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Report No: PAD1947

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

PROJECT APPRAISAL DOCUMENT

ON A

PROPOSED LOAN

IN THE AMOUNT OF US\$318 MILLION

TO THE

REPUBLIC OF INDIA

FOR A

TAMIL NADU IRRIGATED AGRICULTURE MODERNIZATION PROJECT

November 8, 2017

Agriculture Global Practice
South Asia Region

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CURRENCY EQUIVALENTS
(Exchange Rate Effective November 8, 2017)

Currency Unit = Indian Rupee (INR)
INR64.98 = US\$ 1

FISCAL YEAR
April 1 – March 31

ABBREVIATIONS AND ACRONYMS

A&E	Accounts and Entitlements
ABPF	Agri-Business Promotion Facility
ADIU	Animal Disease Intelligence Unit
AG	Auditor General
AHD	Animal Husbandry Department
AI	Artificial Insemination
AMAD	Agricultural Marketing and Agribusiness Department
APMC	Agricultural Produce Marketing Committee
ASCI	Administrative Staff College of India
AWD	Alternate Wetting and Drying
AWP	Annual Work Plan
C&AG	Comptroller and Auditor General of India
CBIGO	Community-based Interest Group Organization
CBO	Community-based Organization
CCWM	Community Collaborative Water Management
CEC	Center of Excellence in Change
CER	Contingent Emergency Response
CERIP	Contingent Emergency Response Implementation Plan
CG	Commodity Group
CP	Collaboration Program
CPS	Country Partnership Strategy
CQS	Selection Based on Consultants' Qualifications
CSO	Civil Society Organization
DC	Direct Contracting
DCE	Deputy Chief Engineer
DEA	Department of Economic Affairs
DGS&D	Directorate General of Supplies and Disposals
DIG	Dairy Interest Group
DoA	Department of Agriculture
DoF	Department of Fisheries
DPR	Detailed Project Report
DSS	Decision Support System
EFA	Economic and Financial Analysis
E-in-C	Engineer-in-Chief
EIMS	Enterprise Information Management System
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan

eNAM	Electronic National Agriculture Market
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
EX-ACT	Ex-Ante Carbon-balance Tool
FA	Framework Agreement
FAO	Food and Agriculture Organization
FCSC	Farmer Common Service Center
FFS	Farmers Field School
FM	Financial Management
FPO	Farmer Producer Organization
FWP	Future with Project
FWOP	Future without Project
GAP	Good Aquaculture Practice
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
GoI	Government of India
GoTN	Government of Tamil Nadu
GRM	Grievance Redress Mechanism
GRS	Grievance Redress Service
GSDP	Gross State Domestic Product
HOD	Head of Department
IA	Implementing Agency
ICB	International Competitive Bidding
ICOLD	International Commission on Large Dams
ICRR	Implementation Completion and Results Report
ICT	Information and Communication Technology
ICM	Integrated Crop Management
LCS	Least-Cost Selection
IMTI	Irrigation Management Training Institute
IPF	Investment Project Financing
IPM	Integrated Pest Management
ISFNM	Integrated Soil Fertility and Nutrient Management
ISM	Implementation Support Mission
IT	Information Technology
IWS	Institute for Water Studies
KPI	Key Performance Indicator
LFAD	Local Fund Audit Department
M&E	Monitoring and Evaluation
MDPU	Multi-Disciplinary Project Unit
MIS	Management Information System
NABARD	National Bank for Agriculture and Rural Development
NCB	National Competitive Bidding
NGO	Nongovernmental Organization
NIC	National Informatics Centre
O&M	Operation and Maintenance
OFD	On-Farm Development
PCU	Project Coordination Unit
PDO	Project Development Objective

