capability of the other members.

EXHIBIT 4.2

An independent body with a focus on monitoring can play a role in driving implementation of key decisions



Revitalise participatory irrigation management

Participatory irrigation management (PIM) should be revitalised to address the gaps in the implementation of this policy. Gujarat and Maharashtra have been reasonably successful in driving the acceptance of WUAs through training and support of NGOs. In Gujarat, NGOs such as the Development Support Centre focus on enhancing farmer capability. In Maharashtra, the involvement of NGOs such as Sinchan Sahyog helps to build awareness among farmers. These NGOs organise conferences and fairs highlighting the benefits of PIM (Exhibit 4.3).

EXHIBIT 4.3

Role of NGOs in driving acceptance of water user associations

Gujarat

- NGOs like Development Support Centre (DSC) involved in programmes to promote water user associations
- 351 training programmes to 12930 farmers and officials spanning 58,000 ha conducted by DSC
- Focus on enhancing farmer capacity through training and community organising
- Policy support to state government for promoting wider adoption

Maharashtra

Capacity building of irrigation farmers

- Involvement of NGOs like 'Sinchan Sahayog' in driving awareness – conferences and fares focused on highlighting benefits of participation in irrigation management
- WUA Awareness week organized annually to build awareness of WUAs, its role and responsibilities

Capacity building of irrigation personnel

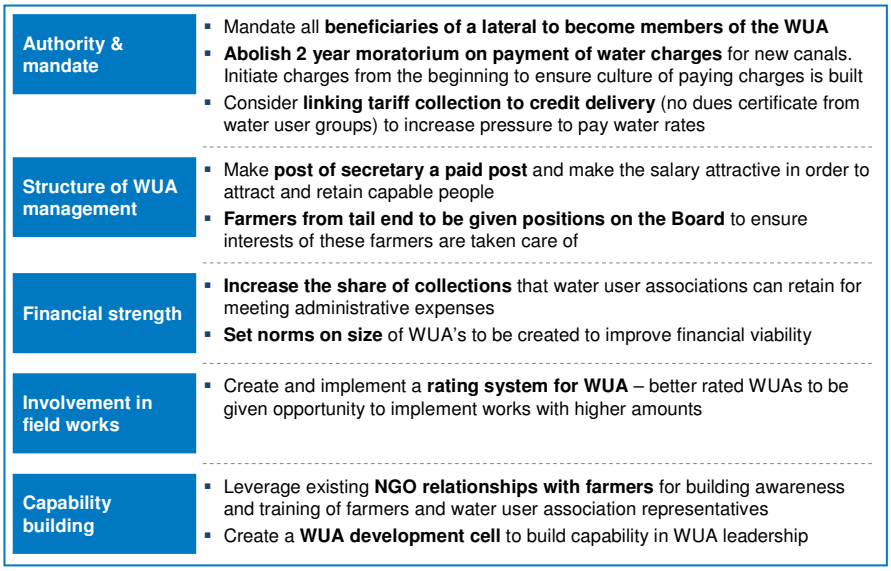
- Training for irrigation personnel from Water and Land Management Institute, Aurangabad and Engineering Staff College, Nashik
- Sharing of experiences of top level officials through regular conferences

It is possible to revitalise PIM in Karnataka by truly empowering WUAs and investing in capability building by setting up a WUA Development Cell. In doing so, the state can work in the following five areas:

- Increase the authority and mandate of the WUA through actions like abolishing the 2-year moratorium on payment of water charges and linking tariff repayment to credit delivery.
- Restructure WUA management to ensure adequate representation of all farmers and attract capable people as secretaries.
- Strengthen the finances of the WUA by rationalising its size and increasing tariff retention percentage.
- Incentivise high-performing WUAs with greater involvement in field work.
- Build capability and awareness by leveraging existing NGO relationships (Exhibit 4.4).

EXHIBIT 4.4

Changes are required to ensure success of WUAs in Karnataka



The revitalised WUAs should play an important role in Karnataka's water transformation. Besides being more actively involved in water management and infrastructure maintenance, they should contribute to providing water-related extension services and improving efficiency of water use in these areas.

Monitoring water use and incentivising improvements in water-use efficiency

A critical factor in meeting the state's future water needs is driving efficiency in the use of water through economic signals, such as building awareness of water used through volumetric measurement of water and a simple tariff system based on area-crop grown.

In the long term, the state should move to a system of charging users or an agglomeration of users based on volumetric usage of water. We suggest installing volumetric metering at the distributory level and then scaling it up to the laterals. Given the challenge in charging and recovering a direct price for water, the state should also explore alternative pricing signals that are easier to implement – such as rewarding farmers/associations for saving water.

Build capability and capacity in key institutions

Capability building is an important enabler across multiple initiatives, including project excellence, water management centricity, micro-irrigation scale-up, and programmes for rice and sugarcane.

Delivery organisations that directly interact with farmers require institutional capacity to train personnel. Around 250 WUA representatives and 250 extension agents from sugarcane mills should be trained to provide drip irrigation-related extension services to achieve the target 2 lakh hectares of drip-irrigated sugarcane by 2020. Similarly, 8,000 extension workers should be trained to provide agriculture-related extension services across the state. It is also estimated that to promote the development of WUAs, around 1,500 CADA co-operative and technical staff members need to be trained in addition to 32,000 WUA board members from around 4,000 WUAs.

The state should explore collaborating with the National Skills Development Corporation (NSDC) to fund and create training programmes for extension agents and WUAs where the scale is large.

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These enablers will be critical in strengthening Karnataka's drive for efficient water use towards spearheading the water sector transformation. Without action on the enablers, the state will fail to gain the full returns on its investment in the seven proposed initiatives.

5. Building momentum for implementation

Successfully transforming the water and agriculture sector in Karnataka is a complex journey requiring several long-term actions. Early momentum and quick wins are essential to maintain interest among the stakeholders (government departments, users, political establishment, etc.).

We recommend the following as four immediate steps to build this momentum:

1. Launch the **water transformation effort as a state priority and create alignment around the vision and strategy** with political leadership, government departments such as Water Resources, Agriculture and Horticulture, civil society, the central government and the Planning Commission.
2. **Launch pilot projects** to scale up proven technologies such as System of Rice intensification, drip irrigation, etc. In addition, **launch programmes** to institutionalise "project management excellence" and "water management excellence".

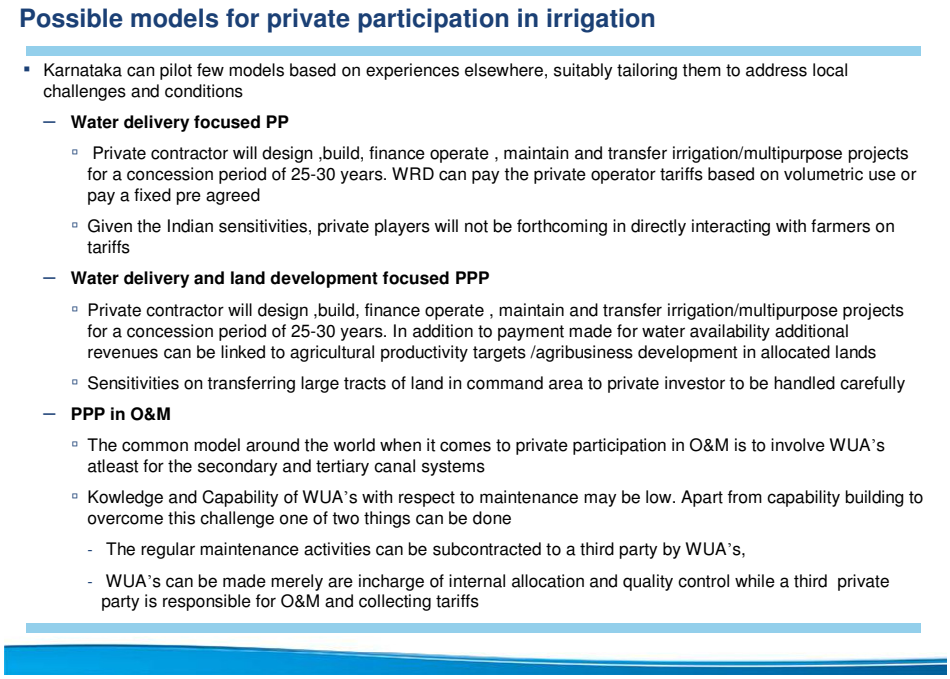
3. **Explore private participation in the scale-up of pilot projects in the agriculture and irrigation infrastructure sectors.** It is possible to leverage events such as Global Investors Meets to accelerate involvement of the private sector in select areas in agriculture (e.g., commercialisation of hybrid seed varieties, establishing food processing units and cold chain facilities). The WRD should also evaluate how the private sector can contribute in the efficient construction and maintenance of irrigation infrastructure (Exhibits 5.1 and 5.2).
4. **Initiate work on the State Water Policy and Irrigation Act** and align it with the vision and strategy of the state water transformation. This is necessary to move from the pilot stage to large-scale implementation of solutions and strategies across the state.

