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PROJECT PERFORMANCE ASSESSMENT REPORT



INDIA

Tamil Nadu Irrigated Agriculture  
Modernization and Water-Bodies  
Restoration and Management Project

**Report No. 140642**

AUGUST 22, 2019

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**INDIA**

**TAMIL NADU IRRIGATED AGRICULTURE MODERNIZATION AND  
WATER-BODIES RESTORATION AND MANAGEMENT PROJECT  
(IBRD-48460, IDA-42550)**

August 22, 2019

*Financial, Private Sector, and Sustainable Development*

*Independent Evaluation Group*

## Currency Equivalents (annual averages)

*Currency Unit = Indian Rupee (Re)*

2007	\$1.00	Re 41.2
2009	\$1.00	Re 46.4
2011	\$1.00	Re 44.5
2013	\$1.00	Re 59.5
2015	\$1.00	Re 63.6

## Abbreviations

CIG	commodity interest group
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IEG	Independent Evaluation Group
M&E	monitoring and evaluation
MDPU	multidisciplinary project unit
O&M	operation and maintenance
PPAR	Project Performance Assessment Report
Re	Indian rupee (currency)
SRI	System of Rice Intensification
SWaRMA	State Water Resources Management Agency
TNAU	Tamil Nadu Agriculture University
TN-IAMWARM	Tamil Nadu Irrigated Agriculture Modernization and Water-Bodies Restoration and Management Project
TNIAM	Tamil Nadu Irrigated Agriculture Modernization
WRCP	Water Resources Consolidation Project
WRO	Water Resources Organization
WUA	water user association

*All dollar amounts are U.S. dollars unless otherwise indicated.*

## Fiscal Year

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This report was prepared by Ramachandra Jammi and Bhuvanewari Parakalan (consultant), who assessed project in February 2019. The report was panel reviewed by Vibecke Dixon and peer reviewed by Vijay Jagannathan. Romyne Pereira provided administrative support.

## Principal Ratings

Indicator	ICR	ICR Review	PPAR
Outcome	Satisfactory	Satisfactory	Satisfactory
Risk to development outcome	Substantial	Substantial	Substantial
Bank performance	Moderately satisfactory	Moderately satisfactory	Satisfactory
Borrower performance	Moderately satisfactory	Moderately satisfactory	Satisfactory

*Note:* The Implementation Completion and Results Report (ICR) is a self-evaluation by the responsible Global Practice. The ICR Review is an intermediate Independent Evaluation Group product that seeks to independently validate the findings of the ICR. PPAR = Project Performance Assessment Report.

## Key Staff Responsible

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**IEG Mission: Improving World Bank Group development results through excellence in independent evaluation.**

**About This Report**

The Independent Evaluation Group (IEG) assesses the programs and activities of the World Bank for two purposes: first, to ensure the integrity of the World Bank's self-evaluation process and to verify that the World Bank's work is producing the expected results, and second, to help develop improved directions, policies, and procedures through the dissemination of lessons drawn from experience. As part of this work, IEG annually assesses 20–25 percent of the World Bank's lending operations through fieldwork. In selecting operations for assessment, preference is given to those that are innovative, large, or complex; those that are relevant to upcoming studies or country evaluations; those for which Executive Directors or World Bank management have requested assessments; and those that are likely to generate important lessons.

To prepare a Project Performance Assessment Report (PPAR), IEG staff examine project files and other documents, visit the borrowing country to discuss the operation with the government, and other in-country stakeholders, interview World Bank staff and other donor agency staff both at headquarters and in local offices as appropriate, and apply other evaluative methods as needed.

Each PPAR is subject to technical peer review, internal IEG panel review, and management approval. Once cleared internally, the PPAR is commented on by the responsible World Bank Country Management Unit. The PPAR is also sent to the borrower for review. IEG incorporates both World Bank and borrower comments as appropriate, and the borrowers' comments are attached to the document that is sent to the World Bank's Board of Executive Directors. After an assessment report has been sent to the Board, it is disclosed to the public.

**About the IEG Rating System for Public Sector Evaluations**

IEG's use of multiple evaluation methods offers both rigor and a necessary level of flexibility to adapt to lending instrument, project design, or sectoral approach. IEG evaluators all apply the same basic method to arrive at their project ratings. Following is the definition and rating scale used for each evaluation criterion (additional information is available on the IEG website: <http://ieg.worldbankgroup.org>).

**Outcome:** The extent to which the operation's major relevant objectives were achieved, or are expected to be achieved, efficiently. The rating has three dimensions: relevance, efficacy, and efficiency. *Relevance* includes relevance of objectives and relevance of design. Relevance of objectives is the extent to which the project's objectives are consistent with the country's current development priorities and with current World Bank country and sectoral assistance strategies and corporate goals (expressed in Poverty Reduction Strategy Papers, country assistance strategies, sector strategy papers, and operational policies). Relevance of design is the extent to which the project's design is consistent with the stated objectives. *Efficacy* is the extent to which the project's objectives were achieved, or are expected to be achieved, taking into account their relative importance. *Efficiency* is the extent to which the project achieved, or is expected to achieve, a return higher than the opportunity cost of capital and benefits at least cost compared with alternatives. The efficiency dimension is not applied to development policy operations, which provide general budget support. *Possible ratings for outcome:* highly satisfactory, satisfactory, moderately satisfactory, moderately unsatisfactory, unsatisfactory, highly unsatisfactory.

**Risk to development outcome:** The risk, at the time of evaluation, that development outcomes (or expected outcomes) will not be maintained (or realized). *Possible ratings for risk to development outcome:* high, significant, moderate, negligible to low, and not evaluable.

**Bank performance:** The extent to which services provided by the World Bank ensured quality at entry of the operation and supported effective implementation through appropriate supervision (including ensuring adequate transition arrangements for regular operation of supported activities after loan or credit closing, toward the achievement of development outcomes). The rating has two dimensions: quality at entry and quality of supervision. *Possible ratings for Bank performance:* highly satisfactory, satisfactory, moderately satisfactory, moderately unsatisfactory, unsatisfactory, and highly unsatisfactory.

**Borrower performance:** The extent to which the borrower (including the government and implementing agency or agencies) ensured quality of preparation and implementation, and complied with covenants and agreements, toward the achievement of development outcomes. The rating has two dimensions: government performance and implementing agency(ies) performance. *Possible ratings for borrower performance:* highly satisfactory, satisfactory, moderately satisfactory, moderately unsatisfactory, unsatisfactory, and highly unsatisfactory.

## Preface

This is a Project Performance Assessment Report (PPAR) prepared by the Independent Evaluation Group (IEG) of the World Bank Group for the Tamil Nadu Irrigated Agriculture Modernization and Water-Bodies Restoration and Management (TN-IAMWARM) project in India (P090768).

The project was approved on January 23, 2007, for a cost of \$566 million, supported by an International Bank for Reconstruction and Development (IBRD) loan of \$335 million and an International Development Association (IDA) credit of \$150 million. The project cost at completion was \$489 million, of which \$287 million was financed by IBRD and \$153 million by IDA. The project closed on June 30, 2015—two years and three months later than originally scheduled.

This project was selected for a performance assessment because its design goes significantly beyond typical irrigation projects by combining traditional infrastructure rehabilitation components with extension activities for agriculture, horticulture, livestock, and fisheries; storage facilities for produce; and marketing links—all activities geared to contribute to improved farmer livelihoods. Lessons from the design and implementation of this project were expected to provide valuable input for IEG’s ongoing evaluation on sustainable irrigation service delivery (expected in 2019). The primary target audience is the Water and Agriculture Global Practices of the World Bank.

The assessment is based on a review of relevant documentation, interviews with World Bank staff at headquarters and in the country office, and the findings of an IEG mission that visited the state of Tamil Nadu during February 8–15, 2019. Project performance was discussed in interviews with officials of the state government and the multidisciplinary project unit (MDPU) and staff of the World Bank’s country office. Site visits were conducted to 11 villages along with MDPU officials and district-level officials, and discussions were conducted in each location with village officials, farmers, fishermen, and livestock owners, capped by a general assembly of villagers with large representation of women and tail-end farmers. Appendix G lists the persons met during the mission. The mission deeply appreciates the meticulous preparation and conduct of the field visits by the MDPU and district officials, and the project director’s time given for detailed and insightful discussions on the project’s experience.

Following standard IEG procedures, a copy of the draft PPAR was sent to government officials and implementing agencies for their review and comments. The response received from MDPU is attached in appendix H.

# Summary

This Project Performance Assessment Report assesses the development effectiveness of India's Tamil Nadu Irrigated Agriculture Modernization and Water-Bodies Restoration and Management (TN-IAMWARM) project, which was approved in 2007 and closed in 2015. The development objective of the project was "to assist selected subbasin stakeholders in increasing the productivity of irrigated agriculture in the state of Tamil Nadu within an integrated water resources management framework."

## State and Sector Context

Tamil Nadu is the second largest state economy in India, with a population of 62 million and a per capita gross state domestic product of \$2,500 in 2016–17. Agriculture accounts for 12 percent of the state's gross state domestic product. About 35 percent of its population depends on agriculture for employment. The state has 17 river basins, most of which are water stressed because of a limited supply and competing demands for water use. About 61 major reservoirs, 40,000 tanks (traditional water bodies that are central to the state's water and irrigation systems), and 3 million wells irrigate more than 2 million hectares out of 5.5 million hectares of cropland. These sources of water also supply an increasingly urbanized and industrialized population and hydropower, fisheries, environmental flows, and community uses.

The state's agriculture sector output has grown modestly in recent years at less than 3 percent per year compared with 6–9 percent growth of the state's economy. This is caused by multiple factors, including water shortages, stagnant crop yields, a low level of diversification, weak market development, high rates of postharvest losses, and increasing concerns related to climate change threats.

## Performance and Ratings

Relevance of the project development objective is rated **high** based on Tamil Nadu's major needs for modernization of its irrigation infrastructure. The objective is in line with the Country Partnership Strategy for India (2013–17), which calls for increasing agricultural productivity in targeted areas through inclusive agricultural and rural growth. It is also in line with the strategic initiatives of the government of Tamil Nadu's Vision 2023, which includes improving agriculture productivity, promoting market-driven agricultural production, assuring timely irrigation, and enhancing capacity building in agriculture.

Relevance of project design is rated **substantial**. The project covered the hardware (rehabilitation of infrastructure) and the software (improvement of water management both at state and community levels, and capacity building), along with agricultural

inputs and extension activities to promote productivity of irrigated agriculture. The project took a measured risk based on previous experience in working with several implementing agencies and included a specific component to coordinate and ensure the integration of all activities. The project also addressed statewide water management issues, including through the establishment of a water resources management agency and subbasin boards, a strategically important policy move with potential for long-term payoffs.

Efficacy is rated **substantial** in performance under three implied subobjectives intended to assist selected subbasin stakeholders in increasing the productivity of irrigated agriculture in the state of Tamil Nadu through: (A) irrigation systems modernization, (B) agricultural intensification and crop diversification, and within (C) an integrated water resources management framework.

Under subobjective A (irrigation systems modernization), the increased availability of water from modernized and rehabilitated tanks and adoption of micro-irrigation (mainly drip irrigation) has increased yields for most major crops, including paddy, pulses (lentils), maize, and horticultural produce. The project rehabilitated or modernized 5,260 irrigation tank systems against a target of 5,700, benefiting an area of 404,055 hectares, slightly higher than the target of 400,000 hectares. The area under micro-irrigation increased by 53,901 hectares compared with a target of 100,000 hectares at project completion, partly because of farmers' risk aversion. Since then, the adoption of micro-irrigation is increasing, encouraged by peer experience and generous state and central government subsidies. The rehabilitation work was carried out with sound design, the latest equipment and techniques, and third-party quality control. The tanks have been resilient and withstood major floods in 2015, with no reports of any major breaches. The rehabilitated facilities in the sites the mission visited were generally in good condition four to six years after construction.

Under subobjective B, agricultural intensification and crop diversification, crop intensification was most prominently achieved on a large scale and sustained adoption of the System of Rice Intensification (SRI) for paddy. This effort stands out as a collaborative effort in introducing new agricultural practices between a project entity (the multidisciplinary project unit; MDPU), a research institution (the Tamil Nadu Agriculture University; TNAU), and state line departments (agriculture, water resources, and others). As of January 2019, SRI paddy cultivation covered 1.62 million hectares across the state (compared with 0.27 million at project completion), and yield increases of more than 30 percent have been achieved compared with those using traditional cultivation.

Crop diversification efforts have increased the cultivation of maize and oilseeds and led to a revival of old traditions of growing minor millets. Horticultural crop coverage (aided by micro-irrigation) has been sustained from data available at project completion fiscal years (FY)13–14 (683,508 hectares) to FY16–17 (696,267 hectares). The project provided a platform for introducing fish breeding and inland fishing techniques in irrigation tanks and farm ponds and for meeting the supply-demand gap for fish seed. Increases in livestock conception rates (from a 42 percent baseline to 52 percent at project completion and about 49 percent in 2017–18) and milk yields (2–5 liters per animal per day) were possible through the provision of artificial insemination services at the farmers' locations and better fodder and nutritional supplements.

Crop intensification and diversification was supported strongly by the MDPU, line state departments (water resources organization [public works], agriculture, agricultural engineering, agricultural marketing, horticulture, fisheries, and animal husbandry) and the TNAU through awareness building, training and demonstrations, extension services, improved practices (such as integrated nutrient management and vermicomposting), drying and storage facilities, and marketing support.