PEC	Project Empowered Committee
PIM	Participatory Irrigation Management
PIP	Project Implementation Plan
PPP	Public-Private Partnership
PPSD	Project Procurement Strategy Document
PWD	Public Works Department
QBS	Quality-Based Selection
QCBS	Quality- and Cost-Based Selection
RAP	Rehabilitation Action Plan
RFB	Request for Bid
RFCTLAR&R	Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation & Resettlement
RFP	Request for Proposal
RPF	Resettlement Policy Framework
RFQ	Request for Quotation
SAPGE	Strategy and Action Plan for Gender and Empowerment
SBDP	Sub-basin Development Plan
SG&SWDC	State Ground & Surface Water Resources Data Center
SPD	Standard Procurement Document
SRI	System of Rice Intensification
SSI	Sustainable Sugarcane Initiative
SSS	Single-Source Selection
STEP	Systematic Tracking of Exchanges in Procurement
SWaRMA	State Water Resources Management Agency
SWIKC	Single Window Information and Knowledge Center
TANUVAS	Tamil Nadu Veterinary and Animal Sciences University
TN	Tamil Nadu Irrigated Agriculture Modernization and Water-Bodies Restoration and Management Project
IAMWARMMP	
TNAU	Tamil Nadu Agriculture University
TNFMIS	Tamil Nadu Farmers' Management of Irrigation Systems
TNFU	Tamil Nadu Fisheries University
TNIAMP	Tamil Nadu Irrigated Agriculture Modernization Project
TOR	Terms of Reference
WOP	Without Project
WP	With Project
WRCP	Water Resources Consolidation Project
WRD	Water Resources Department
WUA	Water Users' Association

Regional Vice President: Annette Dixon

Country Director: Junaid Kamal Ahmad

Senior Global Practice Director: Juergen Voegele

Practice Manager/Manager: Kathryn Hollifield

Task Team Leaders: Bayarsaikhan Tumurdavaa, Kazuhiro Yoshida

INDIA
TAMIL NADU IRRIGATED AGRICULTURE MODERNIZATION PROJECT

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PAD DATA SHEET

India

Tamil Nadu Irrigated Agriculture Modernization Project (P158522)

PROJECT APPRAISAL DOCUMENT

SOUTH ASIA

0000009246

Report No.: PAD1947

Basic Information			
Project ID P158522	EA Category B - Partial Assessment	Team Leader(s) Bayarsaikhan Tumurdavaa, Kazuhiro Yoshida	
Financing Instrument Investment Project Financing	Fragile and/or Capacity Constraints []		
	Financial Intermediaries []		
	Series of Projects []		
Project Implementation Start Date 17-Dec-2017	Project Implementation End Date 17-Dec-2024		
Expected Effectiveness Date 17-Dec-2017	Expected Closing Date 02-Jun-2025		
Joint IFC No			
Practice Manager/Manager Kathryn Hollifield	Senior Global Practice Director Juergen Voegele	Country Director Junaid Kamal Ahmad	Regional Vice President Annette Dixon
Borrower: Republic of India			
Responsible Agency: Water Resources Department, Public Works Department, GoTN			
Contact: Telephone No.: 919840122674	Vibhu Nayar	Title: Project Director	Email: vibhunayar@gmail.com
Project Financing Data(in USD Million)			
[X] Loan	[] IDA Grant	[] Guarantee	
[] Credit	[] Grant	[] Other	
Total Project Cost:	455.80	Total Bank Financing:	318.00
Financing Gap:	0.00		

Financing Source	Amount
Borrower	136.30
International Bank for Reconstruction and Development	318.00
LOCAL BENEFICIARIES	1.50
Total	455.80

Expected Disbursements (in USD Million)

Fiscal Year	2018	2019	2020	2021	2022	2023	2024	2025	0000	0000
Annual	9.90	13.30	49.60	59.60	56.30	56.30	53.00	20.00	0.00	0.00
Cumulative	9.90	23.20	72.80	132.40	188.70	245.00	298.00	318.00	0.00	0.00

Institutional Data

Practice Area (Lead)

Agriculture

Contributing Practice Areas

Water

Proposed Development Objective(s)

The Project Development Objective (PDO) is to enhance productivity and climate resilience of irrigated agriculture, improve water management, and increase market opportunities for farmers and agro-entrepreneurs in selected sub-basin areas of Tamil Nadu.