EXHIBIT 5.1

Private participation opportunities in agriculture

	Key features	Examples
Research and development consortium	▪ Consortium between agricultural universities and private players. May also include international institutes like International Rice Research Institute ▪ University to provide local germplasm and expertise and get a royalty fee in return ▪ Private player provides and global techno-logy in return for exclusive marketing rights	▪ Monsanto - Punjab Agricultural University tie up for rice, cotton, soyabean and maize. First right of product development lies with Monsanto while PA would get royalty
End-to-end value chain tie-ups	▪ End-to-end involvement of private players from seed supply and extension services to procurement and marketing of the produce ▪ Can help **drive shift to horticulture crops** by removing price uncertainties especially in horticulture ▪ Can **drive agricultural productivity** through promotion of better seed varieties and agricultural practices	▪ **Namdhari Fresh:** Contract farming model for fruits and vegetables. Namdhari provides extension & financial assistance for seeds, etc. Produce is procured & distributed in India and abroad through an un-interrupted cold chain network ▪ **Rallis – Tamil Nadu** tie-up for pulses. Rallis produces seed at commercial scale from breeder seeds developed by university & provides extension services. Produce is procured, package and marketed by Rallis
Annuity model for promoting micro-irrigation	▪ Private player builds and maintains irrigation projects where water is delivered through micro-irrigation systems only	▪ **Shiggaon lift irrigation project**: Jain Irrigation is responsible for setting up sprinkler infrastructure and maintain it for 2 years in return for an annuity payment

EXHIBIT 5.2



Possible models for private participation in irrigation

- Karnataka can pilot few models based on experiences elsewhere, suitably tailoring them to address local challenges and conditions
  - **Water delivery focused PP**
    - Private contractor will design ,build, finance operate , maintain and transfer irrigation/multipurpose projects for a concession period of 25-30 years. WRD can pay the private operator tariffs based on volumetric use or pay a fixed pre agreed
    - Given the Indian sensitivities, private players will not be forthcoming in directly interacting with farmers on tariffs
  - **Water delivery and land development focused PPP**
    - Private contractor will design ,build, finance operate , maintain and transfer irrigation/multipurpose projects for a concession period of 25-30 years. In addition to payment made for water availability additional revenues can be linked to agricultural productivity targets /agribusiness development in allocated lands
    - Sensitivities on transferring large tracts of land in command area to private investor to be handled carefully
  - **PPP in O&M**
    - The common model around the world when it comes to private participation in O&M is to involve WUA's atleast for the secondary and tertiary canal systems
    - Kowledge and Capability of WUA's with respect to maintenance may be low. Apart from capability building to overcome this challenge one of two things can be done
      - The regular maintenance activities can be subcontracted to a third party by WUA's,
      - WUA's can be made merely are incharge of internal allocation and quality control while a third private party is responsible for O&M and collecting tariffs

We have identified 10 possible pilots that the state can adopt as a first step in this transformation journey (Exhibit 5.3).

EXHIBIT 5.3

Water-enabled growth – Pilots from Phase 1 (1/2)

Involves significant private participation

Initiative		Pilot description	Pilot priority	Est. Timeline Months	Outcome
Excellence in project execution & maintenance	1	▪ Achieving time reduction for 2-3 surface irrigation projects,. Change process supported by the central design and project management center	High	6	▪ Microplanning, MIS and project debottlenecking systems ▪ Setting up design and project management center
	2	▪ Executing one project by contracting a private player to be the Bulk water supplier (Build-operate-transfer) to establish PPP model for irrigation infrastructure in the UMPP mode	High	6-12	▪ Proving alternate models for private player participation
Water management excellence		In two command areas, drive water management excellence by:		12-18	▪ Prove new model for working of CADA
	3	▪ Prioritize the activities of the CADA to focus only on irrigation related infrastructure – field drains, field irrigation channels, etc.	High		
		▪ Select 2-3 themes for training of farmers (e.g. adoption of SRI)	Medium		
	4	▪ Install volumetric measurement (best available tamper proof technology) in main canal, distributaries	Medium		▪ Shortlist 2-3 critical technology interventions that can be scaled up (volumetric measurement, etc)
		▪ Set up web-based/ mobile update system to display status of canal and distributories	Medium		
Micro-irrigation scale-up		Conduct two drip adoption pilots with Anthar Ganga as nodal agency, with strong private support		12-18	
	5	▪ 1-2 new surface irrigation projects in Upper Krishna basin (Scheme B) to be selected for last mile irrigation as drip. Target for conversion of 0.5-1 lakh hectares.	High		▪ Prove drip irrigation for surface irrigation projects
	6	▪ ~10,000 ha in an existing command areas where sugarcane is an major crop (e.g. Ghataprabha, Malaprabha, etc)	Medium		

Water-enabled growth – Pilots from Phase 1 (2/2)

Involves significant private participation

Initiative		Pilot description	Pilot priority	Est. Timeline Months	Outcome
Rice productivity practices	7	▪ Pilots at scale on SRI targeted at head reach areas of major rice growing command areas such as Narayanpur of Tungabhadra basin – Adoption in 1 lakh ha. in 1.5 years – Thrust on proving usage of farm mechanization to address labour challenges in SRI – Village by village adoption through key opinion leaders. Collaboration with agencies with expertise in SRI (from IRRI, etc.)	High	12-18	▪ Prove SRI adoption at scale
	8	▪ Pilots on aerobic rice adoption (10,000-30,000 ha) launched in taluks at tail-end of major irrigation projects & low rainfall districts like Tumkur, Bangalore, Kolar, Mandya, Mysore, etc.	Medium	12-18	▪ Prove aerobic rice at scale
Sustainable Sugarcane Initiative	9	▪ Medium scale pilot (~4000-8,000 ha) to address challenges to large scale adoption of SSI, in collaboration with select sugar mills – Partnership with organizations like ICRISAT-WWF or AgSri to train department personnel and extension staff for the pilots – Organizations like NIRMAN & local sugar mills leveraged for extension	Medium	12	▪ Establish benefits of SRI and model to scale-up
Horticulture	10	▪ Attract private sector investments for setting up cold chain and agro-processing for 2 agro-climatic zones	High	12-18	▪ Establish model for scaling up horticulture

These pilot areas were discussed in detail and prioritised in a workshop chaired by the Hon. Minister of Water Resources, Basavaraj Bommai and Principal Secretary – Water Resources, Mr. Satyamurty D. The workshop led to identifying three main themes to be pursued for the future:

1. Irrigation efficiency improvement of water-intensive crops
2. Project management excellence for irrigation infrastructure
3. Water management excellence in command areas

1. Improving Irrigation efficiency of water-intensive crops

The pilot aims to demonstrate improvement in the irrigation efficiency of rice and sugarcane – the two water-intensive crops for Karnataka. This pilot will integrate volumetric metering (which has already been piloted by the Government of Karnataka). The broad contours of the pilot are illustrated in Exhibit 5.4.