Under subobjective C, integrated water resources management framework, increased productivity of irrigated agriculture might have been only partially achieved from enhancing the water resources management framework at different levels. The State Water Resources Management Agency (SWaRMA) became operational in June 2011 but has yet to grow into its envisioned larger role of providing advice and support for the management and allocation of water resources across sectors in the state. At the village level, introducing a water budgeting exercise in 400 model villages is a significant beginning for ultimately mainstreaming this function more widely. Elections for the water user associations (WUAs) are overdue, but the associations appear to be generally functioning informally, carrying out their duties for basic maintenance and water allocation and management.

Efficiency is rated **substantial** with an estimated economic rate of return of 21.0 percent at project completion, close to the 20.4 percent estimated at appraisal. The estimates were based conservatively on the expected expansion in irrigated area, increased crop productivity, market-led shift or diversification into higher-value crops in irrigated agriculture, increased milk productivity, and increased fish productivity.

Overall development outcome is rated **satisfactory**. Relevance of project objectives is rated **high** based on their alignment with government priorities and related pillars of the World Bank Group's Country Partnership Strategy. Project design is rated **substantial** because it is logically linked to outcomes by covering physical infrastructure, capacity, and agricultural inputs and links, and it included an institutional component for

addressing larger water resources management. Efficacy is rated **substantial** overall, given the significant and largely sustained outcomes in agricultural productivity. Together with a **substantial** efficiency rating, the overall development outcome is rated **satisfactory**.

Risk to development outcome is rated **substantial**. There are four important areas of risk to the sustainability of the project's development outcomes that can materialize at different levels: insufficient resources for operation and maintenance of the rehabilitated irrigation infrastructure, continuing delay in elections and strengthening WUAs to carry out their responsibilities, sustaining collaboration and maintaining convergence between line state departments (with the farmer as the focal point of services), and state government's commitment to continue building capacity for water resource management and informed decision-making on water allocation and use.

Bank performance is rated **satisfactory**. At project preparation, the World Bank considered the experience and lessons from previous irrigation projects in Tamil Nadu and other Indian states to inform project design, which combined investments in irrigation infrastructure with agricultural inputs and practices and investment in improved water management to achieve the expected agricultural production and livelihood impacts. The likelihood of covenants relating to the SWaRMA and WUAs being honored in a timely and comprehensive manner was overestimated. The World Bank's regular and frequent supervision missions provided insightful advice and guidance for project implementation, and their collegial approach is appreciated by officials at all levels. Overall Bank performance is rated **satisfactory** based on satisfactory quality at entry and Bank supervision.

Borrower performance is rated **satisfactory**. The government has demonstrated commitment to the irrigation sector from the preceding Water Resources Consolidation Project to the ongoing successor Tamil Nadu Irrigated Agriculture Modernization project. The government has ensured the stability and continuity of the implementing arrangements, including the MDPU's leadership and key staff. Under the successor project, various government departments have worked to mainstream some of the project's successful practices into policy and programs for the entire state, especially for SRI, micro-irrigation, and animal husbandry practices. The government has set the basis for making effective use of SWaRMA and associated institutions to mainstream a culture of water resource management and apply it to decision-making related to water allocation, usage, and measurement for irrigation.

The project was implemented by eight Tamil Nadu government agencies coordinated by the MDPU: Water Resources Organization; the Departments of Agriculture, Agricultural Engineering, Agriculture Marketing, Animal Husbandry, Fisheries, and Horticulture;

and TNAU. Implementing officials were provided training in change management to understand the value proposition in their contributions. There was a conscious and consistent effort by the MDPU leadership and staff to foster collaborative behavior and convergence among the staff of various departments geared toward the farmer as the focal point of project assistance, with positive attitudinal change and results.

## **Lessons**

Irrigation project design that combines improvements in infrastructure with activities for improving agricultural and water use practices, agricultural inputs, and marketing support and links can be a viable and effective approach for improving agricultural productivity and rural livelihoods. This project experience has shown the efficacy of combining multiple irrigation and agricultural components for coordinated results and impact.

For the several line departments that are necessarily involved in multidimensional irrigation projects, the provision of appropriate training can play a pivotal role in fostering collaborative behavior among the departments and orient them toward the farmer beneficiary as the focal point of their services. This project engaged training resources that included social scientists and technical specialists to foster collaborative behavior among line officials of diverse departments that were earlier disposed to work in a more compartmentalized manner. This effort helped them greatly to see the farmer beneficiary as the focus of their collective efforts.

The tone the project leadership sets is crucial for fostering and sustaining collaborative behavior across diverse implementing agencies. In this project, the implementing agency leadership played a proactive role in encouraging cross-learning across participating districts, provided incentives and recognition for collaborative behavior, and closed the loop with beneficiary feedback and monitoring.

Including a water resource management component in an irrigation project can be a strategically important decision with long-term payoffs, but it might have to be supplemented by other projects to realize the potential for wider water management and climate-smart agricultural policies. The World Bank's attempts in this regard in Tamil Nadu date to 1995, when the preceding project was approved. Although there has been progress in setting up an institution, progress in intersectoral water resource management requires a different timeline and the involvement of additional ministries and stakeholders.

Introduction of water budgeting concepts at the village or subbasin level is a crucial first step to build on by gradually promoting the measurement of water use and agricultural water productivity. This project's experience shows that instructing beneficiaries on

water budgeting principles might not have a significant impact on water management unless provision is gradually made for measuring water use and water use at the farm level.

José Carbajo Martínez

Director, Financial, Private Sector,  
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# 1. Background and Context

## Tamil Nadu State: Overview of Economy and Issues in the Irrigation Sector

1.1 Tamil Nadu is the second-largest state economy in India, with one of the fastest growth rates. During 2006–07 to 2016–17, its gross state domestic product grew at 7.4 percent per year, reaching about Re 170,929 (\$2,500) in 2016–17, with agriculture accounting for 12 percent of the state's. About 35.2 percent of the state's population depends on agriculture for employment, and more than two-thirds of the state's poor live in rural areas and are engaged predominantly in agricultural activities.

1.2 The state is home to about 62 million people living in 17 river basins. Many of these basins continue to be water stressed because of a limited supply and competing demands for water use, which are serious constraints to agricultural growth. Tamil Nadu receives an average annual rainfall of 925 millimeters, which is well below the national average of 1,200 millimeters. Per capita availability of water in the state is about 750 cubic meters a year compared with the national average of 2,100 cubic meters. In 2011, the total demand for water was about 49.8 billion cubic meters against a supply of 47.8 billion cubic meters, or a shortfall of 4 percent. This gap between demand and supply in water is projected to increase to 11 percent in 2020 and 17 percent by 2050 unless drastic measures are taken to rectify these imbalances.

1.3 About 61 major reservoirs, 40,000 tanks (traditional water bodies that are central to the state's water and irrigation systems) and 3 million wells help irrigate more than 2 million hectares out of 5.5 million hectares of cropland. These sources also supply water to an increasingly urbanized and industrialized population, and attempt to meet other demands, such as hydropower, fisheries, environmental flows, and community uses. The increasing use of wells for irrigation is depleting groundwater levels. Water shortages for agriculture are exacerbated by the decreasing storage capacity, neglected infrastructure of irrigation systems, and poor water management.

1.4 The state's agriculture sector has grown modestly in recent years at less than 3 percent per year compared with 6–9 percent growth of the state's economy. This is caused by multiple factors, including increasing water shortages, stagnant crop yields, low level of diversification, weak market development, high rates of postharvest losses, and increasing climate change threats.

1.5 Tamil Nadu has been tackling these challenges through a multipronged approach of promoting policy reforms, institutional changes, and investment programs.

Recently, the government of Tamil Nadu developed the Tamil Nadu Vision 2023 and the State Framework Water Resources Plan for River Basins.

1.6 The government has operationalized a decentralized, farmer-driven agricultural extension system through the Agricultural Technology Management Agency model. It has introduced policy reforms to increase private sector participation in the marketing of agricultural commodities by removing restrictions on purchase, stocking, movement, and sales of 13 key crops and allowed greater wholesale marketing outside restricted markets.

### The Role of the World Bank in Tamil Nadu’s Irrigation Sector

1.7 The World Bank has supported Tamil Nadu through two completed projects and one ongoing project since 1995 (table 1.1). The Water Resources Consolidation Project (WRCP; 1995–2004), whose development outcome was rated satisfactory, sought to improve the productivity and sustainability of the state’s irrigation sector, introduce multisectoral water planning, integrate farmers in irrigation management, and strengthen the state's institutional and technical capacity in water development, management, and planning.

1.8 The active Tamil Nadu Irrigated Agricultural Modernization (TNIAM; fiscal years [FY]17–25) project includes innovative elements and good practices that build on lessons learned from the TN-IAMWARM project. These innovative aspects include improved design of irrigation infrastructure, a much stronger focus on the demand side of irrigation with an aim to improve water use efficiency, further advances in agricultural diversification, agri-entrepreneurship, and substantial improvements of participatory irrigation management practices by beneficiaries and extensive application of information and communications technology-based technologies for improved water resource management. TNIAM will also rehabilitate and modernize high-priority tank irrigation systems in more than 50 percent of the state’s subbasins that were not part of the TN-IAMWARM project.

**Table 1.1. World Bank Projects in the Irrigation Sector in Tamil Nadu State**

<b>Project Title and Identification Number</b>	<b>Duration (fiscal year)</b>	<b>World Bank Commitment (\$, millions)</b>
Water Resources Consolidation project: P010476	1995–2004	245.2
Tamil Nadu Irrigated Agriculture Modernization and Water-Bodies Restoration and Management project: P090768	2007–15	443.92
Tamil Nadu Irrigated Agricultural Modernization project: P158522	2017–25	318.00

## 2. Relevance of the Objectives and Design

2.1 **Project development objective.** The project objective was “to assist selected subbasin stakeholders in increasing the productivity of irrigated agriculture in the state of Tamil Nadu within an integrated water resources management framework.”

2.2 The project included the following five components (see appendix B for more details):

- A. Irrigation systems modernization in a subbasin framework (appraisal cost: \$282.83 million; revised cost: \$395 million; actual cost: \$364 million). This component was to improve bulk water delivery to irrigation systems through modernization of irrigation systems and service delivery in schemes in about 63 selected project subbasins.
  - Subcomponent A1. Tank systems modernization. Revive traditional water bodies (tanks) that are an integral part of most irrigation systems networks in the state.
  - Subcomponent A2. Other irrigation systems modernization. Focus on the few subbasins where tanks are not part of the larger canal-irrigated systems.
- B. Agricultural intensification and diversification (appraisal cost: \$166.23 million; revised cost: \$115 million; actual cost: \$103 million). This component was to build on the improved bulk water delivery of component A to increase the productivity of agriculture-related activities through intensification and diversification in about 63 selected subbasins.
  - Subcomponent B1. Tank systems. Focus on intensification and diversification of tank-dependent ayacuts (the area served by the tank).
  - Subcomponent B2. Other systems. Focus on the intensification and diversification of the larger canal-irrigated systems.
- C. Institutional modernization for irrigated agriculture (appraisal cost: \$52.69 million; revised cost: \$22 million; actual cost: \$15 million). This component was to improve the institutional capacity for modern, efficient, and accountable irrigation service delivery; modernize the functioning of the Water Resources Organization (WRO); assist in the formation and capacity building of about 2,500 water user associations (WUAs) in the 63 subbasins under the project; set up an irrigation research fund of about \$3 million for fostering research in irrigation development and management.

- D. Water resources management (appraisal cost: \$5 million; revised cost: \$1 million; actual cost: \$1 million). This component was to improve the institutional arrangements and capacity for sustainable water resources management in the state. This would include the creation of a State Water Resources Management Agency (SWaRMA). It provided financing for additional multisectoral expertise, especially on economics, environmental and social aspects, basin analysis and modeling, geographic information system and remote sensing, planning future water uses, and stakeholder communications.
- E. Project management support (appraisal cost: \$8.32 million; revised cost: \$8 million; actual cost: \$6 million). This component would support the management and coordination efforts related to this project.

## Financing and Duration

2.3 **Project cost and financing.** Project cost at completion was \$489 million, 87 percent of the planned cost of \$566 million. This was financed by a loan of \$485 million (\$150 million from the International Development Association and \$335 million from the International Bank for Reconstruction and Development), of which \$153 million and \$287 million, respectively, were disbursed at completion, representing 103 percent and 86 percent of the appraisal amounts.<sup>1</sup> Undisbursed funds (\$45 million) were canceled for the following reasons: (i) foreign exchange savings, (ii) savings on civil works contracts, (iii) downsizing of micro-irrigation activities, and (iv) low disbursement of component C caused by overbudgeting for some expenditures.

2.4 **Borrower contribution.** The government contributed \$49 million, 87 percent of the planned contribution of \$56 million. Farmers were expected to contribute \$25 million, but no information was available in this respect.

2.5 **Dates.** The project closed on June 30, 2015, two years and three months after the planned date of March 31, 2013. This was mainly because of delays in procurement (partly from cumbersome government and World Bank compliance procedures) and delays in obtaining government sanctions for some civil work contracts.

2.6 The project was restructured twice, and both were level two restructurings.<sup>2</sup> The first was on February 1, 2013, to extend the closing date from March 31, 2013, to September 30, 2014. The second restructuring was on September 23, 2014 to extend the closing date from September 30, 2014, to June 30, 2015.

## Relevance of the Objectives

2.7 Tamil Nadu continues to have major needs for modernization of its irrigation infrastructure. It needs to improve the flexibility of its systems for delivering water as required for different crops, including the promotion of piped and sprinkler systems. This needs to be accompanied by capacity building of irrigation institutions, combined with innovative agricultural technologies to stimulate agricultural growth and sustainable water use.

2.8 At appraisal, the project development objectives were highly relevant to the government's priorities to achieve sustainable growth and contribute to poverty alleviation. The objectives were also in line with the World Bank Group Country Assistance Strategy for India (FY05–08), which emphasized scaling up support to improve rural livelihoods, and the Country Partnership Strategy for India (2013–17), which called for increasing agricultural productivity in targeted areas through inclusive agricultural and rural growth; technology development; food and nutrition security; agricultural markets; and water and natural resources management.