Components

Component Name	Cost (USD Millions)
Component A: Irrigation and Water Management	352.80
Component B: Agriculture Productivity Enhancement, Diversification, Improved Livelihoods, Marketing, and Value Addition	95.60
Component C: Project Management Support	7.40
Component Z: Contingency Response	0.00

Systematic Operations Risk- Rating Tool (SORT)

Risk Category	Rating
1. Political and Governance	Low
2. Macroeconomic	Low
3. Sector Strategies and Policies	Moderate
4. Technical Design of Project or Program	Moderate
5. Institutional Capacity for Implementation and Sustainability	Moderate

6. Fiduciary	Moderate		
7. Environment and Social	Moderate		
8. Stakeholders	Low		
9. Other	Low		
OVERALL	Moderate		
Compliance			
Policy			
Does the project depart from the CAS in content or in other significant respects?	Yes []	No [X]	
Does the project require any waivers of Bank policies?	Yes []	No [X]	
Have these been approved by Bank management?	Yes []	No [X]	
Is approval for any policy waiver sought from the Board?	Yes []	No [X]	
Does the project meet the Regional criteria for readiness for implementation?	Yes [X]	No []	
Safeguard Policies Triggered by the Project	Yes	No	
Environmental Assessment OP/BP 4.01	X		
Natural Habitats OP/BP 4.04	X		
Forests OP/BP 4.36		X	
Pest Management OP 4.09	X		
Physical Cultural Resources OP/BP 4.11		X	
Indigenous Peoples OP/BP 4.10		X	
Involuntary Resettlement OP/BP 4.12	X		
Safety of Dams OP/BP 4.37		X	
Projects on International Waterways OP/BP 7.50		X	
Projects in Disputed Areas OP/BP 7.60		X	
Legal Covenants			
Name	Recurrent	Due Date	Frequency
Proceeds of the Loan for Project implementation	X		CONTINUOUS
Description of Covenant			
The Borrower to make the proceeds of the Loan available to the State of Tamil Nadu in accordance with the Borrower's standard arrangements for developmental assistance to the States of India. The Borrower to cause the State of Tamil Nadu to make available the Loan proceeds to Participating Implementing Agencies in accordance with the PIP.			
Name	Recurrent	Due Date	Frequency

PEC, MDPU, PCUs	X		CONTINUOUS
Description of Covenant			
Tamil Nadu to: (a) maintain, throughout the period of Project implementation, a Project Empowered Committee (PEC), chaired by the Chief Secretary of the State of Tamil Nadu and comprising of the Principal Secretaries and Secretaries; (b) maintain, throughout the period of Project implementation, a Multi-Disciplinary Project Unit (MDPU), within the Water Resource Department (WRD) to be headed by the Project Director; and (c) establish and maintain, throughout the period of Project implementation, ten Project Coordination Units (PCUs), one within each Participating Implementation Agency.			
Name	Recurrent	Due Date	Frequency
PIP, FPO Manual, and Grant Agreements	X		CONTINUOUS
Description of Covenant			
For purposes of implementing Part B.3 of the Project, Tamil Nadu to: (a) prepare, approve and adopt the PIP and the FPO Manual, in a manner and substance satisfactory to the Bank, and thereafter carry out, and cause Participating Implementing Entities and Beneficiary FPOs to carry out, the Grant-funded activities in accordance with the provisions of the PIP; (b) refrain from amending, suspending, waiving, and/or voiding any provision of the PIP, whether in whole or in part, without the prior written concurrence of the Bank; (c) ensure that the relevant Participating Implementing Agencies: (i) invite, screen and select, pursuant to the criteria, rules and procedures set forth in the PIP, eligible FPOs for financing through Grants; and (ii) enter into written legal agreement with each selected FPO for the purpose of Grant financing, on terms and conditions set forth in the PIP.			
Name	Recurrent	Due Date	Frequency
Safeguards	X		CONTINUOUS
Description of Covenant			
Tamil Nadu to ensure, and cause Participating Implementing Agencies, and the Beneficiary FPOs, to ensure, that: (a) Project activities are prepared and carried out in accordance with: the ESMF (which includes the RPF), the PMP, the EMP(s), and the RAPs (referred to as the “Safeguard Documents”); and refrain from taking any action, which would prevent or interfere with the implementation of the Safeguard Documents, including any amendment, suspension, waiver, and/or voidance of any provision of the Safeguard Documents, whether in whole or in part, without the prior written concurrence of the Bank; (b) qualified and experienced environment and social specialists are engaged as needed under terms of reference agreed with the Bank, (c) the Participating Implementing Agencies and the Beneficiary FPOs, as applicable, maintain and operate grievance re-dressal committees for the handling of any stakeholder complaints/grievances arising out of the implementation of Project activities, in a manner and substance agreed with the Bank; and (d) not later than ninety (90) days after the Effective Date, a qualified and experienced full-time Environmental Expert shall be engaged/hired in the MDPU, under terms and references satisfactory to the Bank, and maintained throughout the implementation of the Project, to regularly monitor the implementation of Safeguards policies and regulations. Additionally, staff shall be designated as environment nodal officer in all Participating Implementing Agencies.			
Name	Recurrent	Due Date	Frequency
CERC Component	X		CONTINUOUS
Description of Covenant			