EXHIBIT 5.4

Water efficiency improvement of water intensive crops

Water efficiency improvement through farmer centric, integrated scale-up models in an area with water intensive crops:

- **Model 1 :** Volumetric measurement with scale up of technologies relevant for rice dominated command areas (e.g., SRI, aerobic rice) driven by an effective CADA
- **Model 2:** Volumetric measurement with scale up of technologies relevant for sugarcane dominated command areas (micro-irrigation – ground & surface water drip, SSI, etc) driven by sugar mills
- **Design principles** for choosing pilot areas
  - Water deficit basins (e.g. Shadow zones with limited rains. etc)
  - Areas with known issues for which impact can be tested (tail enders not getting water, differences between envisioned crop plan and actual crops)
  - Take advantage of existing programs to leverage capacity on the ground
- **Hypothesis on the regions**
  - Tungabhadra, Bhadra command
  - Ghataprabha or Karanja, Godavari Basin
- **Timeline** : 3 seasons, 2 years
- **Scale** : 1 Lakh hectares

The CADA management would be the key drivers for change for the rice command area pilot. Key aspects of the pilot design and challenges to be addressed are illustrated in Exhibit 5.5.

EXHIBIT 5.5

Pilot 1: Rice command area pilot driven by an effective CADA (1/2)

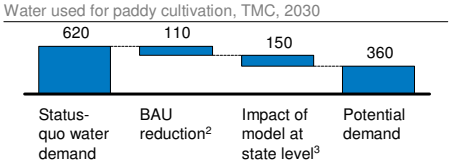
Pilot design

- **Focus crop**: Paddy
  - Largest crop: 30% irrigated area under cultivation; accounts for 45% of total water consumed by agriculture
  - Productivity in Karnataka is 2.5 tonnes per ha as against 3.25 tonnes per ha in Andhra Pradesh and 4 tonnes per ha in Punjab
- **Target area**: 1,00,000 hectares
- **Pilot location**: Tungabhadra, Bhadra command
- **Key elements**:
  - *Water efficient agriculture techniques*: System of Rice Intensification (SRI) in irrigated areas, aerobic rice in non-irrigated areas
  - *Volumetric measurement* of water at canals to allow controlled release of water and monitor efficiency of the canal network
  - *Command Area Development Authority (CADA)* as the nodal agency responsible for implementation of the programme including data collection and monitoring of adoption levels

Successful implementation across the state could lead to significant benefits

Reduction in water use[1]

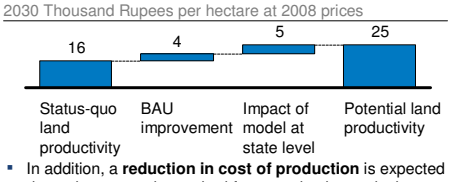
Water used for paddy cultivation, TMC, 2030



- Saving of 150 TMC translates to **lower capex requirements** for small and medium irrigation projects by approx. Rs. 1,000 crores

Increase in farmer income

2030 Thousand Rupees per hectare at 2008 prices



- In addition, a **reduction in cost of production** is expected due to lesser seeds required for transplanting and a lower fertilizer requirement under SRI method

1. Water use reduction estimated assuming constant paddy production 2. Estimate based on historical improvement in yield of 1%
3. Estimated impact of implementing the pilot programme across the entire state

Pilot 1: Rice command area pilot driven by an effective CADA (2/2)

Key challenges

- **Higher labour requirements** under SRI due to a shorter transplanting window and greater weeding requirements. Labour constraints expected to be significant initially as transplanting younger seedlings prescribed by SRI would require higher skill
- **Modification of irrigation system** in areas with plot-to-plot irrigation to field channel system to allow better water control in fields
- **Ensuring timely supply of water** to ensure that the right variety of paddy can be grown and that water is available in adequate quantity during preparation of nursery and transplanting
- **Changing the mindset of farmers** to not over-irrigated and use lesser seeds as advocated by SRI through focused extension programmes

Success has been seen at a large scale in India and other countries like Vietnam

Success in Vietnam

- SRI methods being applied by over 264,000 farmers in 21 districts on approx. 85,422 ha
- Benefits seen:
  - Average **yield increase of 9-15%** compared to current practices
  - **35% saving in water use**
  - 70-90% reduction in seed requirement
  - 20-25% reduction in the need for nitrogen fertilizers
- Key drivers for success include extension programmes focused on building farmer confidence and capability through evidence-based learning approached through **Farmer Field Schools**

Adoption in India

- SRI method incorporated into the agenda of the National Food Security Mission
- **Tamil Nadu**: Successfully implemented over 70,000 ha under the World Bank funded IAMWARM project. Benefits seen include
  - Increase in **rice yields between 30% to 80%**
  - Reduced **water use by 30%**
  - Lower fertilizer requirement
- Proven in Karnataka. 400 demonstrations under NFSM covering 40,000 ha in 7 districts. 10-15% improvement in yield across districts

SOURCE: Interviews; Press articles; WWF-ICRISAT report on SRI

For sugarcane, the state can drive the pilot by involving the sugar mills in the command area. Key aspects of the pilot design and challenges to be addressed are illustrated in Exhibit 5.6.

EXHIBIT 5.6

Pilot 2: Sugarcane command area pilot driven through sugar mills (1/2)

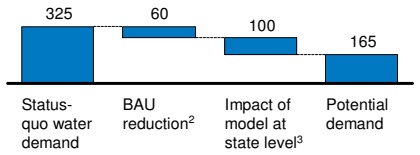
Pilot design

- **Focus crop**: Sugarcane
  - Second largest irrigated crop; accounts for 14% of irrigated land and 25% of total water used by agriculture
  - Productivity in Karnataka is ~83 tonnes per ha as against 106 tonnes per ha in Tamil Nadu and ~93 tonnes per ha in Punjab
- **Target area**: 1,00,000 hectares
- **Pilot location**: Ghataprabha or Karanja, Godavari basin
- **Key elements**:
  - *Promoting drip irrigation* both in surface irrigated and groundwater irrigated areas.
  - *Water efficient agriculture techniques*: Sustainable Sugarcane Initiative (SSI) and adoption of better practices like IPM
  - *Volumetric measurement* of water to allow controlled release of water and monitor efficiency of the irrigation network
  - *Local sugar mills* as the nodal agencies for driving water productive agriculture in their respective commands

Successful implementation across the state could lead to significant benefits

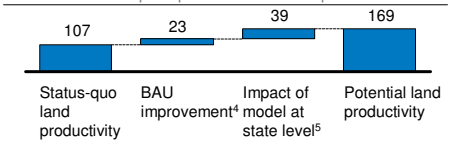
Reduction in water use[1]

Water used for sugarcane cultivation, TMC, 2030



Increase in farmer income

2030 Thousand Rupees per hectare at 2008 prices



- In addition, a **reduction in cost of production** is expected due to lesser grafts required under SSI; lower fertilizer requirement with drip irrigation

1. Water use reduction estimated assuming constant sugarcane production 2. Estimate based on historical improvement in yield of 1%
3. Estimated impact of implementing the pilot programme across the entire state

Pilot 2: Sugarcane command area pilot driven through sugar mills (2/2)

Key challenges

- **High equipment cost** – approx. Rs. 70,000 per ha in groundwater irrigated areas and more than Rs. 1,00,000 per ha in surface water irrigated areas
- **Scale-up challenges**–such as – educating farmers on usage to get yield benefit etc.
- **Unreliable power supply** – power is required for operating the drip equipment as a result of which power cuts lead to stoppage of irrigation
- **Proving usage & economics in** surface water drip – clogging of systems, storage mechanism to create a head for drip systems
- **Changing the mindset of farmers** to adopt methods advocated by SSI
- **Proving economics of SSI as with increase in labour requirements** due to the additional step of transplanting sugarcane sapplings

Success has been seen in pilots in India and also at scale in countries like Indonesia, Israel, Mexico, etc

Adoption in India

- **Karnataka**: Sprinkler irrigation project being installed at Shiggaon with the objective of providing irrigation to 9,900 ha. Project is funded by the state and implementation is in partnership with Jain Irrigation and L&T.
- **Andhra Pradesh Micro Irrigation Project** –Micro irrigation systems are being installed over an area of 2.5 la. ha. covering sugarcane, cotton, fruits and vegetables, etc. Focus is on drought prone regions of Rayalaseema and Telangana. Farmers have seen significant benefits in terms of higher yield, flexibility to grow higher value crops, etc.