2.9 The project objectives remained highly relevant to the National Water Policy of the Ministry of Water Resources in 2012. The policy prioritized demand management and water use efficiency through water-saving technologies in agriculture systems by introducing maximum efficiency in the use of water and avoiding wastage. The objective is also aligned with government's Tamil Nadu Vision 2023, whose strategic initiatives include improving agriculture productivity, promoting market-driven agricultural production, assuring timely irrigation, and enhancing capacity building in agriculture.

2.10 The relevance of project objectives is rated **high**.

## Relevance of the Design

2.11 The project's activities supported the overall project objective, and the logical connections among inputs, outputs, and outcomes can be traced in the project description provided in the appraisal document. The project covered the hardware (rehabilitation of infrastructure) and the software (improvement of water management both at the state and community levels, and capacity building), along with agricultural inputs and extension activities to ensure more effective and efficient use of water.

2.12 The implementing agency, the multidisciplinary project unit (MDPU), coordinated as many as eight entities: Water Resources Organization (public works); the Departments of Agriculture, Agricultural Engineering, Agriculture Marketing, Animal Husbandry, Fisheries, and Horticulture; and the Tamil Nadu Agricultural University

(TNAU). The Independent Evaluation Group's (IEG) assessment of experience from projects across sectors suggests that engaging multiple agencies generally introduces problems of coordination and efficiency in project implementation. However, this project's design took a measured risk in working with several agencies and included a specific component to coordinate and ensure the integration of all activities. It accounted for the likelihood of continuity in project leadership from the previous WRCP project, consistent support from successive governments, administrative traditions in the state, and clearly defined and substantive roles and budgets for each participating entity. These factors are also discussed in the sections on implementation and borrower performance.

2.13 The project also addressed larger water management issues, including the establishment of subbasin boards, which in retrospect should have been taken up separately by or in conjunction with other relevant ministries in the state government.

2.14 Overall, the relevance of project design is rated **substantial**.

## Monitoring and Evaluation

2.15 **Monitoring and evaluation (M&E) design.** The project results framework included six outcome indicators, most of which were appropriate to the project objectives. Three of these indicators—increased area under micro-irrigation, high-value crops, and horticulture—were amenable to measurement. The indicator “percentage increase in value of crop production per unit of irrigated water” was not accompanied by a clear methodology and proved to be complex to measure in practice. The indicator “joint preparation and implementation of subbasin development plans across relevant implementing agencies” could be considered an intermediate outcome indicator at most. The indicator “enhanced sustainable water resources capacity” could have benefited from a clearer definition.

2.16 The results framework included 20 intermediate outcome indicators, many of which were of output indicators. Several intermediate outcome indicators were amenable to measurement such as “increase in crop, animal, and fisheries production” and “percentage area covered by integrated nutrient management or organic farming.” The indicator “percentage increase in value of marketable surplus” was relevant but lacked a clear definition. Some intermediate outcome indicators that should have been classified as outputs included “number of information kiosks,” “percentage of staff trained,” and “multidisciplinary project unit adequately staffed.”

2.17 **M&E implementation.** The contract award for implementing the project's M&E system was delayed for nearly three years from the original deadline of March 31, 2007, because of complex procurement steps, lengthy discussions between the World Bank

and MDPU on shortlisting bidders, and a renegotiation of the original contract. The baseline, midterm, and final impact assessment reports were therefore concentrated in less than three years—2011, 2012, and 2014, respectively. Implementing agencies provided regular and systematic monitoring of activities. MDPU developed an effective management information system by aggregating data from the implementing agencies and other government agencies and made this information available on a dedicated website. A geographic information systems specialist was hired to produce a set of maps for each subbasin that were used to support project planning and monitoring activities.

2.18 **M&E use.** The private M&E consultancy firm SMEC provided independent feedback to implementation and management teams about field activities, achievements, stakeholder perceptions, and challenges leading to recommendations on potential corrective measures.<sup>3</sup> Based on these recommendations, MDPU was able to follow up with contractors and the WRO on design and quality issues that were identified in irrigation infrastructure rehabilitation works.

2.19 The project's M&E is rated **substantial**.

## Implementation

2.20 **Implementation arrangements.** The project was implemented by the MDPU, headed by a project director who integrated and coordinated with seven implementing state departmental agencies—Water Resources Organization (Public Works), Agriculture, Agriculture Engineering, Animal Husbandry, Fisheries, Horticulture, and Marketing—along with TNAU. The MDPU, which continues in the same role and structure for the successor TNIAM project, is a dedicated team of specialists representing each department and TNAU coordinating with the special IAMWARM cell created in each participating department. Among them, WRO was the nodal department coordinating with the other departments for implementing project activities. The project activities were implemented by line department staff located at the district level as part of their regular functions. At the district level, the project activities were monitored in regular District-Level Coordination Committee meetings chaired by the District Collector (administrative head of the district).

2.21 Overall, the multidisciplinary and flexible implementation approach followed in IAMWARM increased collaboration and convergence of departments in addressing the issues of water and agriculture in an integrated manner, with the farmer as the focal point. This is discussed in some more detail in the section on implementing agency performance.

2.22 **Environmental and social safeguards compliance.** The project was classified as category A (full assessment) under the World Bank's environmental and social

safeguards policy and triggered the following policies: Environmental Assessment (OP/BP 4.01), Pest Management (OP 4.09), Cultural Property (OPN 1 1.03, being revised as OP 4.11), Involuntary Resettlement (OP/BP 4.12), and Safety of Dams (OP/BP 4.37).

2.23 According to the environmental assessment, no significant negative environmental impacts and risks or forestry or biodiversity issues were identified in connection with the physical works under the project. MDPU appointed an environmental expert to ensure that the Social and Environment and Social Management Framework was implemented in contract works. No issues arose during implementation that related to physical cultural property. A Dam Safety Review Panel carried out periodic inspections as required for dams under subprojects, following and instituting mitigation measures for critical issues. The project complied with dam safety policy requirements.

2.24 **Fiduciary compliance.** Financial management arrangements were mainstreamed around state public financial management systems and benefited from having a stable core team of finance staff in the MDPU, headed by a professionally qualified finance official. Audit reports were sometimes filed with delays of three to four months. Issues raised by the audit reports were adequately addressed by the MDPU in coordination with line departments.

2.25 **Procurement.** The bidding and selection process was conducted in a fair and transparent manner with very few complaints, but those were addressed promptly. The project's initial and third phases experienced procurement delays from re-bidding of work packages and prolonged delays in issuing administrative sanctions that slowed the progress of civil works. These issues were generally addressed through regular training and capacity building.

### **3. Achievement of the Objectives**

3.1 The degree to which the project's development objective (to assist selected subbasin stakeholders in increasing the productivity of irrigated agriculture in the state of Tamil Nadu within an integrated water resources management framework) was achieved is rated **substantial**.

3.2 **IEG mission field visits.** The IEG mission visited 11 locations or villages in different subbasins covered by the project.<sup>4</sup> The purpose of the site visits was to assess the extent to which the outcomes from the infrastructure, institutional, and capacity building activities have been sustained and built on since project completion and to get firsthand feedback from beneficiaries and field officials in this regard. The locations were selected from among the set of districts and villages that were visited by the TN-

IAMWARM project team in 2015 during the preparation of the project's Implementation Completion and Results Report.

3.3 At each site, the mission visited the rehabilitated irrigation tank and related structures and standing crops in the ayacut (area served by an irrigation project) and conducted walking tours with farmers, livestock owners, fishermen, and officials from WRO and other line departments. The mission visited drying yards, storage godowns (warehouses), and WUA offices wherever they are present and noted the quality of facilities and records maintained by the managing members. At each village, these walking tours were followed by a one- to two-hour meeting with a broader assembly of 80–120 village residents (appendix F, figures 1 and 2), including village leaders and members of the WUA and commodity interest groups (CIGs), especially the participation of downstream or tail-end farmers in the irrigation system. At least one-third of those present were women. The mission used these assemblies to gather the views of a cross-section of farmers and other beneficiaries about how the project activities had impacted their work and livelihoods and to corroborate feedback from WRO and line department officials. A complete list of locations and facilities that were visited by the mission is presented in appendix C.

3.4 Based on the project development objective and the project components, the project outcome is assessed in terms of three subobjectives, specifically: to assist selected subbasin stakeholders in increasing the productivity of irrigated agriculture in the state of Tamil Nadu through (i) irrigation systems modernization, (ii) agricultural intensification and crop diversification, and within (iii) an integrated water resources management framework. The next sections discuss the main findings and observations and feedback gathered from the site visits in the context of each subobjective.

### **Subobjective A. Increasing the Productivity of Irrigated Agriculture Through Irrigation Systems Modernization**

3.5 The project undertook rehabilitation and modernization of irrigation structures in 61 of 127 subbasins in the state for restoration of water bodies (mainly tanks), bunds (embankments), sluice gates, recharge and underground wells, and canal linings.<sup>5</sup>

#### **Outputs and Outcomes at Project Completion**

3.6 **Tank rehabilitation and modernization.** At project completion, 1,069 of the planned 1,070 civil works packages (irrigation schemes) were completed; 5,260 tank systems were rehabilitated or modernized against a target of 5,700 tanks that covered a command area of 404,055 hectares—slightly higher than the original target of 400,000 hectares.<sup>6</sup> The conveyance efficiency of the Parambikulam Aliyar project main canal was improved from 69 percent to 92 percent against a target of 86 percent. Removing silt

from the tank beds for bunds strengthening resulted in an additional storage of 2.15 million cubic meters of water. The fully irrigated area in the project subbasins increased from about 365,000 hectares in 2007 to about 508,000 hectares in 2016 (an increase of 39 percent), which met 98 percent of the targeted coverage.

3.7 **Micro-irrigation (mainly drip irrigation).** Drip irrigation is a type of micro-irrigation system that can potentially save water and nutrients by allowing water to drip slowly to the roots of plants either from above or buried below the soil surface.<sup>7</sup> During the project, micro-irrigation coverage increased by 53,901 hectares against a target of 100,000 hectares.<sup>8</sup> Thirty-six different crops were targeted for micro-irrigation (in line with subobjective B for agricultural intensification and diversification), including fruit and multipurpose trees, cash crops, spices, flowers, and fodder. However, the main focus was on coconut, sugarcane, vegetables, tapioca, mango, banana, turmeric, and areca nut.

### **Mission Observations**

3.8 The physical rehabilitation works in the sites visited by the mission were generally in good condition four to six years after construction. The tanks in the project subbasins withstood major floods in 2015, and there were no reports of any major breaches in the tanks. WRO and MDPU officials attribute this to sound design, use of improved construction techniques and equipment, and effective quality control by a third-party consultancy. Illustrations from facilities in Dharapuram Village are shown in appendix F, figures 3 and 4.

3.9 The increased availability of water has resulted in increased yields for the full range of crops from paddy, pulses (lentils), and maize to high-value horticultural crops. These results are discussed in detail under subobjective 2. Illustrative observations of the infrastructure improvements and outcomes in Chidambarapuram Village and feedback from beneficiaries and government officials are described in box 3.1. Similar details for all villages visited by the mission are presented in appendix D.

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### Box 3.1. Outcomes from Irrigation Infrastructure Improvement in Chidambarapuram

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The Tamil Nadu Irrigated Agriculture Modernization and Water-Bodies Restoration and Management Project made improvements in the Chettikurichi small tank structure in Chidambarapuram Village in Senkottiyar subbasin in Virdhunagar district. The improvements consisted of strengthening the tank's bund (embankment), repairing two sluices, and construction of a recharge well at a cost of Re 3.82 million (\$54,908). The tank's original ayacut area of 49.17 hectares increased by 8.16 hectares. The tank's capacity increased by nearly 1 million cubic feet, and the groundwater table increased by an average of 9 feet.

Greater availability of water enabled the farmers to take up System of Rice Intensification paddy, resulting in yield increases of 700–800 kilograms per hectare and an increase in yield of 130–150 kilograms per hectare for pulses during the project implementation period. Greater availability of groundwater enabled the introduction of micro-irrigation drip for bananas and sprinklers for vegetables. The local fishermen's cooperative carries out fish culture. Availability of green fodder from some portion of the ayacut contributed to improved milk yields from dairy animals.

Although updated figures were not available, anecdotal evidence from farmers indicates that yield gains from the infrastructure have been sustained. The mission confirmed the continuing cultivation of System of Rice Intensification paddy, pulses, maize, fodder, bananas, and vegetables with micro-irrigation, and fisheries and dairy activity.

*Source:* Tamil Nadu State Government 2019 Department Reports prepared for the IEG Mission

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3.10 The use of an “OK Card” that required sign-off by the contractor, quality control consultants, and WRO officials proved to be an effective in confirming that the modernization and rehabilitation works were completed satisfactorily. This is corroborated by officials of the MDPU, line departments, and the farmers in various locations visited by the mission. The farmers indicated that after rehabilitation, tanks storage capacity has increased, irrigated area has been restored or expanded, water delivery has improved, and groundwater levels have increased in some cases. They felt that the full impact of the rehabilitation is yet to be seen because two continuous drought years have occurred since project completion, and conditions would have been worse without the rehabilitation supported by the project. An illustrative OK Card is shown in appendix F, figures 5 and 6.

3.11 After project completion, the repairs and maintenance of the tanks are expected to be carried out using a maintenance fund in the WRO. In practice, this is likely to be done only when serious issues arise with the infrastructure. The government has yet to put a consistent framework in place for collection of water charges to meet full operation and maintenance (O&M) expenditures. Minor repairs, cleaning of channels, and clearing vegetation is expected to be carried out by WUAs. However, at the time of the mission, the tenure of the existing WUAs had lapsed, and fresh elections are overdue. In many

cases, the old WUAs are informally carrying out their responsibilities but are constrained for resources and capacity.