Tamil Nadu to: (a) prepare and furnish to the Bank for its review and approval, an Annex to the PIP (the “CERC Annex”) which shall set forth detailed implementation arrangements for the CER Component, including: (i) criteria for activating the CER Component; (ii) designation of terms of reference for, and resources to be allocated to, the entity to be responsible for the coordination and implementation of the CER Component (the “Coordinating Authority”); (iii) activities which may be included in the CER Component, Eligible Expenditures required therefor (“Emergency Expenditures”), and any procedures for such inclusion; (iv) financial management arrangements for the CER Component; (v) procurement methods and procedures for Emergency Expenditures to be financed under the CER Component; (vi) documentation required for withdrawals of Emergency Expenditures; (vii) environmental and social safeguards instruments, including management frameworks, assessments and/or plans for the CER Component consistent with the Bank’s policies on the matter; and (viii) any other arrangements necessary to ensure proper implementation of the CER Component; (b) afford the Bank a reasonable opportunity to review said proposed CERC Annex; (c) promptly adopt the CERC Annex for the CER Component as shall have been approved by the Bank; and (d) not amend, suspend, abrogate, repeal or waive, whether in whole or in part, any provision of the CERC Annex without the prior approval by the Bank.

After the Borrower and Tamil Nadu have both determined that an Eligible Crisis or Emergency has occurred, Tamil Nadu to prepare and furnish to the Bank for its review and approval, in accordance with the provisions set forth in the CERC Annex, a Contingent Emergency Response Implementation Plan (the “CERIP”) which shall set forth detailed arrangements for the activation of CER Component, including: (i) specific activities to be financed out of the Emergency Expenditures; (ii) itemized costs for each expenditure item; (iii) implementation arrangements for the CER Component, as defined in the CERC Annex or with proposed amendments; (iv) procurement plan for the CER Component; (v) details regarding compliance with environmental and social safeguards instruments; and (vi) any other arrangements necessary to ensure proper implementation of the CER Component.

Tamil Nadu to ensure that the CER Component is carried out in accordance with the CERC Annex and the CERIP.

Name	Recurrent	Due Date	Frequency
Grants under Part B.3 (Category (2)) and for CER Component (Category (3))	X		CONTINUOUS

Description of Covenant

No withdrawal shall be made: (a) under Category (2) unless Tamil Nadu has submitted evidence acceptable to the Bank confirming that it has adopted the FPO Manual in a manner and substance satisfactory to the Bank; and (b) under Category (3), unless and until the Bank is satisfied, and has notified the Borrower and Tamil Nadu of its satisfaction, that all of the following conditions have been met: (i)(A) the Borrower and Tamil Nadu have both determined that an Eligible Crisis or Emergency has occurred, (B) Tamil Nadu has furnished to the Bank a request through the Borrower to include certain activities in the CER Component in order to respond to said Eligible Crisis or Emergency, and (C) the Bank has agreed with such determination, accepted said request, and notified the Borrower and Tamil Nadu thereof; (ii) Tamil Nadu has prepared and disclosed all safeguard instruments, acceptable to the Bank, required for said activities, and have implemented any actions which are required to be taken under said instruments; (iii) Tamil Nadu has provided sufficient evidence satisfactory to the Bank, that the Coordinating Authority has adequate staff and resources; (iv) Tamil Nadu has adopted the CERC Annex, as part of the PIP in form, substance and manner acceptable to the Bank; and the provisions of said Annex remain – or have been updated in accordance with Section I. E. 1 (a) of the Schedule to the Project Agreement, so as to be – appropriate for the inclusion and implementation of said activities under the respective CER Component; and (v) Tamil Nadu has prepared and submitted to the Bank a CERIP, in form, substance and manner acceptable to the Bank, and the Bank has reviewed and approved the CERIP.