Success in several countries worldwide

- **Israel**
  - Well known success story in drip irrigation with more than 50% of the irrigated land in Israel uses drip irrigation – based on ground water systems
  - A team from GoK had visited Israel to better understand key factors of success
- **Indonesia**
  - Surface water drip systems at pilot scale demonstrated. A team from WRDO-GoK had visited this location.

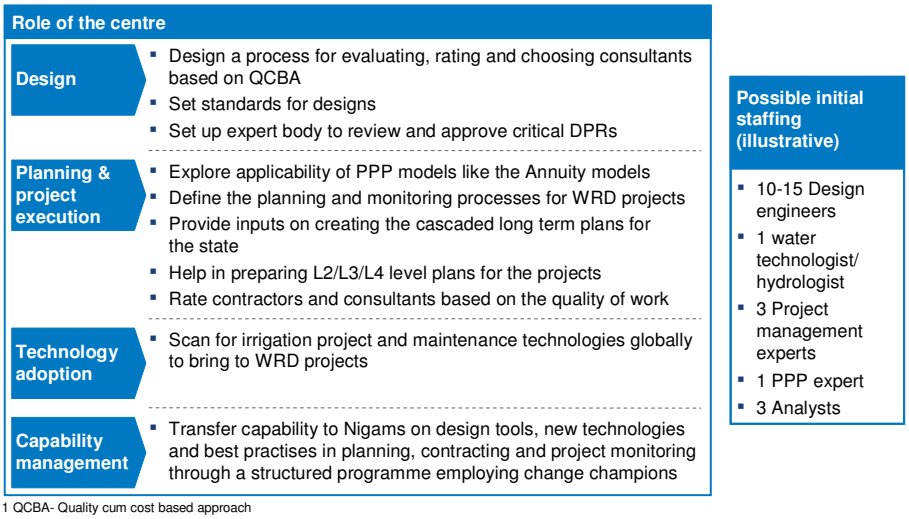
SOURCE: Interviews; Press articles

2. Project management excellence for irrigation infrastructure

This initiative focuses on creating an institution which can drive excellence in project execution and act as a nodal agency for the water transformation of the state. The state can assign this responsibility to the centre currently planned for implementation of the Integrated Water Resources Management (IWRM). Key activities for driving the pilot initiatives and scaling up the pilot to the rest of the state are detailed in Exhibit 5.7.

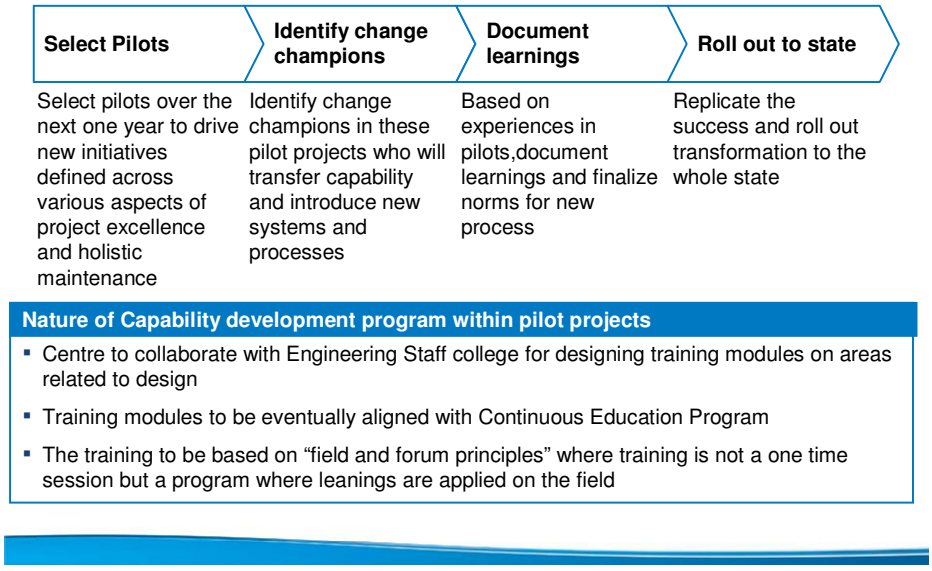
EXHIBIT 5.7

Design and project management centre for strengthening design and project management capability



1 QCBA- Quality cum cost based approach

Driving the Water Resources Department transformation and capability development through the design and project management centre



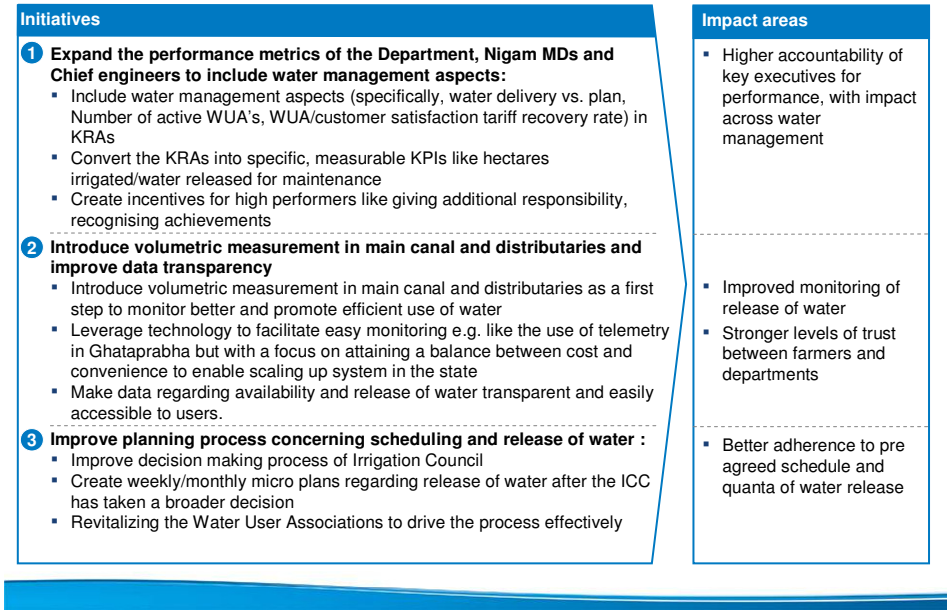
3. Water management excellence in command areas

Water management in identified pilot areas will be integrated into the existing irrigation efficiency pilots. The water management programmes will focus on (Exhibit 5.8):

- Demonstrating and proving the utility of distributory volumetric measurement systems
- Driving appropriate performance metrics and the planning process in the CADA for better management
- Revitalising WUAs to enable them to participate actively in the improvement of delivery systems.

EXHIBIT 5.8

Increasing accountability and focus on water management



A second workshop is being planned to provide inputs to the agencies driving the Detailed Project Report for the pilots.

The key questions that this workshop should answer are:

- What are the broad contours of the pilot?
- Who/which departments/groups should be involved in creating the initial pilot design?
- What should the geographic coverage be (districts/command areas)?
- What are the key milestones in the 6 months, 1-year and 2-year mark?
- What sort of governance and monitoring mechanism is needed to track progress on the pilots?
- Do you see a role for private participation or non-government agencies in the pilot to make it effective?
- What capacity building measures are needed for the pilot to be successful?

Subsequent to this workshop, the steps prior to the pilot launch are:

- Create a rough contour of pilots designed in workshop (discussed above).
- Form a working team from agencies handling the DPR (e.g., ICRISAT, IWMI), GoK, Water Resources Group. This should comprise a maximum of five individuals supported by a team of around 10 to 15 people.