3.12 **Micro-irrigation.** Despite attractive subsidies, farmers were very reluctant initially to adopt micro-irrigation because they thought it as too sophisticated for their experience and were risk-averse to using smaller amounts of water. Even where micro-irrigation was adopted, farmers would remove water emitters from the laterals to increase the flow of water to their crops.<sup>9</sup> However, there is gradual, greater recognition that micro-irrigation can result in high water savings (up to a factor of 1:5 compared with previous usage patterns) and reduced weed growth, and it can feed water directly to the root zone and raise the productivity of crop per unit of water.

3.13 The area under micro-irrigation in the state has increased to 65,220 hectares at the end of 2018 from 53,901 hectares at project completion. This has been mainly for horticulture and in a few cases for System of Rice Intensification (SRI) cultivation. Separate figures were not available for the project areas, but there has been distinct progress since project completion, which can be at least partly attributed to the project's interventions. It could be reasonable to expect greater adoption of micro-irrigation given continuing attractive subsidies provided by the central and state governments (75 percent to 100 percent) and growing awareness of the efficacy of micro-irrigation.

3.14 The mission noted the use of drip irrigation for vegetables in several locations (Alankuppam, Anaimalai, Chidambarapuram, Ezhuthanivayal, Govindapuram, Mahibalanpatti and Perungudi villages). In Mahibalanpatti, farmers stated that drip irrigation helped them realize an additional income of up to Rs 60,000 (\$859) per acre in each season of mango crop. Drip irrigation has also been introduced in watermelon and musk melon cultivation in Alankuppam village, with increased income of Re 0.2 to 0.3 million (\$2,863 to \$4,295) per ha. Sprinkler Irrigation for paddy was adopted by 86 out of 140 of farmers in Ezhuthanivayal village and sprinkler irrigation for jasmine in Perungudi.

### **Subobjective B. Increasing the Productivity of Irrigated Agriculture Through Agricultural Intensification and Crop Diversification**

3.15 The project supported crop intensification and diversification that was made possible by securing greater availability of water from improving irrigation infrastructure. In addition, fisheries that depend on greater availability of water in irrigation tanks and livestock that depend on greater availability of fodder were promoted. These activities were supported by provision of agricultural inputs, improved agricultural practices, and market links.

## Outputs and Outcomes at Project Completion

3.16 **Crop intensification.** The project supported agricultural intensification mainly through promoting SRI on a large scale and the Sustainable Sugarcane Initiative. SRI is a methodology aimed at increasing the rice yields—a low-water, labor-intensive method that uses younger seedlings spaced singly and typically hand weeded with special tools (box 3.2).

3.17 The project provided the setting for TNAU to introduce SRI technology initially in 2007 over an area of 1,330 hectares in the project subbasins and test 20 different models of SRI in various field locations before promoting their wider adoption. The project was able to overcome the farmers' initial skepticism (especially about SRI's features of low seed rate, single seedling, and alternate irrigation method) through extensive demonstration plots and training.

3.18 By project completion, SRI covered 272,703 hectares against an appraisal target of 66,500 hectares. In some areas, SRI was combined with a cropping cycle of green manure-SRI-rice fallow pulses, which contributed toward statewide production of 12.8 million tons of food grains in 2015 from 0.67 million hectares of land and 0.5 million farmers. Water productivity was enhanced from 3.81 kilograms per cubic meter to 6.88 kilograms per cubic meter, with reported average yield increases up to 22 percent and a 54 percent increase in net income, aided by labor savings and other cost reductions.

3.19 **Sustainable Sugarcane Initiative.** This technology in sugarcane was introduced in the project and helped increase yield by 30 to 40 percent (125–140 metric tons per hectare compared with 90–100 metric tons per hectare under the conventional method).

3.20 **Crop diversification: maize, pulses, and oilseeds.** Maize—which is generally cultivated in upland garden land areas—was introduced in 81,977 hectares of irrigated areas and partially irrigated areas, 190 percent of the target of 28,400 hectares. Oilseeds coverage reached 63,514 hectares compared with a target of 29,000 hectares, an increase of 120 percent. Area under high-value crops reached 49,579 hectares, more than four times the target of 12,000 hectares. Average productivity of maize cultivation rose by 31 percent (from 4,792 kilograms per hectare to 6,259 kilograms per hectare), for pulses by 24 percent (615 kilograms per hectare against 497 kilograms per hectare), and for groundnuts by 21 percent (2,595 kilograms per hectare against 2,152 kilograms per hectare).<sup>10</sup> These developments allowed Tamil Nadu to reduce imports of maize and pulses from neighboring states. Traditional minor millets and new varieties were also introduced.

3.21 **Crop diversification: horticulture.** In some tank command areas in project sites, farmers with access to tube well irrigation were able to diversify to high-value

vegetables: chilies (jalapenos), bhendi (okra), brinjal (eggplant), and bitter gourd, along with some fruits (musk melon and watermelon), especially near urban consumption centers. Overall, the targeted 40 percent increase in yield was achieved for tomatoes and chilies and partially for brinjal, bhendi, and bananas.<sup>11</sup>

## **Mission Observations**

3.22 SRI was widely adopted in the locations visited by the mission (Alankuppam, Anamalai, Govindapuram, Kavanur, Keelathivakkam, Mahibalanpatti, Perungudi, and Pudirivayal), in some cases to the extent of 95–100 percent of all planted paddy. Farmers confirmed that SRI reduced the need for water in the nursery and field, reduced usage of seeds (as low as 8 kilograms per hectare instead of 80 kilograms per hectare for traditional methods). They also noted lower requirement for nursery space and reduced labor for weeding, particularly through use of conoweeders, a hand-drawn tool for farmers to ensure quicker weeding in wetland. Some farmers have gone in for drip irrigation for SRI (in Govindapuram and Kavanur). The use of alternate wetting and drying rather than constant replenishment of water reduced water consumption of paddy by about 25 percent, with a yield increase of about 20 percent. This has made more water potentially available to downstream farmers, with scope for expansion of irrigated area.

3.23 The state government has scaled up and adopted SRI into its implementation policies, and this has ensured sustainability of SRI in the state. As of January, 2019, about 1.62 million hectares across the state (compared with 0.27 million hectares at project completion) are under SRI paddy cultivation. In several areas, yield increases of 5 metric tons per hectare have been realized (an increase of more than 30 percent compared with traditional cultivation; see box 3.2).

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### Box 3.2. Large-Scale Adoption of System of Rice Intensification in Tamil Nadu: A Collaborative Effort in Introducing New Agricultural Practices

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The large-scale and sustained adoption of System of Rice Intensification (SRI) in Tamil Nadu state under the Tamil Nadu Irrigated Agriculture Modernization and Water-Bodies Restoration and Management Project stands out as a collaborative effort in introducing new agricultural practices among a project entity (the multidisciplinary project unit), a research institution (the Tamil Nadu Agriculture University; TNAU), and line departments (Agriculture, Water Resources, and others), with support from the World Bank project team and the overarching endorsement of the state government.

SRI is a technique for increasing rice yields through a low-water, initially labor-intensive method that uses younger seedlings spaced singly and typically hand weeded with special tools. In introducing SRI, the project had to work with farmers who were used to traditional methods and were skeptical of SRI's features of low seed rate, single seedling, and alternate irrigation method.

To convince the farmers, TNAU undertook a very large demonstration program, implemented specific training for transplanting, and refined the technology based on farmer feedback, and in some cases assisted women's groups to develop contract SRI transplanting services. The experimentation, learning, and dissemination from this exercise helped popularize SRI and provided a strong basis for its spread across the state.

At project completion (2016), the area covered by SRI was 0.27 million hectares and has since grown to 1.62 million hectares by early 2019. By some estimates, SRI has resulted in water productivity increasing from 3.81 kilograms per cubic meter to 6.88 kilograms per cubic meter, average yield increases up to 22 percent, and a 54 percent increase in net income, aided by labor savings and other cost reductions.

The project's SRI effort is the largest single exercise by TNAU in applying results from research to the field. As an autonomous organization, TNAU had greater flexibility in deploying resources to match the evolving needs for promoting SRI.

The rapid increase of SRI in the state and its positive results have drawn wide attention and recognition from other parts of India and other countries. Over the years, about 250 officials from 26 countries have visited SRI sites in Tamil Nadu state to learn from the experience.

*Source:* Tamil Nadu State Government 2019 Department Reports prepared for the IEG Mission.

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**3.24 Maize, oilseeds, and millets.** The mission observed cultivation of maize, pulses, and millets in most of the site visits, indicating that diversification promoted during the project has been sustained. However, no updated and segregated statistics on yields and coverage were available, specifically for the subbasins the project covered.

**3.25 Horticulture.** High-value (mainly horticultural) crops production during FY16–17 is reported to have expanded marginally to 696,267 hectares in the project subbasin areas from 683,508 hectares in FY14–15. The actual increase in area and impact from horticultural crops might be higher because this figure does not include area covered by minor crops. Organic cultivation and certification of these high-value crops is also gaining traction. The adoption of micro-irrigation has played a significant role in the spread of high-value crops (box 3.3).

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### Box 3.3. Increased Use of Micro-Irrigation for High-Value Horticulture Crops

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The project contributed to adoption of micro-irrigation for higher-value crops in project areas and stimulated its expansion in conjunction with government schemes, as confirmed by the multidisciplinary project unit and local officials and farmers in various locations. For example, in Alankuppam, Anaimalai, and Keelathivakkam villages, the project supported the adoption of improved practices and micro-irrigation for horticulture and the adoption of organic practices in some cases.

In Anaimalai village, pandal (trellis) vegetables are raised in about 200–400 acres depending on the season on raised beds with drip irrigation and fertigation, with lower need for labor.<sup>a</sup> The vegetables are marketed to the neighboring state of Kerala. A farmer in this location increased the cultivation area for chilies from one to five acres by using drip irrigation from his tubewell.

In various locations, drip irrigation has resulted in increased yield in onion of up to 50 percent, has helped farmers realize additional income from watermelon and musk melon cultivation, and for mango crop, a profit per acre per season of about Re 60,000 (\$859). Labor requirements were also reduced.

Overall, about 95 percent of farmers cultivating pandal vegetables in the Parambikulam Aliyar Project area subbasin have adopted drip irrigation systems for cultivating pandal vegetables (see appendix F, figures 7 and 8).

*Source:* Tamil Nadu State Government 2019 Department Reports prepared for the IEG Mission.

a. Fertigation is the injection of fertilizers into an irrigation system. It is used for soil amendments, water amendments, and other water-soluble products.

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**3.26 Fisheries.** The team visited a fisheries hatchery, an ornamental fish rearing activity, and a fish kiosk supported by the project. The fish hatchery in Ezhuthuanivayal was set up at a cost of Re 1 million (\$14,400), and the owner earns up to Re 30,000 (\$430) every two weeks by selling seed to local farmers. Ornamental fish activity undertaken by a woman farmer in Aliyar village yields a profit of Re 30,000 (\$430) per month. Overall, fisheries in the farm pond yields an annual income of Re 0.15 million (\$2,155). The fish kiosk visited by the mission is situated on a state road close to Pakkam village, selling fresh fish, fish preparations, and pickled fish. The kiosk is a profitable venture run by a group of 40 women from various self-help groups and managed by five members.

**3.27 Livestock.** Livestock conception rates have been maintained close to levels achieved during the project, with a conception rate of 48.7 percent in FY17–18 (table 3.1). Farmers reported that with improved fertility and productivity, distress sales of animals have reduced. Discussions with MDPU and departmental officials indicate a conscious effort at using participatory approaches and innovative extension methods to assess the farmers needs and tailor responses accordingly. This was corroborated by livestock farmers who noted more frequent interaction with animal husbandry officials and greater access through cell phones for seeking advice and support. The farmers appreciated the artificial insemination services provided at their doorstep, saving them

the need to take their cattle to the nearest veterinary location. Several of the activities promoted under the project have been mainstreamed into the animal husbandry department's policies and programs: The model for artificial insemination services, promoting green and seed fodder development (by providing slips), and providing mineral mixtures have been adopted by state government programs. A farmer in Perungudi village earns an average income of Rs 201 (\$2.80) per day by selling fodder to neighboring livestock owners. He has increased his stock from one to six cows, yielding about 60–65 liters per day and a net profit of Re 35,000 (\$500) per month. Another farmer with 100 sheep and 6 white goats makes a semiannual income of Re 0.3 million (\$4,295).

**Table 3.1. Progress in Selected Parameters for Animal Husbandry**

Parameter	2015–16	2016–17	2017–18
Artificial insemination (number)	5,680,387	5,871,908	4,991,807
Percentage of conception	48.1	48.6	48.7
Fodder (hectares)	25,090.53	24,584.68	28,801.5

3.28 Factors supporting agricultural intensification and diversification. Agricultural intensification and diversification activities were supported by awareness building, training and demonstrations, extension services, and improved practices such as integrated nutrient management and vermicomposting.<sup>12</sup> Marketing support was provided through drying and storage facilities and setting up links with private sector marketing entities. Appendix E presents a detailed discussion of the outputs and outcomes of these activities at project completion.

### Factors Supporting Agricultural Intensification and Diversification

3.29 Improved practices. The IEG mission noted the continued use of several practices introduced or reinforced during the project. New practices for the area such as the use of raised beds and mulching, seedling germination in pro trays (reusable trays with depressions for soil), high-density planting, and poly green houses are in use for fruits and vegetables in several locations. Introduction of improved seed (mostly hybrids), production of disease-free seedlings, and micro-irrigation systems were reported to have contributed substantially to improved vegetable productivity.