Name	Recurrent	Due Date	Frequency	
Retroactive Financing	X		CONTINUOUS	
Description of Covenant				
No withdrawal shall be made for payments made prior to the Signature Date of the Loan Agreement, except that withdrawals up to an aggregate amount not to exceed US \$ 63,500,000 may be made for payments made prior to this date but not before December 15, 2016, for Eligible Expenditures under Category (1).				
Team Composition				
Bank Staff				
Name	Role	Title	Specialization	Unit
Bayarsaikhan Tumurdavaa	Team Leader (ADM Responsible)	Senior Agriculture Economist	Economist	GFA04
Kazuhiro Yoshida	Team Leader	Senior Irrigation Specialist	Irrigation	GWA09
Atin Kumar Rastogi	Procurement Specialist (ADM Responsible)	Procurement Specialist	Procurement	GGO06
Mohan Gopalakrishnan	Financial Management Specialist	Sr Financial Management Specialist	Financial Management	GGO24
Anupam Joshi	Team Member	Senior Environmental Specialist	Environmental specialist	GEN06
Charu Jain	Environmental Safeguards Specialist	Environmental Specialist	Environment	GEN06
Geeta Alex	Team Member	Program Assistant	Administration	SACIN
Gizella Diaz Munoz	Team Member	Program Assistant	Administration	GFA12
Loraine Ronchi	Peer Reviewer	Lead Economist	Economist	GTCCS
Marc Peter Sadler	Peer Reviewer	Practice Manager	Agribusiness in Climate Change	GCCFM
Nagaraja Rao Harshadeep	Team Member	Lead Environment Specialist	Institutional Development Specialist	GENDR
Paul Singh Sidhu	Team Member	Consultant	Agriculture Specialist	GFA01
R. K. Malhotra	Team Member	Consultant	Irrigation Specialist	GFA12
Rita E. Cesti	Team Member	Practice Manager	Water	GWA04

Rocio Mariela Malpica Valera	Team Member	Senior Counsel	Counsel	LEGES	
Rohan G. Selvaratnam	Team Member	Operations Analyst	Operations	GFA12	
Samuel Thangaraj	Social Safeguards Specialist	Consultant	Safeguards Specialist	GSU06	
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Victor Manuel Ordonez Conde	Team Member	Senior Finance Officer	Disbursement	WFALA	
Vikas Choudhary	Team Member	Sr Agricultural Spec.	Agribusiness	GFA13	
Vikas Kanungo	Team Member	Consultant	ICT	GTI09	
Xiaokai Li	Peer Reviewer	Lead Water Resource Management Specialist	Water	GWA01	
Extended Team					
Name	Title	Office Phone	Location		
Marimuthu Swaminathan	Livestock Specialist				
Martin Kumar	Fisheries Specialist				
Ranu Sinha	Water Users Association Specialist	7974506028			
Thomas Muenzel	Senior Economist	00390657054643	Rome		
Locations					
Country	First Administrative Division	Location	Planned	Actual	Comments
India	Tamil Nadu	Tamil Nadu		X	

I. STRATEGIC CONTEXT

A. Country Context

1. India, in recent years, has witnessed impressive economic growth and poverty alleviation. During 2006-07 to 2016-17, India's gross domestic product (GDP) grew at 7.3 percent annually and poverty incidence reduced on average by 2.2 percentage points per year during 2005–12. Also, improvements in key development indicators have been remarkable: life expectancy increased from 31 years in 1947 to 68 years in 2015, and adult literacy increased from 18 percent in 1951 to 71 percent in 2015.