- Prepare draft DPR for the pilot (command area, key technical solutions, number of pilot areas, etc.).
- Test DPR through a field visit and workshop at the target command area.
- Refine DPR based on inputs from field visit and conduct a workshop with private players, inviting participation in the pilots.
- Finalise pilot design and submit for approval to the Hon. Minister for Water Resources.
- Finalise operational tie-ups and funding for pilot to be launched.
- Launch pilots 2 months prior to irrigation season.

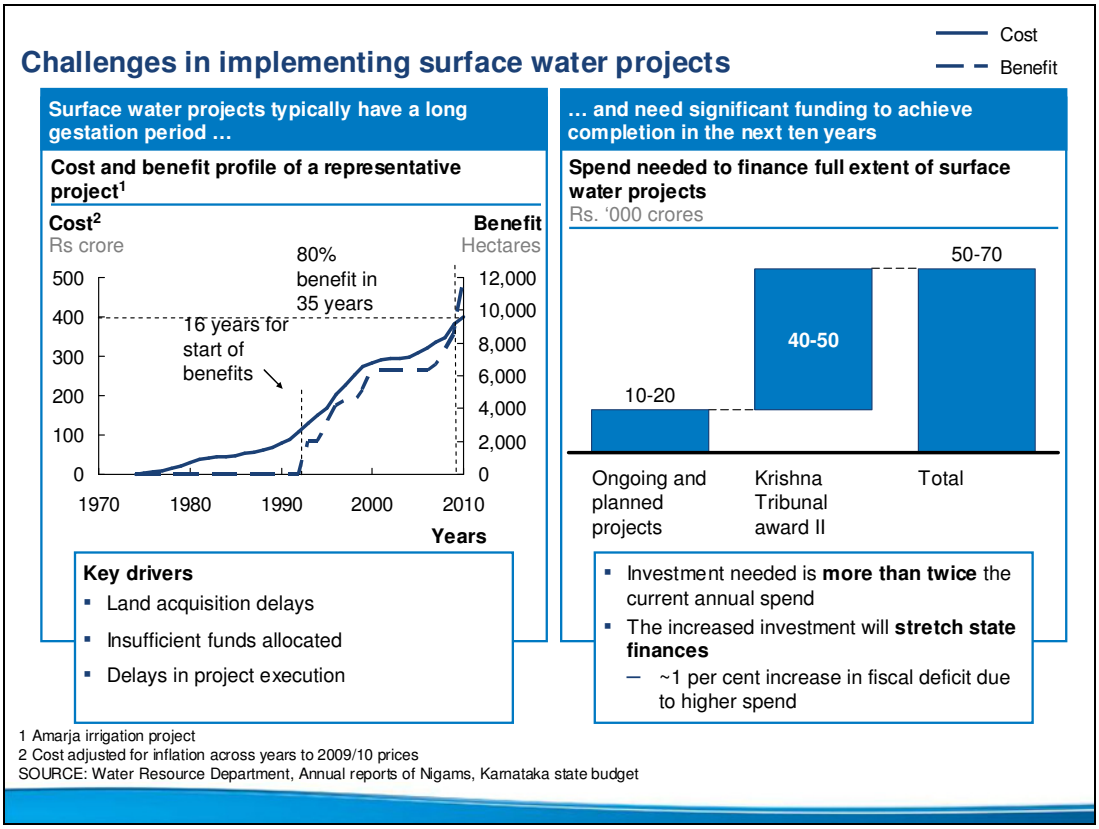
□ □ □

Delivering sufficient water to meet Karnataka's growth aspirations is a significant challenge. However, Karnataka can aspire to become India's most progressive water state by committing to the transformation journey detailed in this report. Focused and speedy implementation will, as always, be key to the state successfully overcoming the water challenge.

Appendix: Achieving excellence in project management

1. The challenge: delays in project execution and poor maintenance

Karnataka plans to augment supply with new supply schemes and rehabilitate existing supply schemes. This is projected to add supply by 290 TMC by 2030 through a mix of projects including utilising the new Krishna award, constructing new lift irrigation schemes and barrages, and building last mile infrastructure and modernising canals. However, past experience has shown that new projects get delayed often by several years. The key reasons for delays are insufficient fund allocation, land acquisition delays and delays in project execution.



Further, the maintenance of several existing projects is poor resulting in significant reduction in the actual supply. A user survey conducted across the 11 projects reveals that poor maintenance of the canal network resulting in the inadequate supply of water to the tail-end farmers are the key problems faced by the users.

Main user issues

Issue	Respondents citing the issue
	Percent
▪ Poor maintenance of canal infrastructure	68
▪ Untimely and inadequate supply of water; especially at the tail end	46
▪ Wastage due to lack of awareness of water efficient techniques	20
▪ Irregular power supply making use of bore-wells, drip irrigation, etc. difficult	15
▪ Inadequate availability of quality inputs – seeds, fertilizers, etc.	15

1 Results based on 41 responses received from farmers on the question 'What are the key challenges that you face?'
SOURCE: Farmer questionnaire

Poor maintenance of canal infrastructure

Broken drop on Distributory #3 of Narayanpur LBC

Damaged lining of Hemavathy LBC main canal

Weeds blocking lateral in Hemavathy LBC

Damaged lining in Ghataprabha project

Damaged masonry lining in Narayanpur project

2. Achieving excellence in project management and maintenance

Transforming the WRD and Nigams will enable the state to achieve excellence in project management, reduce project execution time and costs. This can increase farmer income by INR 1,040 (4 per cent of current) by 2020.

To achieve these outcomes, this study suggests the following nine initiatives.

Excellence in project management & maintenance to accelerate delivery and improve asset efficiency

1	Strengthen design capability and accelerate project execution by creating and leveraging the design and project management centre to implement best practices
2	Follow best practices in packaging and contractor selection to reduce costs and improve quality of output. (e.g., larger packages, engineer selection using QCBA, improved norms and rates for technology adoption)
3	Create a comprehensive long-term projects plan (10 year plan) to help prioritize projects and plan funding
4	Adopt practices that can help reduce land acquisition time (e.g., increased accountability, advance planning, regular benchmarking of land rates)
5	Introduce robust project management systems and review processes (e.g. independent third party observers and quality control, Robust MIS)
6	Consider a separate irrigation cadre, broaden board member profiles and increase MD tenures to increase accountability
7	Launch a large scale program focusing on modernization and rehabilitation of the canal network
8	Increase focus on maintenance of canal network and dam and strengthen maintenance systems and processes. (standardized spend norms, early release of spend, maintenance beyond weeding & de-silting, increased accountability)
9	Drive the entire Water Resources Department transformation and capability development through the design and project management centre

2.1 Strengthen design capability and accelerate project execution: The state should set up a new design and project acceleration centre to implement best practices. This centre should advise Nigams on new technology adoption and standardise designs for common irrigation structures to improve the turnaround time of engineering. Further, the centre should design a process for evaluating, rating and choosing consultants based on a quality cum cost based approach. In addition, the centre should monitor the planning and execution of projects periodically and debottleneck any execution issues leading to delays. This centre should also be responsible for building capability across the Nigams on key areas of design and project management.

2.2 Implement best practices in packaging and contractor selection: This initiative will help to reduce costs and improve quality of output. Prior to rolling out the outlined practices broadly, they can be refined by applying them on a few select projects.

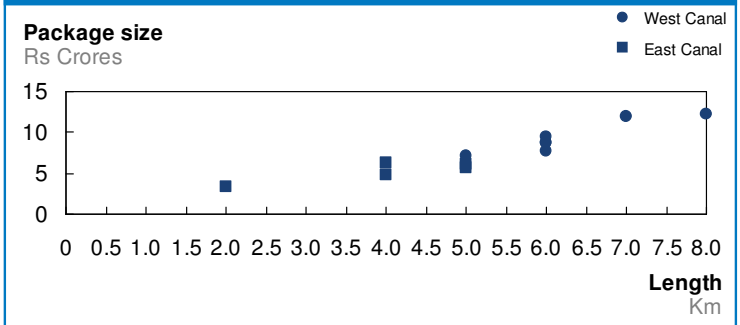
– **Increase sizes of contracts that are bid out** especially in main canals to attract larger EPC and construction companies that can bring in better practices to help save time and cost in the project. The department can enable this by considering larger contracts at the estimation stage itself. In addition, continuing the turnkey model for Lift Irrigation Schemes (LIS) headworks and for future dams should be considered.