3.30 Farmers in almost all the villages visited by the mission are engaged in portable vermicomposting to supplement farm manure as organic fertilizer, especially for use in vegetable production. The vermicompost kit uses a portable silpaulin (a variety of waterproof and fireproof tarpaulin) bag and costs about Re 6,000 (\$86; see appendix F, figure 9). A few farmers (in Ponnapuram village, for example) have taken up fully organic farming and have obtained official organic certification to supply their produce to selected value chains, obtaining a premium price.

3.31 Storage godowns and drying yards. The storage facilities and drying yards that the mission visited (Govindapuram, Keelathivakkam, Mahibalanpatti, Pallathur, and Pappanooth villages) were all in good condition, and the produce is stored in dry and clean conditions. Officials and CIG members showed the mission their account books with updated account information (box 3.4).

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**Box 3.4. Observations from Storage Godown (Warehouse) and Drying Yard in Pappanooth Village**

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A storage godown and drying yard were constructed under the project in Pappanooth village near Chidambarapuram in Sengattaiyar basin in 2010. An individual from the village donated the land for the facilities. The storage godown is equipped with an electronic scale and moisture meter used for storing chilies, maize, and small millets. The drying yard is used for drying millets and food grains. A memorandum of understanding was concluded between commodity interest groups (CIGs) using this facility and the Department of Agricultural Marketing. The godown's capacity is 120 metric tons. So far, 135 of 176 CIG members have used this facility, and they pay a nominal amount to use it. A quantity of 453 metric tons of produce valued at Rs 56,105 (\$803) has been transacted so far. The CIGs maintain a separate bank account and keep a record of material and financial transactions.

*Source:* Tamil Nadu State Government 2019, reports prepared for IEG mission.

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3.32 The number of CIGs and signed memorandums of understanding have increased across the state since project completion, though the number of farmers benefited and quantities transacted have not grown at the same pace (table 3.2). Eighty new farmer producer organizations have been formed, and 40 of those have been supported with cold storages, ripening chambers (in Trichy and Theni), and a modern pack house.<sup>13</sup> Although the trend is in the right direction, agricultural marketing and related line departments should carefully monitor the need to strengthen these entities and the availability of alternative means for farmers to market their produce. This is underlined by the finding from an earlier FAO report that such farmer groups tend to wither when project interventions end (FAO 2014). The marketing tie-up with Cadbury's for cocoa has been expanded, and farmers in Aandikaadu and Aliyar villages noted that the crop yields an additional income of Re 300,000 (\$4,311) per acre annually.

**Table 3.2. Growth of Commodity Interest Groups since Project completion**

<b>Activities</b>	<b>2015–16</b>	<b>2017–18</b>
Commodity groups on various crops	6,577	9,496
Memorandums of understanding signed	6,483	8,818
Value of produce (millions)	6,48.192	6,68.448
Farmers benefited (number)	15,692	16,182
Quantity transacted (metric tons)	29,939.84	30,875.46

### **Subobjective C: Integrated Water Resources Management Framework to Assist Selected Subbasin Stakeholders in Increasing the Productivity of Irrigated Agriculture**

3.33 Productivity of irrigated agriculture may have gained only partially from enhancing the water resources management framework at different levels. The project aimed to improve institutional arrangements, capacity, and awareness for water resources management at the state, subbasin, and farm levels.

3.34 **State level.** The project attempted to build on the existing elements of water resources management (State Water Policy, Water Resources Control, Review Council, nine subcommittees, Water Resources Research Fund, Basin Board setup, Groundwater Act, and so on). The SWaRMA Act was enacted on April 2009, and the agency became operational in June 2011, three and a half years after the target date of December 2007.

3.35 SWaRMA has established a statewide, web-based Water Resources Information System. The system receives data and information from various government departments and is available to the public through an open data portal (<http://www.tnwrms.gov.in>). Progress was limited in developing the intended multisectoral expertise on economics, environmental and social aspects, basin analysis and modeling, geographic information system and remote sensing, planning future water uses, and stakeholder communications.

3.36 SWaRMA is not yet in a position to play its larger role of providing advice and support for the management and allocation of water resources across sectors in the state. The institutional reform associated with SWaRMA and securing its intended role requires broad political and governmental consensus that goes beyond the core concerns of this project.

3.37 **Subbasin level.** The goal of establishing subbasin water boards was not met. The two basin boards that existed before the project have not been functioning since 2004. The constraining factors are the unwieldy structure and membership that made effective operation and decision-making virtually impossible. At the basin level, top-down



teams, each consisting of an WRO representative overseeing two mobilization and training specialists and 10 field organizers.

3.40 By project completion, 2,775 WUAs were formed, trained, and effective (against a target of 2,500 WUA), commanding a total area of 669,154 hectares. Participatory irrigation management cells were established at the district level with multidisciplinary teams, including agriculture, to support WUAs more generally in mobilization, planning, and accessing other schemes and water resource planning and monitoring. Maintenance of canals serving less than about 700 hectares and structures in the project area are now the responsibility of WUAs.

3.41 However, an assessment of WUA capacity carried out toward the end of the project showed that although about 50 percent had achieved a strong level of functionality, about 40 percent had achieved a middle level of functionality, and 10 percent needed substantial capacity building.

3.42 As of February 2019, the elected term of WUAs has expired, and new elections are overdue. WUAs are not formally functional, and if this continues for too long, it will gradually impact the upkeep of irrigation structures and weaken institutional and capacity gains and the continuity of beneficial interaction with WRO and line department officials that was developed during the project. However, it is noted that in most locations visited by the mission, the last elected leadership of WUAs appears to be functioning informally and carrying out some of their responsibilities regarding minor O&M of irrigation structures, cleaning the subcanals, bush clearing, tree cutting, and so on.

## **4. Efficiency**

4.1 At appraisal, the project's economic and financial efficiency was estimated based on a representative sample of nine subbasins spread over three major agro-climatic zones of the state. The intention was to reflect the nonhomogeneous production and resource environment in the subbasins covered by the project. The benefits that were considered were drawn from the major investment activities of irrigation system modernization and agriculture intensification and diversification, including livestock and fisheries, which together accounted for 87 percent of the project costs.

4.2 The parameters that were quantified were the expected expansion in irrigated area, increased productivity of crops, market-led shift into higher-value crops in irrigated agriculture, increased milk productivity because of subbasin-specific integrated breed-health-feed management programs, and increased fish productivity because of comprehensive fish seed stocking and feed management programs.

4.3 The project's ex post economic and financial analysis was based on the same benefit streams considered at appraisal but was comprehensive in drawing on actual aggregated data from the entire project area of 61 subbasins made available by the participating departments.

4.4 The economic rate of return for the project was estimated at 21.0 percent at project completion, which was nearly the same as the 20.4 percent figure estimated at appraisal. The estimated financial rate of return at completion was 30 percent, significantly higher than 24 percent estimated at appraisal. The corresponding net present values were \$276 million and \$251 million, respectively in 2006 prices over a 25-year project cycle.

4.5 Based on the discussion in the Efficacy section, it is reasonable to assume that the project's benefits have been generally sustained and might have improved in some cases, despite two years of drought after project completion.

4.6 **Administrative efficiency.** The International Bank for Reconstruction and Development credit saw a cancellation of \$45 million primarily because of (i) foreign exchange savings and (ii) cost savings on civil works procurement packages as reported by MDPU. Despite the canceled amount, the project achieved most of its major quantitative outputs and targets. The implementation of components A and C suffered implementation delays. The M&E contract was awarded almost three years into implementation. Financial management also suffered from delays.

4.7 Overall, efficiency is rated **substantial** despite some shortcomings in aspects of administrative matters.

## 5. Ratings

### Outcome

5.1 Relevance of project objectives is rated **high** based on alignment with government priorities and related pillars of the Bank Group's Country Partnership Strategy. Project design is rated **substantial** because it logically links inputs covering physical infrastructure, capacity building, agricultural inputs, marketing links, and the creation of a water resources management agency with agricultural outcomes and livelihood impacts, although the larger water resources management outcomes were ambitious. Efficacy is rated **substantial** overall given the significant and largely sustained outcomes in agricultural productivity. These, together with substantial efficiency, yield an overall **satisfactory** development outcome rating.

5.2 The project development outcome is rated **satisfactory**.

## Risk to Development Outcome

5.3 There are four important sources of risk to the sustainability of the project's development outcomes: resources for O&M of the rehabilitated irrigation infrastructure, strengthening WUAs to carry out their responsibilities, continued collaboration and convergence between line departments with the water users as the focal points, and the state government's commitment to continue building capacity for water resource management and informed decision-making on water allocation and use.

5.4 According to the project appraisal document for the follow-on TNIAM project, the state budget in Tamil Nadu allocates \$7.5 million annually for O&M of the 14,000 tanks in the state (World Bank 2006). However, the 5,260 tanks rehabilitated under the TN-IAMWARM project would receive a lower share of the O&M funds given their current good condition. The government has undertaken to establish functional maintenance norms with reliable benchmarking of costs for conducting the set of required maintenance measures, determining the necessary work plan for all tanks in the state annually, and allocating necessary budgetary funds for this purpose.

5.5 The momentum built during the project for WUAs through training and involvement in project activities has slowed down because of pending elections for WUAs, whose terms for elected representatives have expired. It is critical to reactivate the WUAs, provide for capacity building, and initiate the practice of regular collection of the WUA subscription fees for carrying out regular system O&M and other WUA activities.

5.6 The IEG mission considered the likelihood that the spirit of collaboration and convergence displayed by the line departments at the state and district levels and cooperation with TNAU in the project areas might dilute gradually after project completion. This could be partly caused by project funds ceasing and a lowered scale of training and support. During meetings with line department officials in various site visits, the mission noted awareness among officials of issues across departmental lines, the continuing practice of conducting joint visits with officials from other departments for coordination and cost-sharing, and informal exchange of information on beneficiary needs. These are positive signs given that more than three years have elapsed since project completion. The successor TNIAM project, which continues a similar scale of participation for the line departments (though in new locations), also reinforces the behavioral changes introduced through TN-IAMWARM, aided by the fact that experienced officials are rotated to the new districts.

5.7 The implementation of irrigation and water sector reforms has been slow at different levels. SWaRMA is yet to be resourced and empowered sufficiently for serving its intended purpose of data-driven allocation of water across sectors and within the

irrigation sector. WUAs need rejuvenated to play their role in the on-farm allocation of water. This shows that more needs to be done to implement measures to manage and mitigate the four sources of risk described.

5.8 Overall risk to development outcome is rated **substantial**.

### **Bank Performance**

5.9 **Quality at entry.** The project design benefited from a background analysis of the water situation in the state, which revealed the overuse of water compared with available resources and the consequent need to enhance efficiencies in agricultural water use. The project design also benefited from the experience and lessons of the preceding International Development Association–financed WRCP in the state and other similar World Bank–funded irrigation projects in other Indian states. Among these lessons was the potential for achieving better-than-expected agricultural production and livelihood impacts by combining investments in irrigation infrastructure rehabilitation with a substantial focus on agriculture and investment in improved water management and institutional development. The inclusion of a specific water resource management (WRM) component sent an important signal to government agencies about the importance of data collection for analysis as a basis to manage this increasingly scarce and vulnerable resource in the state.

5.10 The project contained covenants designed to build on outcomes from the preceding WRCP project, especially regarding WRM and institutional capacity. The feedback obtained during the mission confirms that these were strategically important measures intended to have long-term payoffs by legitimizing the WRM institution within the state government apparatus and building participatory irrigation management through capacity building for WUAs. In retrospect, the covenants reflected a balance between challenging the system to make significant progress in these areas and the likelihood of achieving the goals in full measure. The provision for agricultural marketing plans was borne out by significant and sustained response from the private sector.

5.11 Overall, the World Bank’s quality at entry is rated **satisfactory**.

5.12 **Quality of supervision.** The World Bank conducted supervision missions twice a year on average and fielded teams with technical expertise in water engineering, participatory irrigation management, agriculture extension, livestock and fisheries, institutional development, and M&E. Feedback from the MDPU (which retains most of its key members in the successor TNIAM project) indicates that the supervision teams provided regular and insightful advice and guidance for project implementation. The

missions played a facilitating role and engaged in frank and informative discussions with officials at all levels, which was highly appreciated.

5.13 During the site visits, the IEG mission confirmed that the irrigation infrastructure rehabilitation activities benefited from the presence of a senior engineer, who oversaw quality standards, trained local engineers in quality supervision, and provided guidance, guidelines, and templates for quality control. The mission confirmed this by triangulating feedback from the MDPU, line department officials, and WUAs. The procedures have been largely mainstreamed into departmental activities. The project also benefited from procurement and financial management training provided to MDPU staff by the first supervision mission.

5.14 The initial delay in making arrangements for implementing the M&E system was overcome through proactive intervention by the supervision team. The World Bank also made efforts to have the government pay greater attention to water management issues and provision of water management expertise, especially at the basin and state levels, which presented administrative and political challenges.

5.15 Overall, risks relating to complexity of coordination across implementing agencies, lack of continued government priority for institutional reforms, and shortage or frequent turnover of field staff leading to time and cost overruns were managed well during implementation.

5.16 The quality of supervision is rated **satisfactory**.

5.17 Based on satisfactory quality at entry and satisfactory quality of supervision, overall Bank performance is rated **satisfactory**.