2. Despite such impressive progress in economic growth, poverty alleviation, and improved human development indicators, India remains home to 263 million poor people (80 percent of whom reside in rural areas) living on less than US\$1.90 per day and the country is still at the bottom of the group of middle-income countries. To address these challenges, the Government of India (GoI) through its 12th Five-Year Plan (FY2013–17) put forward an ambitious goal for economic growth, poverty reduction, job creation, and environmental management. During this period, the plan foresees an annual GDP growth of 8.2 percent, a reduction in poverty rate by 10 percentage points, and 50 million new jobs.

3. Because of its inherently inclusive nature, agriculture sector growth is essential for achieving the national development goals. The sector currently accounts for 17.4 percent of national GDP and is the principal source of livelihood for 48.9 percent of the population. In addition, more than two-thirds of the country's poor live in rural areas, whose chances of getting out of poverty directly depend on the performance of the agriculture and allied rural sectors.

4. Over the past two decades, the agriculture sector has performed below its potential and has not met the envisaged growth targets. In the 1990s and 2000s, the annual agriculture growth rate was around 3–3.5 percent, and during 2013–15, it was less than 2 percent per year, caused by low productivity, growing water and land scarcity, rising labor costs exacerbated by frequent droughts and floods, and declining international commodity prices.

5. The GoI has put forward an ambitious 4 percent annual agriculture growth target in the 12th Five-Year-Plan (FY2013–17). To achieve this target, the plan envisages five strategic shifts that will structurally transform Indian agriculture. These shifts reflect the underlying trends in demand for food and factors affecting supply of food and include: (a) a shift away from food grains toward high-value vegetables, fruits, dairy, and fish products; (b) a shift away from on-farm production toward value addition in postharvest segments; (c) a shift away from focus on productivity toward resilience of diversified farming systems to address climate change effects; (d) a shift away from food security toward nutrition-sensitive agriculture; and (e) a shift away from increasing irrigation water supply toward improved water use efficiency.

6. In recent years, the GoI has launched a number of policy initiatives and programs to support these shifts, including the Second Green Revolution Program (2013) with a focus on higher productivity and diversification; the National Agricultural Development Program (2008); the National Food Security Mission (2008) to promote increasing production and productivity for rice, millets, minor millets, pulses, oilseeds, cotton, and sugarcane for sustainable agriculture; the

National Mission for Integrated Development of Horticulture (2013) to promote diversification into fruits and vegetables; the National Agricultural Market Promotion to accelerate the integrated development of agriculture marketing and trade; and India's Intended Nationally Determined Contribution (2013) as presented to the 2015 United Nations Climate Change Conference (or COP21) in Paris to address the adverse effects of climate change. In the water and irrigation sector, the National Water Policy (2012) puts emphasis on increasing water storage capacity and improved water application methods, including micro-irrigation (drip and sprinkler), as an adaptation to climate change. The *Pradhan Mantri Krishi Sinchayee Yojana* launched in 2012 also advocates efficient irrigation practices and improvement of on-farm water use efficiency.

7. Income growth and urbanization are changing consumer demand for food commodities in India toward better-quality and higher-value agricultural commodities such as vegetables, fruits, meat, and dairy products. The shift to high-value commodities and opportunities in postharvest management underscore the enormous potential for commercialization, job creation, and income growth in irrigated agriculture. India has considerable comparative advantage as it has a very large and untapped domestic market, which reduces reliance on exports as the principal driver for near-term agriculture growth. Beyond the domestic market, there are also strong comparative and competitive advantages in trade of high-value agriculture produces.

B. Sectoral and Institutional Context

8. 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 (GSDP) grew at 7.4 percent per year. In 2016-17, the per capita GSDP of the state was around INR 170,929. Tamil Nadu is also the most urbanized state in India with 48 percent of the population living in cities.

9. In 2016-17, agriculture accounted for 12 percent of the state's GSDP. About 35.2 percent of the state's population is dependent on agriculture for their employment, and more than two-thirds of the state's poor people live in rural areas and are engaged predominately in agriculture activities. The majority of farmers are small and marginal with average family landholdings of 0.83 ha. The main crops are rice, maize, pulses, groundnut, sugarcane, vegetables, and banana. Rice dominates agriculture production systems, accounting for 34 percent of total cropped area and 60 percent of irrigated area. Due to seasonality and scarcity of water supply, cultivation is mostly limited to only one crop per plot per year.