Canal packages are typically in the range of Rs 5-12 crores for main canal sections of length 4-8 km

Current practises

- Lift irrigation works including intake, jackwell, pumping stations, rising main, delivery chamber and substation are given out on a turnkey basis
- Dams till date typically have not been constructed using turnkey contracts
- Distributary works are combined to form larger packages depending on their length
- Criteria for package selection is based on the readiness of estimates for various sections

Main Canal Package sizes[1]



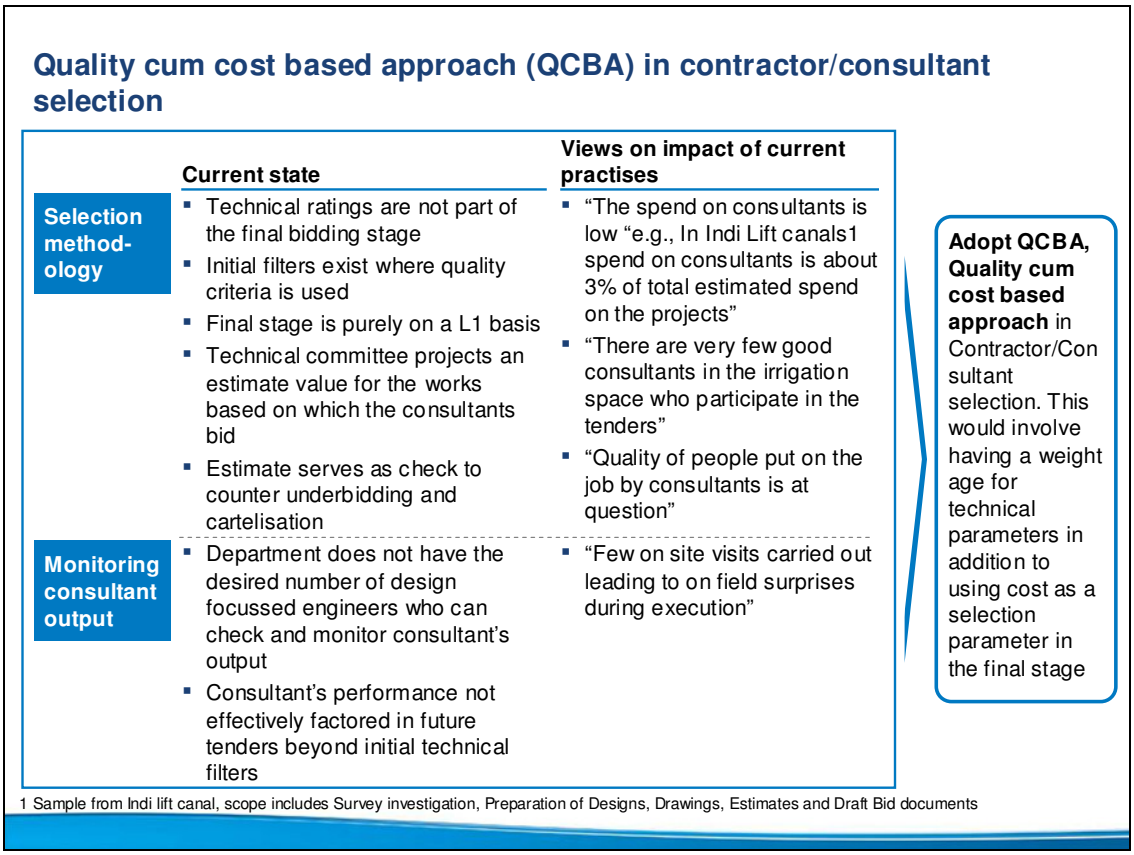
- Distributary packages ranges from Rs 3.5 to Rs 5.3 crores
- The two lift headworks packages are of values Rs 39 cores and Rs 22 crores

Ramthol Lift Irrigation Scheme: Work in progress
East and west Canal: 117 km
Distributaries :75-80
Total Estimated cost: Rs.423 crores

1 Combination of a few concluded, ongoing, and estimated packages

SOURCE: KBJNL

- **Structure contracts to align project progress with last mile infrastructure,** e.g., bundle creation of main canal along with distributaries and laterals for a given area
- **Set norms and explore revision of schedule of rates** to facilitate using the latest technology and materials in relevant sections of projects (e.g., using cement stronger than M30, using pumping equipment for cement)
- **Adopt QCBA** in contractor/consultant selection. This would involve giving weightage to technical parameters in addition to using cost as a selection parameter in the final stage.



2.3 Create comprehensive long-term projects plan (10-year plan) to prioritise projects and plan funding. One of the reasons for time over-runs in irrigation projects is that available funding is spread thin over a large number of ongoing and new irrigation projects. Funding fewer but more impactful projects end to end can help create larger pieces of irrigated land at a lower cost. Creating a 5- to 10-year project progress plan based on priority metrics such as cost per hectare of irrigation created and nearness to completion is critical to achieving more societal impact with the available funds.

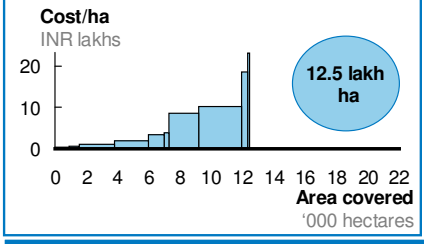
Comprehensive long-term projects plan (10 year plan) to help prioritize projects and plan funding

REPRESENTATIVE PROJECTS

Improved planning can result in more land being brought under irrigation in the same time

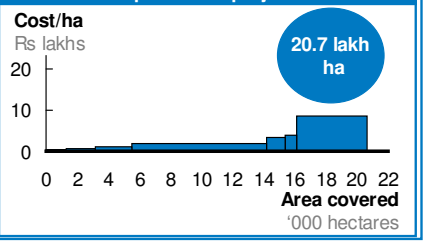
Spreading of funds across multiple projects without a formal prioritization system may not be optimal

Current approach in spreading of funds across multiple projects



Efficient approach of prioritizing projects by considering impact and benefit parameters can create more irrigated land