## **Borrower Performance**

5.18 **Government performance.** The government demonstrated commitment to the project from the planning stage and throughout the project implementation. On a longer time frame, this commitment has been consistent from the preceding WRCP project and to the ongoing successor TNIAM project. A crucial element of the government's performance has been to ensure the stability and continuity of the implementing arrangements, including the leadership and key staff of the MDPU. The government enabled the early creation of the MDPU and the assignment and reallocation of staff within various departments to implement project activities as part of their regular work program. This has enabled a strong institutional memory and steady enhancement from one project to the next regarding capacity in the implementing agencies, expanding the scope of project activities beyond rehabilitation of irrigation infrastructure to

agricultural intensification and diversification and providing backward and forward market links, and introducing elements of water budgeting.

5.19 Various government departments have recognized the value of the project's achievements and have worked to mainstream some of the practices that the project demonstrated successfully into policy and programs for the entire state, especially for SRI, micro-irrigation, and animal husbandry practices. The government's grant and subsidy programs for farmers have been dovetailed with the activities undertaken by the project such as micro-irrigation systems, provision of agricultural equipment, and fish seed distribution to fisheries cooperatives.

5.20 The government's support for development of the subbasin plans and Detailed Project Reporting in Tamil Nadu with inputs from concerned government departments and their involvement from the initial stages of project planning sets it apart from several other states in the country where system planning is done at the irrigation tank level (for example, Andhra Pradesh, Karnataka, and Odisha.)

5.21 The mission's discussions with officials of MDPU indicate that the government recognizes the necessity of an integrated and holistic approach in the planning and management of water resources and demonstrated this by establishing SWaRMA and three Water Resource Department cells for participatory irrigation management, training, and information technology, though after significant administrative delay. These new institutions provide the basis for mainstreaming a culture of water resource management and applying it to decision-making related to water allocation, usage, and measurement for irrigation. The adoption of participatory irrigation management as a mainstream department is continuing under the successor TNIAM project.

5.22 The government provided timely counterpart funding and respected the project's fiduciary requirements. There were delays in meeting schedules related to legal covenants, which were eventually overcome. Regarding institutionalizing participatory irrigation management, the action has been tied to the follow-on TNIAM project.

5.23 Regarding the covenant on reducing subsidies to the Tamil Nadu Electricity Board, in retrospect, it was recognized that this project was not the appropriate vehicle to carry it out.

5.24 Government performance is rated **satisfactory**.

5.25 **Implementation agency performance.** The project was implemented by eight Tamil Nadu government agencies coordinated by the MDPU: Water Resources Organization; the Departments of Agriculture, Agriculture Engineering, Agriculture Marketing, Animal Husbandry, Fisheries, and Horticulture; and TNAU. All

departments deployed the necessary staff as needed in the participating districts rather than having dedicated MDPU cells. This arrangement had the effect of greater ownership among department staff at the district level, who saw themselves as part of the broader project effort. At the district level, progress was monitored by the District Collector (administrator) through regular meetings, and this proved to be an effective coordination mechanism.

5.26 The project benefited from the stable leadership of the same project director for the duration of the project, who also presently oversees the successor TNIAM project. MDPU has also maintained continuity by retaining key senior staff from WRCP through to TNIAM, who are well-placed to transfer the institutional memory of the multiproject effort to new staff members. There was a conscious and consistent effort by the MDPU leadership and staff to foster collaborative behavior and convergence among the staff of various departments geared toward the farmer as the focal point of project assistance. Innovative ideas were encouraged and implemented, ranging from the large SRI initiative to engaging unemployed veterinary graduates to provide targeted services to livestock farmers, creating redress mechanisms through single window knowledge centers, and making contact numbers for officials available for farmers in an accessible location.

5.27 Implementing officials were provided training in change management to understand the value proposition in their contributions. This appears to have had a positive impact on the officials in their interaction and providing support to the farmers. Line department officials told the mission that in addition to developmental work in their disciplines, they also carry out joint visits to the beneficiary sites and have greater awareness of work being done in each other's functional areas.

5.28 The MDPU's experience contrasts with the typical experience of a project implementation unit in World Bank projects that are constituted as a special purpose vehicle and that is likely to be an island of success and have limited impact on the mainstreaming of new practices and procedures into the larger government entities. At the same time, the administrative traditions in Tamil Nadu and receptivity of farmers in the project areas might have been important factors in the MDPU's performance.

5.29 TNAU's role as a technical resource in the project was valuable to the line departments, and the project provided a platform for TNAU to calibrate, disseminate, and implement its technologies. The coordination between the line departments and TNAU helped narrow the gap between lab and land by assessing the farmers' feedback directly. As an autonomous organization, TNAU could quickly hire and train contractual staff (compared with line departments) and conduct fast track implementation.

5.30 Feedback from the mission site visits indicates that there was also a high level of awareness among individual farmers from the treatment area about selected project interventions, and this can be attributed to the efforts of government officials who were the major source of information to the beneficiaries.

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### Box 5.1. Fostering Behavior Change

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The project supported change management training at a micro level for officials working in 20 villages during 2011, and the experiment's success led to a medium-scale rollout of the program in 2014. A study of the impact of this training found that officials who received specialized change management training are perceived by the community as having different attitudes and behavior compared with officials who have not had such training. Specifically, villagers felt that officials with the specialized training visit more frequently, visit more often with officials from other participating departments, visit more often whenever there is a need, meet more stakeholders (including small and marginal farmers), met all beneficiaries, answered villagers' queries, discussed project interventions, and gave information on various relevant issues such as farming, water management, or overall development of the village. The mission was broadly able to corroborate these findings from discussions with government and village officials and farmers.

The study found that villagers no longer view officials as symbols of authority when they participate in the meeting, and this change occurred because of how the officials conduct themselves on such public occasions. The community perceives them as behaving more like part of the community, sitting with the farmers, give them respect, discussing issues with them in a friendly manner, and trying to help by channeling services from other departments.

*Source:* ISD 2015.

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5.31 MDPU had a good collaborative relationship with the World Bank team in an atmosphere of frank discussions and openness to trying new ideas that might not have been included at the appraisal stage. Together, they provided space for the departments to innovate and experiment, find solutions, and suit the local context. By involving beneficiaries in planning, implementation, and monitoring, the project ensured transparency and could minimize or resolve potential conflicts during implementation.

5.32 In the initial years of the project, there were delays in procurement, partly because of weak WRO capabilities in design and knowledge of World Bank procedures and cumbersome state procurement procedures. Even at the midterm review, award of contracts took about six months from receipt of bids, and there was a reluctance to recruit international consultants. These matters were gradually resolved, and the procurement picked up in the second half of project implementation.

5.33 The implementing agency performance is rated **satisfactory**.

5.34 Based on satisfactory government and the implementing agency performance, overall borrower performance is rated **satisfactory**.

## 6. Lessons

6.1 Irrigation project design that combines improvements in infrastructure with activities for improving agricultural and water use practices, agricultural inputs, and marketing support and links can be a viable and effective approach for improving agricultural productivity and rural livelihoods. This project experience has shown the efficacy of combining multiple irrigation and agricultural components for coordinated results and impact.

6.2 For the several line departments that are necessarily involved in multidimensional irrigation projects, the provision of appropriate training can play a pivotal role in fostering collaborative behavior among the departments and orient them toward the farmer beneficiary as the focal point of their services. This project engaged training resources that included social scientists and technical specialists to foster collaborative behavior among line officials of diverse departments that were earlier disposed to work in a more compartmentalized manner. This effort helped them greatly to see the farmer beneficiary as the focus of their collective efforts.

6.3 The tone the project leadership sets is crucial for fostering and sustaining collaborative behavior across diverse implementing agencies. In this project, the implementing agency leadership played a proactive role in encouraging cross-learning across participating districts, provided incentives and recognition for collaborative behavior, and closed the loop with beneficiary feedback and monitoring.

6.4 Including a water resource management component in an irrigation project can be a strategically important decision with long-term payoffs, but it might have to be supplemented by other projects to realize the potential for wider water management and climate-smart agricultural policies. The World Bank's attempts in this regard in Tamil Nadu date to 1995, when the preceding project was approved. Although there has been progress in setting up an institution, progress in intersectoral water resource management requires a different timeline and the involvement of additional ministries and stakeholders.

6.5 Introduction of water budgeting concepts at the village or subbasin level is a crucial first step to build on by gradually promoting the measurement of water use and agricultural water productivity. This project's experience shows that instructing beneficiaries on water budgeting principles might not have a significant impact on water management unless provision is gradually made for measuring water use and water use at the farm level.

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<sup>1</sup> The disbursed amount exceeds the appraised amount because of foreign exchange rate fluctuations with respect to special drawing rights.

<sup>2</sup> A level two project restructuring generally involves a change in project duration or financing, without substantive changes in the project development objective.

<sup>3</sup> For more information about the consultancy SMEC, visit <http://www.smec.com>.

<sup>4</sup> The 11 locations or villages visited were Alankuppam, Chidamarapuram, Govindapuram, K. K. Pudur, Kavanur, Keelathivakkam, Mahibalanpatti, Peramanur, Perungudi, Pollachi, and Pudirivayal.

<sup>5</sup> Sixty-one subbasin plans were developed and implemented compared with a target of 63 plans and a baseline of nine integrated subbasin plans.

<sup>6</sup> The difference was because of an adjustment of the subbasins participating in the project at the midterm review.

<sup>7</sup> Drip irrigation is a type of micro-irrigation system that has the potential to save water and nutrients by allowing water to drip slowly to the roots of plants either from above the soil surface or buried below the surface. The goal is to place water directly into the root zone and minimize evaporation. Drip irrigation systems distribute water through a network of valves, pipes, tubing, and emitters. Depending on how well designed, installed, maintained, and operated it is, a drip irrigation system can be more efficient than other types of irrigation systems, such as surface irrigation or sprinkler irrigation.

<sup>8</sup> During the project, micro-irrigation coverage increased by 53,901 hectares against a target of 100,000 hectares, including 47,922 hectares (21,952 hectares for drip irrigation and 26,350 hectares under sprinkler irrigation) under the Agriculture Engineering Department's interventions and 5,979 hectares under Tamil Nadu Agriculture University's precision farming interventions.

<sup>9</sup> Drip irrigation—also known as low-flow, micro, and trickle irrigation—is the slow, measured application of water through devices called emitters that are attached by microtubing to lateral lines that branch out from the main tube.

<sup>10</sup> Pulses are the edible seeds of plants in the legume family—lentils, cow peas, and pigeon peas, for example.

<sup>11</sup> Tomato yield increased by 47 percent from 13.8 metric tons per hectare to 20.2 metric tons per hectare, dried chili by 42.6 percent (1.9 metric tons per hectare to 2.7 metric tons per hectare), bananas by 15.1 percent (39.2 metric tons per hectare to 45.2 metric tons per hectare), bhendi by 22.2 percent (7.0 metric tons per hectare to 8.6 metric tons per hectare), and brinjal by 22.2 percent (12.1 metric tons per hectare to 14.8 metric tons per hectare).

<sup>12</sup> Vermicomposting, or worm composting, produces a rich organic soil amendment containing a diversity of plant nutrients and beneficial microorganisms.

<sup>13</sup> A farmer producer organization is a legal entity formed by primary producers, such as farmers, milk producers, fishermen, and the like. The organization can be a farmer producer company, a

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cooperative society, or any other legal form that provides sharing of profits or benefits among the members.

<sup>14</sup> After passage of the Farmers Management of Irrigation Systems Act in 2000, the existing farmer committees were rearranged into 1,566 water user associations covering 654,000 hectares. The first elections for these associations were completed only in March 2004, and the newly elected associations have so far had little opportunity to demonstrate their capabilities to raise resources and maintain their systems to an adequate standard.

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## Appendix A. Basic Data Sheet

### Tamil Nadu Irrigated Agriculture Modernization and Water-Bodies Restoration and Management (P090768; Credit No. 2745)

Table A.1. Key Project Data

Financing	Appraisal Estimate (\$, millions)	Actual or Current	
		Estimate (\$, millions)	Actual as Percent of Appraisal Estimate
Total project costs	315.6	245.2	78
Loan amount	282.9	219.8	78
Cofinancing	n.a.	n.a.	n.a.
Cancellation	n.a.	n.a.	n.a.

Table A.2. Cumulative Estimated and Actual Disbursements

Disbursements	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
Annual	5	70	90	100	100	70	45	5
Cumulative	5	75	165	265	365	435	480	485

Date of final disbursement: August 19, 201

Table A.3. Project Dates

Event	Original	Actual
Concept review	n.a.	06/01/1993
Board approval	n.a.	06/20/1995

Table A.4. Staff Time and Cost

Stage of Project Cycle	World Bank Budget Only	
	Staff time (no. weeks)	Cost <sup>a</sup> (\$, thousands)
Lending		
FY06	46.44	229.23
FY07	76.04	391.13
Total	122.48	620.36
Supervision or ICR		
FY07	17.65	101.93
FY08	47.00	247.72
FY09	53.28	261.26
FY10	53.56	257.32
FY11	60.03	213.74
FY12	20.74	141.63

World Bank Budget Only		
Stage of Project Cycle	Staff time (no. weeks)	Cost <sup>a</sup> (\$, thousands)
FY13	22.80	128.52
FY14	12.14	91.91
FY15	15.29	109.15
FY16	4.83	29.76
<b>Total</b>	<b>307.32</b>	<b>1,582.94</b>

Note: ICR = Implementation Completion and Results Report.

a. Including travel and consultant costs.