10. Tamil Nadu is one of the driest and most water-stressed states of India with average annual rainfall of 925 mm, which is well below the national average of 1,200 mm. Per capita availability of water in the state is around 750m³ a year compared with the national average of 2,100 m³. The state is heavily dependent on irrigated agriculture, and over the years, it has built an impressive inventory of irrigation and water infrastructure. In Tamil Nadu, there are 89 major reservoirs, 39,000 tanks (traditional water harvesting structures), and 3 million wells. Irrigated agriculture is the largest consumer of water in Tamil Nadu, accounting for 75 percent of total water usage. About 3 million ha of land (54 percent of total crop land) is under irrigation with different sources of water: 30 percent of the total irrigated area is under canal irrigation, 21 percent is under tank irrigation, and 49 percent is irrigated by wells.

11. In recent years, the state's agriculture sector has grown modestly at less than 3 percent per year compared with 6–9 percent growth of the state's economy. This performance of agriculture sector below its potential is due to 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.

- **Increasing water shortage.** Tamil Nadu, being a water-stressed state, continues to experience water shortages, which are expected to further exacerbate in the future. According to a government report on climate change,¹ in 2011, the total demand for water was around 49.8 billion m³ against total supply of 47.8 billion m³, or 4 percent of shortage. This gap between demand and supply in water is projected to increase to 11 percent in 2020 and 17 percent in 2050, unless drastic measures are taken to rectify these imbalances. Currently, only half of the registered command area (*ayacut*) is adequately irrigated, and the increasing use of wells for irrigation is depleting groundwater level. Such water shortages are due to decreasing storage capacity, dilapidated infrastructure of irrigation systems, and poor water management. In addition, increasing population and greater demand from non-agriculture sectors put further pressure on water supply.
- **Stagnant crop yields.** In Tamil Nadu, for the past 15 years, yield growth of major crops has been largely stagnant. According to an evaluation study commissioned by the Tamil Nadu Planning Commission,² between 2000 and 2010 in Tamil Nadu, yields of rice and sugarcane grew by less than 1 percent, whereas yields of pulses and ginger had negative growth rates. Today, the average yields of rice and maize are slightly higher than the national average, but the average yields of vegetables, cotton, and pulses are lower than the national average.
- **Low level of diversification and high postharvest losses.** Despite significant progress being made during the past decade in crop diversification, its level in the state continues to remain low. Paddy dominates the crop sector occupying 34 percent of total cropped areas, whereas fruits and vegetables are grown on 11 percent and pulses and oilseeds on 14 percent of total cropped areas. Value addition is low and postharvest losses of agriculture products are significant: Only 25 percent of food grains utilize storages with adequate standards, less than 2 percent of fruits and vegetables produced are processed, and the estimated postharvest losses are 10 percent for grains and 25 percent for fruits and vegetables.
- **Weak agriculture marketing system.** Agriculture marketing system in Tamil Nadu is less developed compared to its own potential and to performances of other states.³ Most agriculture commodities are still traded through traditional marketing

¹ State Action Plan on Climate Change in Tamil Nadu (2014).

² Tamil Nadu Planning Commission (2012): Evaluation Studies on Important Development Programs in Agriculture.

³ According to the 'Agricultural Marketing and Farmer Friendly Reform Index' published by the National Institution for Transforming India (also called *NITI Aayog*) on October 31, 2016, Tamil Nadu is ranked 25th out of 30 states included in the study. The index, among other things, demonstrates the ease of doing agribusiness as well as opportunities for farmers to benefit from modern trade and commerce and have wider options for sale of produce.

channels such as Agricultural Produce Marketing Committees (APMCs), Direct Procurement Centers, and traders, which are primarily geared for paddy procurement, have not been modernized, and suffer from severe infrastructure bottlenecks. New alternative marketing channels such as direct procurement by lead buyers or farmer aggregations of producers for direct sale have not been developed yet. These constraints not only hamper farmers' ability to remuneratively market their produce but also do not provide market incentives for diversification from paddy to alternative crops.