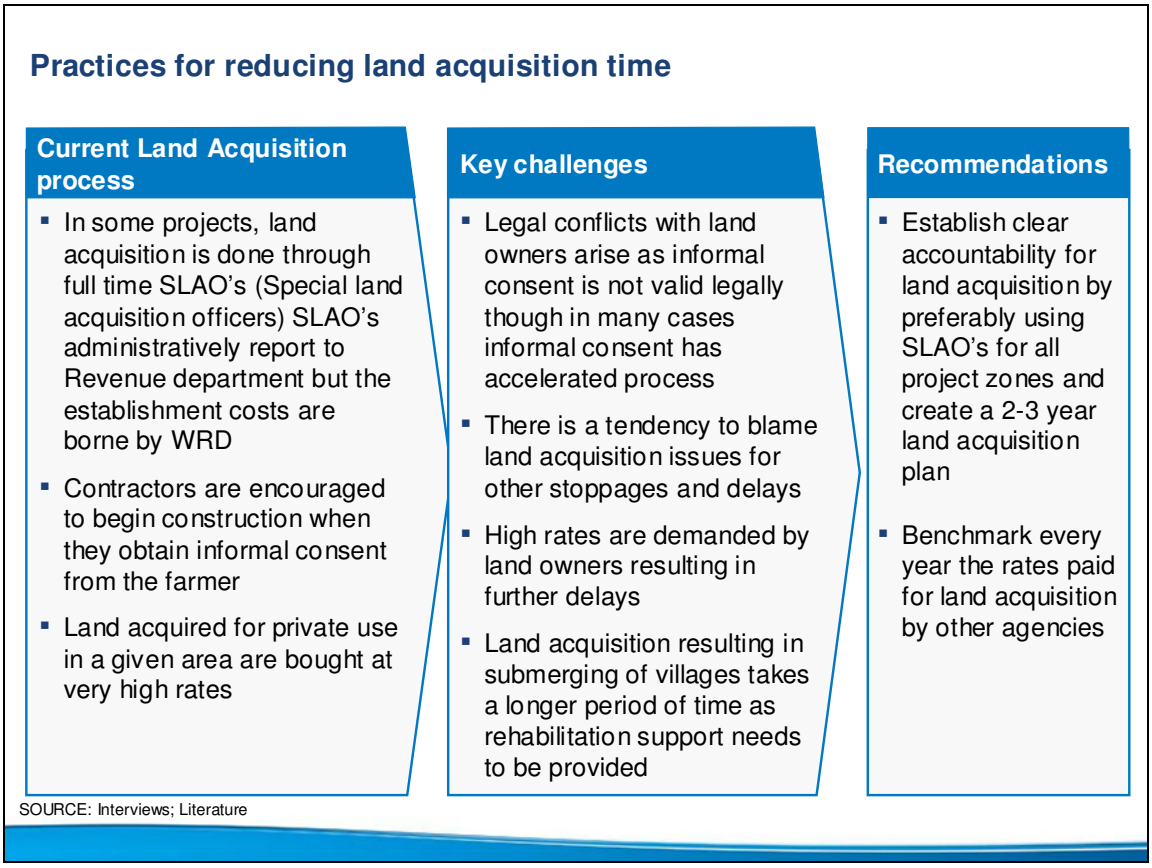
Efficient approach in spreading of funds across prioritised projects



- Prioritise projects on the basis of relevant parameters to get results early (e.g., nearness to completion , cost per hectare, benefit to farmers etc.)
- Create a cascaded plan based on prioritized projects and availability of funds estimated from previous allocations over a prolonged period
- Improve accuracy of estimation process by factoring increase in price of raw materials over the project lifetime

1 Projects with a completion of more than 60% of total planned hectares in 2009-10
SOURCE: Water Resource Department

2.4 Adopt practices to help reduce land acquisition time. Land acquisition should be an area of focus given it is one of the key bottlenecks to completion of projects. Special Land Acquisition Officers (SLAO) should be used for all major project zones and they should be made accountable by creating a 2 to 3 year land acquisition plan and measuring performance against plan. The process should be reviewed frequently through initiatives, such as benchmarking of rates paid for land acquired for irrigation purposes against prevailing market rate of land every year.



2.5 Introduce robust project management system and processes

- Independent third party observers can be appointed to check violations such as unauthorised sub-contracting and other contractor practices.
- A comprehensive MIS system can be introduced to increase transparency in contractor management and enable on the ground debottlenecking regularly
- Quality control divisions must become more independent and effective by reporting directly to a senior administrator in the WRD rather than to chief engineers.

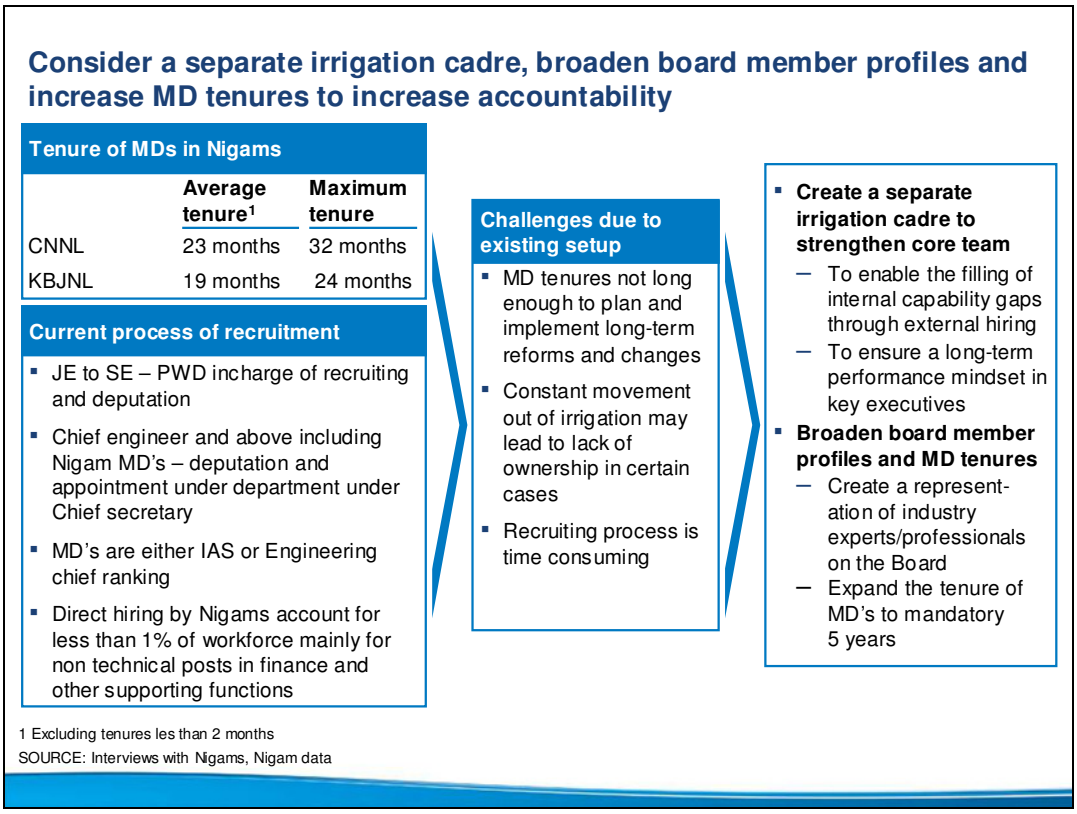
Introduction of robust project management systems and review processes

- **Establish a comprehensive review mechanism** at multiple levels, e.g., Executive Engineer (weekly), Chief Engineer (monthly) and Secretary/Minister (quarterly)
- **Develop detailed project planning templates** that facilitate clarity on project status, completion targets and resource mobilization. A daily activity plan and daily monitoring to increase transparency in contractor management and enable on the ground debottlenecking
- **Introduce a comprehensive project management system** with standardized action-oriented report formats to increase visibility across stakeholders. Several software options are available from complex packages like Primavera and Suretrack to simple packages like Microsoft Project. It has been seen that easy to use project management software are sufficient to monitor progress of irrigation projects.
- **Use independent third party observers** to check violations like, unauthorized subcontracting and other contractor practices
- **Make quality control divisions more independent** by making them report to a central entity

2.6 Implement changes in staffing process for Water Resources Department and Nigam personnel

– **Create a separate irrigation cadre to strengthen core team**. Currently, the Nigams recruit a large part of their staff from the Public Works Department (PWD), who may have the disadvantage of insufficient exposure to irrigation. To help create a core team of irrigation engineers, we propose forming a separate irrigation cadre and recruiting, training and developing people for it.

– **Broaden profiles of board members of the Nigams and increase tenure of Nigam MD.** An increased MD tenure of 4 to 5 years compared to the current average of around 2 years will enable the MD to drive long-term strategic reforms more effectively. Also, participation by independent external experts in the board will help bring in new ideas.



2.7 Launch a large-scale programme by modernising and rehabilitating the canal network. Apart from the 4 to 5 currently identified projects, others should be taken up for **modernisation** and rehabilitation over the next 10 years to improve the condition of canal infrastructure. Currently identified projects require around INR 3,800 crore for modernisation and an equal amount should be allocated for future projects too. The state should also set stringent targets for contractors to reduce execution time to ensure completion during the off-season.