**Table A.5. Task Team Members**

Name	Title	Unit	Responsibility or Specialty
World Bank Staff			
Anupam Joshi	Sr. Environmental Specialist	GENDR	Environmental safeguards
Atin Kumar Rastogi	Procurement Specialist	GOGDR	Procurement
Deborah Lee Ricks	Sr. Program Assistant	SASDO	Program assistance
Edward C. Cook	Sr. Agriculture Economist	GFADR	Task Team Leader
Gennady Pilch	Sr. Legal Counsel	LEGEC	Legal
Grahame Dixie	Adviser	GFADR	Agriculture marketing
Anju Gaur	Sr. Water Resources Specialist	GWADR	Water management
Sitaramachandra Machiraju	Sr. Water and Sanitation Specialist	GWASP	Agriculture marketing
Javier Zuleta	Sr. Water Resources Management Specialist	GWADR	Water management
Krishna Pidatala	Sr. Operations Officer	GTIDR	Information and communications technology (ICT)
Geeta Alex	Program Assistant	SACIN	Program assistance
Leena Malhotra	Program Assistant	SACIN	Program assistance
Jurminla	Procurement Specialist	GGODR	Procurement
Mohan Gopalakrishnan	Sr. Financial Mgmt. Specialist	GGODR	Financial management
Nagaraja Rao Harshadeep	Lead Environmental Specialist	GENDR	Co-Task Team Leader
Philip Beauregard	Sr. Legal Counsel	LEGMS	Legal
Rabih Karaky	Operations Advisor	LCROS	Task Team Leader
Sarita Rana	Sr. Program Assistant	SACIN	Program assistance
Shankar Narayanan	Sr. Social Dev. Spec.	GSURR	Social safeguards
Srinivasan Raj Rajagopal	Lead Water Resources Specialist	SASAR	Task Team Leader
Sushil Kumar Bahl	Sr. Procurement Specialist	SARPS	Procurement
Syed I. Ahamed	Lead Legal Counsel	LEGMS	Legal
Thao Le Nguyen	Sr. Finance Officer	LOAG2	Financial management

Name	Title	Unit	Responsibility or Specialty
Venkatakrishnan Ramachandran	Program Assistant	GFADR	Program assistance
Vinayak Ghatate	Livelihoods Specialist	SASSD	Livelihoods
Wilhelmus G. Janssen	Lead Agriculture Specialist	GFADR	Agriculture
Winston Yu	Sr. Water Resource Specialist	GWADR	Water management
Sashank Ojha	Sr. e-Government Specialist	GTIDR	ICT
<b>Consultants</b>			
R K Malhotra	Construction Design Specialist		Irrigation works
Anil Borwanker	Construction Design Specialist		Irrigation works
Benjamin O'Brien	Agriculture Specialist		Agriculture
Paul Sidhu	Agriculture Specialist		Agriculture
Ranu Sinha	Social Specialist		Social specialist
Martin Kumar	Fisheries Specialist		Fisheries
Mudnakudu Nandeesha	Fisheries Specialist		Fisheries
M Swaminathan	Livestock Specialist		Livestock
Dhirendra Kumar	Procurement Specialist		Procurement
S Selvarajan	Economist		Economic and Financial Analysis
Jagdish Anand	IT Specialist		ICT
Cossio Ferdinando	Horticulture Specialist		Horticulture

**Table A.6. Other Project Data**

**Borrower or Executing Agency: Water Resources Department, Public Works Department, Government of Tamil Nadu**

**Follow-on Operations**

Operation	Loan no.	Amount (\$, millions)	Board Date
Tamil Nadu Irrigated Agriculture Modernization Project	8797-IN	318	12/01/2017

## Appendix B. Project Components

The project included five components:

**Component A.** Irrigation systems modernization in a subbasin framework (appraisal cost: \$282.83 million; revised cost: \$395 million; actual cost: \$364 million). This component would aim to improve bulk water delivery to irrigation systems through modernization of irrigation systems and service delivery in schemes in about 63 selected project subbasins. Activities would be carried out under two subcomponents:

**Subcomponent A1.** Tank systems modernization. This subcomponent would focus on reviving traditional water bodies (tanks) that are an integral part of most irrigation systems networks in the state. Special effort would be made to consider tanks in a multidisciplinary, holistic framework to yield sustainable benefits to the farmers of such systems.

**Subcomponent A2.** Other irrigation systems modernization. This subcomponent would focus on the few subbasins where tanks are not part of the larger canal-irrigated systems. These irrigation systems would also be modernized in a shared-vision subbasin perspective.

**Component B.** Agricultural intensification and diversification (appraisal cost: \$166.23 million; revised cost: \$115 million; actual cost: \$103 million). This component would build on the improved bulk water delivery of the previous component to increase the productivity of agriculture-related activities through improved agricultural intensification and diversification in about 63 selected subbasins. This component would also be implemented as two subcomponents:

**Subcomponent B1.** Tank systems. This subcomponent would focus on intensification and diversification of tank-dependent ayacuts (the area served by the tank).

**Subcomponent B2.** Other systems. This subcomponent would focus on the intensification and diversification of the larger canal-irrigated systems.

**Component C.** Institutional modernization for irrigated agriculture (appraisal cost: \$52.69 million; revised cost: \$22 million; actual cost: \$15 million). This component seeks to improve the institutional capacity for modern, efficient, and accountable irrigation service delivery. The scope of this activity would be statewide. Under this component funds (for civil works, training, consultancies, goods and equipment, and incremental operating expenses) would be provided to assist the Tamil Nadu government to improve training and sourcing of additional skills relevant to modern irrigation systems management, facilitate systematic change management efforts to modernize the

functioning of the WRO, and build on good practice expenses in India and abroad. Funds would be provided to assist in the formation and capacity building of about 2,500 water users associations (WUAs) and cluster WUAs (about 10 WUAs clustered on a hydraulic basis to serve as a focus for extension and information technology efforts) in the 63 subbasins under the project. An irrigation research fund with about \$3 million (to be revised during project midterm based on implementation progress) would be set up and used to foster research in irrigation development and management.

**Component D.** Water Resources management (appraisal cost: \$5 million; revised cost: \$1 million; actual cost: \$1 million). This component aimed to improve the institutional arrangements and capacity for sustainable water resources management in the state. This would include the creation of a State Water Resources Management Agency, amalgamating the existing Institute of Water Studies and the State Surface and Groundwater Data Center. Financing would be provided for expert consultants, incremental operating expenses, civil works, training, and equipment required to provide additional multisectoral expertise (especially on economics, environmental and social aspects, basin analysis and modeling, GIS and remote sensing, planning future water uses, stakeholder communications).

**Component E.** Project management support (appraisal cost: \$8.32 million; revised cost: \$8 million; actual cost: \$6 million). This component would support the management and coordination efforts related to this project. Support would include key consultancies (such as for the project monitoring and evaluation, internal audit capacity building, and specialized multidisciplinary contract staff), and the necessary civil works (to house the multidisciplinary project unit to be combined with the Water Resources Organization), and goods (including computer hardware, software, connectivity, video and audio conferencing, project library, vehicle purchase and hire, and so on), and operating costs to facilitate interagency coordination, project monitoring, adaptive project management, and effective reporting.

## Appendix C. List of Mission Site Visits and Facility and Activity Locations

Table C.1. Mission Site Visits and Facility and Activity Locations

Main Site Visit Village Location (Adjoining No. Locations)	Facility/Activity Visited							
	Tanks/ Canals	Micro- Irrigation	SRI	SSI	Crop Diversification	Inter- crop with Cocoa	ABC	Livestock and Fisheries
1. K. K. Pudur	✓		✓		✓			
2. Keelathivakkam	✓	✓	✓		✓		✓	✓
3. Alankuppam	✓	✓	✓		✓			
4. Pudirivayal (Eazhuthanivayal) Pallathur Aandikaadu	✓	Eazhuthanivayal				Aandi.	Pall.	Eazh.
5. Kavanur		✓	✓		✓			✓
6. Mahibalanpatti		✓	✓		✓		✓	
7. Perungudi Peramanur	✓		✓		✓			Per.
8. Peramanur Perungudi			✓	Per.	✓			
9. Chidamarapuram Papanooth	✓	✓			✓		Pap.	✓
10. Govindapuram	✓	✓	✓		✓		✓	
11. Pollachi (Anamalai Aliyar Chinnampalyam Thathur, Ponnapuram)	Anai. Aliyar	Anai. Aliyar	Anai. Chinnam. Thathur Aliyar		Anai. Aliyar		Ponn.	Aliyar

Note: ABC = agribusiness knowledge center; SRI = System of Rice Intensification; SSI = Sustainable Sugarcane Initiative.

## Appendix D. Rehabilitation and Modernization of Irrigation Infrastructure Outputs and Outcomes

Table D.1. IEG Observations Summary

Village, Completion Year, Nature of Works	Physical Condition (Affirmed by WRO and MDPU Officials and Farmer Representatives)
<p>K. K. Pudur 2013</p> <p>Check dam construction</p> <p>Capacity: 9.63 million cubic feet capacity</p>	<p>In good condition. The check dam has increased recharge of water in eight panchayats (village local government areas); increased the irrigated area and restored the drinking water supply; and prevents surplus water flowing into the sea. More assured irrigation has facilitated cultivation of additional crops, and especially increased cultivation of paddy, groundnut, pulses, and vegetables. Increased water availability has benefited livestock.</p>
<p>Keelathivakkam 2013</p> <p>Reconstruction of sluice with sluice gate shutter arrangements and lining works; strengthening of bund; desilting of supply channel</p> <p>Capacity: 7.08 million cubic feet</p>	<p>In good condition, with no major breaches, and has increased the irrigated area, covering 40 hectares, and has brought additional crops under cultivation. Increased recharge of surrounding wells. Raising of two to three crops in a year was made possible by the increase in the supply of water. Paddy, sugarcane, vegetables, pulses, and chilies are raised in the command area. The farmers in the command area have a mechanism of water sharing among them. When there is limited supply of water, priority is given to farmers who are entirely dependent on tank irrigation.</p>
<p>Alankuppam 2012</p> <p>Strengthening of tank bunds; sluice construction; desilting of supply channels; lining of field channels and flow measuring device</p>	<p>In good condition, and has been successful in recharging wells in the vicinity and bringing additional area under cultivation. Paddy, vegetables, and more diverse cash crops like watermelon, musk melon, and sugarcane are cultivated. Different production strategies and water-saving technologies have enabled assured income throughout the year for the farmers. The supply channels are regularly maintained by the water user association using contributions of Re 250 (\$3.60) per hectare toward the annual maintenance.</p>
<p>Pudirivayal 2013</p> <p>Concrete works and repairs to anicut; desilting of supply channel, sluice reconstruction</p>	<p>The farmers felt that the OK Card used for monitoring the construction was very useful in meeting the quality standards. Irrigation tank covers 40 hectares and has increased groundwater recharge in the surrounding areas, and it has realized maximum potential during good monsoons. Additional acreage was brought under groundnut cultivation, with a yield increase of 30 percent. Small repairs and cleaning of canals are undertaken by the members of the water</p>

Village, Completion Year, Nature of Works	Physical Condition (Affirmed by WRO and MDPU Officials and Farmer Representatives)
Perungudi 2015 Bund strengthening; sluice repair and surplus weir construction works across system tank	<p>user association with contributions of Re 50 (\$0.80) per hectare and shared labor.</p> <p>The bund (embankment) is in good condition and has sufficient width to enable access to vehicles for transporting produce. The tank is at the tail end of the Vaigai River and has enabled 100 hectares to be brought under cultivation after three continuous areas of drought. The land value in the surrounding area has increased. Encroachments were cleared during the construction works, and the actual area of the tank was ascertained for the first time. Paddy, pulses, vegetables, and jasmine cultivation has been taken up or expanded, and intercropping has been introduced. Inland fisheries has also been taken up.</p>
Chidambarampuram 2014 Chettikulam small tank Tank desilting; bund strengthening; sluice repairs; artificial recharge wells Tank capacity: 23.45 million cubic feet	<p>Tank storage capacity has increased by 28,200 cubic meters, and the groundwater table has increased up to nine feet. The additional water helps recharge wells in the surrounding areas during water-stressed periods. The tank irrigates an area of 20 hectares. System of Rice Intensification paddy yields have increased, and pulses, maize, bananas, and vegetables have been taken up. Tissue culture bananas and bhendi (okra) have been introduced.</p>
Govindapuram 2014 Check dam and sluice construction	<p>Rehabilitation has helped overcome overexploitation of groundwater. The desilting works has enabled the water to reach the tail end by six hours (it took 36 hours previously). The construction of the check dam has increased the well recharge. Farmers are able to raise three crops in a year because of increased water availability (onion, paddy, and maize). water user association members undertake small repairs and maintenance of the channels.</p>
Parambikulam Aliyar Canal 2015 Canal lining	<p>The lining works are intact and have minimized seepage losses and helped increase acreage of cultivation. Irrigation increased to about 40 hectares through sluice operations, screw gearing shutters, and bund strengthening. The water user association plays an important role in coordinating and regulating the irrigation and also undertakes minor repair works.</p>

## **Appendix E. Observations from Site Visits: Factors Supporting Agricultural Intensification and Diversification**

Agricultural intensification and diversification activities were supported by awareness building, training and demonstrations, extension services, and improved practices such as integrated nutrient management and vermicomposting.<sup>1</sup> Marketing support was provided through drying and storage facilities and setting up links with private sector marketing entities.

**Awareness building, training, and demonstration pilots.** The project conducted farmers' field days, farmers' training events, and exposure visits, among others. The Department of Agriculture promoted crop diversification with hybrid maize demonstrations under its Intensive Maize Mission and for pulses under the Converged Pulses Mission, including in the tail-end areas of the ayacuts.<sup>2</sup>

A notable project intervention was the establishment of multiagency single window information and knowledge centers in some villages to serve as a focal point for officials of all line departments to provide technical knowledge and information about irrigation, water management, production and marketing of crops, fruits, vegetables, livestock, and fish. This is discussed in the context of water resources management under subobjective C.

**Improved practices.** Introduction of irrigated pulses was accompanied by new techniques such as seed priming, soaking in water, and drying. The concept of integrated nutrient management was introduced, and farmers were trained in the project areas along with the use of leaf color charts to adopt optimum dosage of fertilizers and vermicomposting, biofertilizers, and biopesticides. Mulching was introduced, which served as an effective water-saving technique. New practices for the area such as the use of raised beds and mulching, seedling germination in pro trays (reusable trays with depressions for soil), high-density planting, and poly green houses were introduced. Introduction of improved seed (mostly hybrids), production of disease-free seedlings, and micro-irrigation systems substantially raised vegetable productivity.

**Marketing support.** The project supported the formation of 6,577 commodity interest groups and marketing links through 6,483 and 1,320 memorandums of understanding, respectively, for paddy and maize buyers. Training given to water user associations on sales and marketing added an enterprise dimension to the activity.

Marketing tie-ups were facilitated for some commodities with prominent private sector entities—Suguna Poultry for maize products and Haldiram and Tata Rallis (under their brand name I-Sakthi) for pulses. Tamil Nadu Agriculture University facilitated an agreement with Cadbury for marketing cocoa beans, which were developed as an intercrop between coconut trees (in Aandikaadu and Aliyar). In Villupuram district, arrangements were made for marketing moth bean (panipayaru) in nearby towns.

Value addition to maize was made possible by providing processing machines like sheller machines in the village and was linked to poultry industries for markets. Similarly, value addition to millets was made possible by introducing 100 processing machines.

An agricultural extension model named e-Velanmai,<sup>3</sup> which combines both personal and information and communications technology-based advisory services by using field coordinators and information and communications technology tools (internet, tablets, mobile phones, and so on), was tested and deployed in 26 subbasins under the project with Tamil Nadu Agriculture University's guidance. An estimated 85 percent of responses to farmers' queries were adopted by them, and successful results were obtained in 91 percent of those cases.

Storage facilities and drying facilities. The project developed 28 drying yards, 525 storage godowns (facilities), 23 collection centers, and one pack house for storage of produce and marketing inputs such as fertilizers and seeds. A storage facility typically has a capacity of store 100–120 metric tons of produce. These facilities helped reduce postharvest losses and avoid distress sales. The storage structures are owned and managed by commodity interest groups (CIGs) composed of farmers, who were provided training on sales and marketing. The total quantity transacted through these facilities over the project period was 380,350 metric tons, with the value of produce over 2007–15 amounting to Re 7,502 million (\$107.8 million) and additional income generated of Re 655 million (\$9.4 million), benefiting 173,422 members.

Improved practices. Farmers in almost all the villages visited by the mission are engaged in portable vermicomposting to supplement farm manure as organic fertilizer, especially for use in vegetable production. The vermicompost kit uses a portable silpaulin bag (a variety of waterproof and fireproof tarpaulin) and costs about Re 6,000 (\$86). A few farmers (for example, in Ponnapuram village) have taken up fully organic farming and have obtained official organic certification to sell their produce, which obtains a premium rate.

Storage godowns and drying yards. The storage facilities and drying yards that the mission visited (Govindapuram, Keelathivakkam, Mahibalanpatti, Pallathur, and

Pappanooth villages) were all in good condition, and the produce is stored in dry and clean conditions. Officials and CIG members showed the mission their account books, which were invariably well maintained and displayed healthy balances.

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**Box E.1. Observations from Storage Godown (Warehouse) and Drying Yard in Pappanooth Village**

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A storage godown and drying yard were constructed under the project in Pappanooth village near Chidambarapuram in Sengattaiyar basin in 2010. An individual from the village donated the land for the facilities. The storage godown is equipped with an electronic scale and moisture meter used for storing chilies, maize, and small millets. The drying yard is used for drying millets and food grains. A memorandum of understanding was concluded between commodity interest groups (CIGs) using this facility and the Department of Agricultural Marketing. The godown’s capacity is 120 metric tons. So far, 135 of 176 CIG members have used this facility, and they pay a nominal amount to use it. A quantity of 453 metric tons of produce amounting to Rs 56,105 (\$803) has been transacted so far toward this service. The CIGs maintain a separate bank account and keep a record of material and financial transactions.

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The number of CIGs and signed memorandums of understanding have increased across the state since project completion, though the number of farmers benefited and the quantities transacted have not grown at the same pace (table E.1). Eighty new farmer producer organizations have been formed, and 40 of those have been supported with cold storages, ripening chambers (Trichy and Theni), and a modern pack house.<sup>4</sup> Although the trend is in the right direction, agricultural marketing and related line departments should carefully monitor the need to strengthen these entities and the availability of alternative means for farmers to market their produce. This is underlined by the finding from an earlier FAO report that such farmer groups tend to wither when project interventions end (FAO 2014). The marketing tie-up with Cadbury’s for cocoa has been expanded, and farmers in Aandikaadu and Aliyar villages noted that the crop yields an additional income of Re 300,000 (\$4,311) per acre annually.

**Table E.1. Growth of Commodity Interest Groups since TN-IAMWARM Project Completion**

<b>Activities</b>	<b>2015–16</b>	<b>2017–18</b>
Commodity groups on various crops	6,577	9,496
Memorandums of understanding signed	6,483	8,818
Value of produce (million)	6,48.192	6,68.448
Farmers benefited (number)	15,692	16,182
Quantity transacted (metric tons)	29,939.84	30,875.46

The e-Velanmai facility has been moved to the Department of Agriculture. A 2017 study on the impact of e-Velanmai on a sampling basis found that more than one-fourth of the respondents had reported 11–20 per cent yield increases.

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<sup>1</sup>Vermicomposting, or worm composting, produces a rich organic soil amendment containing a diversity of plant nutrients and beneficial microorganisms.

<sup>2</sup> Groundnut demonstrations were conducted in 6,587 hectares with an impact area of 40,003 hectares. Pulses demonstrations were conducted in 23 locations with an impact area of 60,004 hectares.

<sup>3</sup>“Velanmai” means “agriculture” in the Tamil language.

<sup>4</sup> A farmer producer organization is a legal entity formed by primary producers, such as farmers, milk producers, fishermen, and the like. The organization can be a farmer producer company, a cooperative society, or any other legal form that provides sharing of profits or benefits among the members.

# Appendix F. Selected Illustrations from IEG Site Visits

**Figure 1.** Walking tour of facilities with officials and farmers and IEG consultant at K.K. Pudur



**Figure 2.** Meeting with villagers in Alankuppam village in Villipuram district



**Figures 3 and 4.** Illustration of rehabilitated irrigation infrastructure: check dam and sluice gates at Dharapuram Village

TN IAMWARM PROJECT PHASE I	
GOVERNMENT OF TAMIL NADU: PWD / WRD,	
COIMBATORE REGION,	
DHARAPURAM CHECK DAM HYDRAULIC PARTICULARS	
MAXIMUM FLOOD DISCHARGE	: 60000 C/S
FRONT MAXIMUM FLOOD LEVEL	: +235.200M
REAR WATER LEVEL	: +237.250 M
LENGTH OF CHECK DAM	: 100 M
CHECK DAM	
CREST LEVEL	: +234.000M
LENGTH OF WEIR	: 106.80 M
DISCHARGE OVER CHECK DAM	: 588915/s
UP STREAM BED LEVEL	: +232.000M
DOWN STREAM BED LEVEL	: +231.600M
STILLING BASIN LEVEL	: +231.300M
LENGTH OF STILLING BASIN	: 21.15 M
TOTAL LENGTH OF FLOOR	: 31.00 M
SCOUR VENT	
DISCHARGE THROUGH SCOUR VENT	: 3700000/s
NO OF SCOUR VENT	: 4 Nos
SIZE OF SCOUR VENT	: 480 X 180 M
SILL LEVEL	: +232.200M
UP STREAM BED LEVEL	: +232.200M
DOWN STREAM BED LEVEL	: +231.600M
Q/S BASIN LEVEL	: +231.300M
LENGTH OF STILLING BASIN	: 19.70 M



Figures 5 and 6. Illustration of “OK Card” for Pudirivayal Anicut, Thanjavur District

**PROJECT INFORMATION:**  
 NAME OF THE PROJECT: PUDIRIVAYAL ANICUT  
 NAME OF THE CONTRACTOR: M/S. JEGATHI CONSTRUCTIONS, THANJAVUR  
 AGREEMENT NO.: 4LS IAWWARM / 2013 - 2014

**EXECUTION TABLE:**

S. No.	DESCRIPTION	DATED SIGNATURE OF					REMARKS
		Contractor	JE / AE	AEE	EE	Inspecting Officer	
1	MATERIAL SUITABILITY						
	i) Cement / கீழ்க்க	✓					
	ii) Steel / இரும்பு	✓					
	iii) Aggregate / கல்லை	✓					
	a) 40mm / 40 கி.மீ	✓					
	b) 20 mm / 20 கி.மீ	✓					
	iv) Sand / மணல்	✓					
	v) Water / நீர்	✓					
	vi) Admixture / கலப்பினம்	✓					

**CONSTRUCTION CHECKLIST:**

S. No.	DESCRIPTION	DATED SIGNATURE OF					REMARKS
		Contractor	JE / AE	AEE	EE	Inspecting Officer	
2	FORM WORK & CURING	✓					
3	REINFORCEMENT	✓					
4	CONCRETE	✓					
5	FINAL OK FOR BACKFILL	✓					

Figure 7. Drip irrigation for Mango trees in Kavanoor village

Figure 8. Drip irrigation for musk melon in Alankuppam village



**Figure 9.** Portable Vermicomposting Kit in use in Keelathivakkam village



## **Appendix G. List of Persons Met**

### **Tamil Nadu State Government**

Vibhu Nayar, Principal Secretary to Government, Project Director, TNIAM

K. Gopal, Principal Secretary to Government, Animal Husbandry Department

K. Padmanabhan, Special Secretary to Government, PWD

### **Tamil Nadu State Government Line Departments**

M. Bakthavathsalam, Engineer-in-Chief, Water Resource Department and Chief Engineer (General), PWD

V. Dakshinamoorthy, Director of Agriculture, Chennai.

N. Subbaiyan, Director of Horticulture and Plantation Crops, Chennai

Thilagavathy, Joint Director, Agriculture Marketing, Chennai

A. Maheshwaran, Additional Director of Animal Husbandry, Chennai

G. Sameeran, Director of Fisheries, Managing Director, TNFDC Ltd., Chennai

R. Murugesan, Chief Engineer, Agriculture Engineering Department, Chennai

S. Gunasekaran, Chief Engineer, Institute of Water Studies and Hydrological Study Department, Chennai

R. Selvakumar, Chief Engineer, Water Resource Department, Groundwater and Surface Water Data Center, Chennai

### **State Water Resources Management Agency**

S. Vimala, Director

### **Tamilnadu Agricultural University**

N. Kumar, Vice Chancellor, Coimbatore

S. Paneerselvam, Director (Water Technology Centre), Coimbatore

A. Velayutham, Professor (Agronomy), Project In-Charge (TN-IMP), Water Technology Centre

J. Pandian, Retired Professor and former Director, Water Technology Centre

### **Multidisciplinary Project Unit, Chennai**

S. Prabakaran	Executive Engineer (P&A)
V. K. Ravichandran	TNAU Specialist
S. Rajagopalan	Water resource management specialist
D. Santhi	Assistant Executive Engineer
D. Rajasekar	Assistant Engineer
K. Arunkumar	Assistant Engineer
C. Vidhyasagar	Horticulture Specialist
R. Thiruthalinathan	Animal Husbandry Specialist
G. Vijayaram	Social Development Specialist
N. Kavitha	GIS specialist
K. Sekhar	Agriculture Business Specialist
V. Santhalingam	Communication Specialist
Judith D Silva	Environmental Specialist
A. K. Rajasekaran	Agriculture Marketing Specialist
K. M. Shahjahan	Agriculture specialist

### **Site Visit Districts**

S. Natarajan, District Administrative Officer, District Collectorate, Madurai

Water Resources Organization regional units

Officers of district line departments (Agriculture, Horticulture, Agriculture Marketing, Agriculture Engineering, Animal Husbandry, and Fisheries)

Faculty, regional research stations, TNAU

District Livestock Centre, Manimuthar

### **Site Visit Villages**

Farmers, fishermen, livestock rearers, water user associations, commodity interest groups, agriculture labor, village leaders

### **World Bank**

Harshadeep Nagaraja Rao, Lead Environmental Specialist

Rabih Karaky, Operations Advisor

Sitaramachandra Machiraju, Senior Agribusiness Specialist

## Appendix H. Borrower Comments

**From:** MDPU <mdputn@gmail.com>

**Sent:** Wednesday, August 14, 2019 4:09 AM

**To:** Abel Lufafa <alufafa@worldbank.org>

**Cc:** Chakib Jenane <cjenane@worldbank.org>; Ramachandra Jammi <rjammi@worldbank.org>; bhuvanakannan.n@gmail.com; Kumudni Choudhary <kchoudhary@worldbank.org>

**Subject:** TN-IAMWARM - Draft IEG Report- H-Borrowers Comments-reg

[External]

Dear Mr. Abel,

I thank you very much for sharing the draft IEG report on IAMWARM. I am directed to convey you the following.

The Project is happy with the findings of the IEG commending the performance of IAMWARM and also highlighting the efficacy of the design, convergence of multi dimensional activities and fostering of collaborative behaviour across the diverse implementing agencies in infrastructure improvement and increasing agriculture productivity through innovative agri practices.

The training especially the Change Management training brought about the most critical Convergence amongst the varied departments and that included social scientists and technical specialists, which helped greatly to see the farmer beneficiary as the focus of their collective efforts is also appreciated.

The suggestions on water management activities and skill development and measurement of water use will be addressed in the current follow-on [Irrigated Agriculture Modernization] Project.

Overall the ratings by the IEG is also acceptable

With Regards,

S. Rajagopalan

WRM specialist, MDPU

Chennai 600005