Programme for modernization and rehabilitation of the canal network

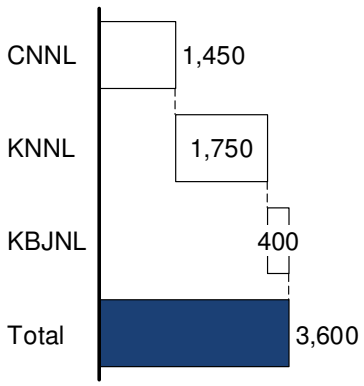
Identify projects for one time modernization apart from the existing 4-5 projects identified

Currently Identified potential projects

- Modernisation of 6 Anicut channels
- Lining in KRBC, HLBC
- Hemavathy modernisation
- Tunghabhadra
- Gondi and Tunga Anicut
- Vijayanagar channels
- Lining of NLBC

Funding needs for modernization projects across Nigams

INR '000 crores



- Apart from currently identified projects other projects need to be taken up for modernisation and rehabilitation over the next 10 years to improve condition of canal infrastructure
- Currently identified projects require ~Rs. 3,600 crores for modernization and an equal amount is to be allocated for future projects too.

SOURCE: Interviews with Nigams, Nigam data

2.8 Improve maintenance of irrigation infrastructure: Apart from one-time rehabilitation, it **is** critical that practices be adopted to ensure maintenance of the structures over time. This can be achieved by rationalising maintenance spend norms, improving planning and increasing accountability for maintenance within the WRD.

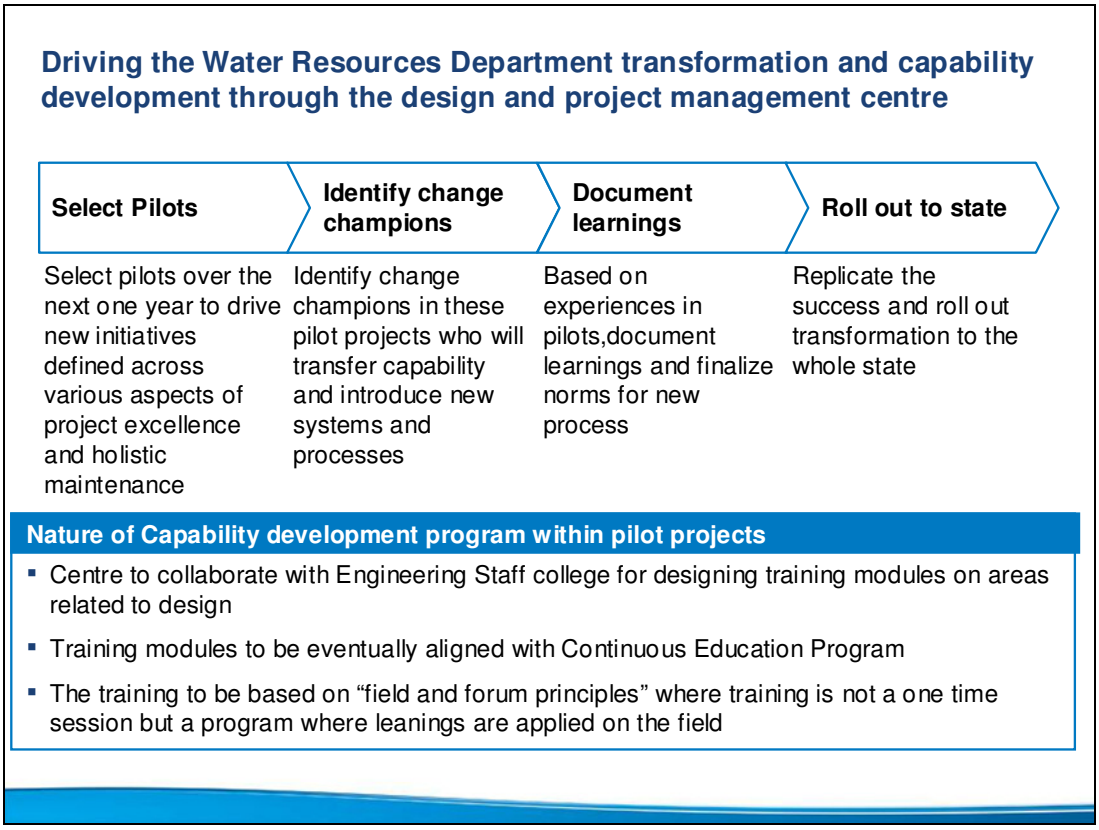
- **Standardise norms for regular maintenance spend** across the three Nigams based on age of project, length of canal network, complexity and buffer for usage as emergency funds by chief engineer. The release of funds should also be aligned with the irrigation season to ensure their effective use.
- **Create a maintenance plan at the beginning of each year** to prioritise and schedule maintenance activities beyond desilting and removal of weeds. It is important that a suitable time window be created in the year to carry out and inspect maintenance activities while not affecting the water release to farmers
- **Increase the accountability for maintenance** by evaluating chief engineers on maintenance-related KPIs like conveyance efficiency of canals. To apportion the work better, the post of an O&M engineer can be created, who will be responsible only for maintenance of the network throughout the year, especially in projects that are still being constructed.

In addition, given its critical position, the main canal should be maintained by a dedicated team rather than dividing the responsibility among several teams.

Focus on maintenance of canal network and dam and strengthening of maintenance systems and processes

	Recommendations
Planning	▪ Create a maintenance plan at the beginning of each year that prioritizes maintenance activities beyond desilting and removal of weeds taking into account performance of canal system ▪ Create suitable window in a year to carry out and inspect maintenance activities while not affecting the water release to farmers
Funding	▪ Rationalize and standardize regular maintenance spend norms across three Nigams based on age of project, length of canal network, complexity and buffer for usage as emergency funds by Chief Engineer
Ownership	▪ In projects which are in still in progress separate responsibility for capital works, operations and maintenance posts. Create a post for an O&M engineer who is responsible only for maintenance of the network throughout the year. ▪ Keep maintenance responsibility of main canal under a dedicated team rather than breaking up main canal maintenance responsibility among several engineers ▪ Evaluate Chief engineer on maintenance related targets like conveyance efficiency of canals

2.9 Drive capability building through the design and project management centre. Transformation and capability development of the Water Resources Department should be driven through the design and project management centre. The state should pick 2 to 3 pilot projects over the next year and implement the new systems, processes and practices in engineering best practices, packaging and contractor selection, land acquisition, project management and maintenance. The state should identify change champions within pilot projects to drive the transformation. The learning and insights gained should be documented and will form the basis of scale-up applied to all projects within the state over the next 2 to 3 years.



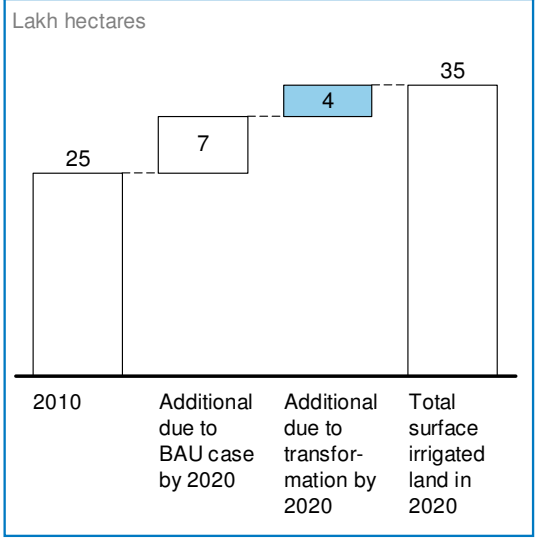
Driving the transformation of the WRD and the Nigams will enable the state to reduce project execution time and costs. This can increase farmer income by INR 1,040 (4 per cent of current) by 2020.

Farmer income can increases by Rs.1,040 crores by 2020 due to excellence in project management and maintenance

Assumptions

- Transformation results in 20% reduction in Capex spend required and 20% reduction in time required to complete projects
- In the Business as usual case Nigam adds ~ 70000 hectares per year based on historical averages
- Additional income arises due to conversion of additional non irrigated land into irrigated land by 2020

Irrigated land



Additional farmer income of Rs.1,040[1]

1 GVO per irrigated hectare calculated to be ~Rs.36,000