- **Increasing climate change risk.** The agriculture sector of the state is highly exposed to climatic risks, especially to droughts, floods, cyclones, and erratic rainfall, which have frequently affected the performance of the agriculture sector in the past. The dry season lasts five months (January through May) even in good years, and droughts occur in three out of ten years. Recent evidence shows that climate change is exacerbating the vulnerability of the agriculture sector with increasing erratic weather patterns and climatic shifts. A clear example is the consequence of the devastating floods in November–December 2015, which severely damaged irrigation infrastructure in three districts and Chennai, the capital city of Tamil Nadu. According to a government report on climate change,⁴ since the 1950s, the temperature across the state has increased by about 0.7–0.8°C, and each year, more dry days are occurring than wet days coupled with significant increase in heavy precipitation events. Also, there is an increasing trend in the frequency of severe cyclones. The report projects that by the end of this century, the minimum and maximum temperatures and intensity of rainfall will increase, and the average temperature will increase by 3°C. This will further stress the water resources situation in the state by increasing crop water requirements and system evapotranspiration.
- **Water resources.** Tamil Nadu is a water-stressed state with a need for integrated multi-sectoral and spatial perspectives on water resources planning and management to balance its agriculture, domestic water, industrial and commercial water, hydropower, environmental, and other demands with increasingly variable, overexploited, and polluted surface water and groundwater resources in a watershed or basin context. This kind of multidisciplinary approach is made essential to more effectively manage existing and changing water uses under a range of development and climate risks (for example, droughts and floods that are already common and the additional stresses of climate change). There is a need for the state to modernize the way in which data are collected, analyzed, visualized, and accessed from a variety of local and global sources to support integrated planning and real-time systems operations. This needs to build on the extensive work already carried out, modern information and communication technology (ICT) and analytical advances, and global good practice.
- **Nutrition.** In Tamil Nadu, due to imbalanced nutrition, significant proportions of population are either underweight or overweight and are anemic. According to the National Family Health Survey conducted in 2015/16, 46 percent of women between

⁴ State Action Plan on Climate Change in Tamil Nadu (2014).

the ages of 15 and 49 years are underweight or overweight, and 51 percent of children below 5 years and 55 percent of women are anemic due to iron deficiency. In Tamil Nadu, it is estimated that one out of ten people is diabetic and eight out of ten people exhibit abnormal lipid levels. The excessive use of rice is considered among the main factors of their causes.

- **Gender.** The overall literacy rate in Tamil Nadu is 80 percent, which is lower for females, especially in rural areas. The literacy rate for females is 66 percent compared with 82 percent for males. Continued decline of employment opportunities in rural areas forces men to migrate to urban areas, leaving women behind in rural areas getting involved more actively in agricultural works, which are often underpaid. Also, while the number of male farmers has been declining, the number of female farmers has been increasing. In Tamil Nadu currently, more than 78 percent of women are involved in various agriculture, horticulture, and livestock activities. Female laborers and farmers are often denied access to resources and assets, and there is an increasing need for pro-poor community-based interest group organizations (CBIGO) to help enhance the skills and capacity of rural women and to ensure women empowerment.

12. To address the above issues and unlock the full potential of the agriculture sector growth in Tamil Nadu, there is a strong need for policies and programs to focus on (a) improvement of water efficiency and productivity, (b) intensification of cropping systems and diversification into high-value crops, (c) enhancement of postharvest management and value addition, and (d) improvement of the resilience of agriculture systems to deal with increasing threats of climate change.

13. 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 (GoTN) developed the Tamil Nadu Vision 2023 and the State Framework Water Resources Plan for River Basins. The Tamil Nadu Vision 2023 Phase 2 (2014) sets out nine strategic initiatives to “achieve the best-in-class productivity in key agricultural produces and to be a global supplier with robust infrastructure.” These are to: (a) improve agriculture productivity; (b) promote market-driven agricultural production; (c) promote agriculture marketing intelligence and business promotion; (d) accelerate innovation and extension reforms; (e) promote functional consolidation of land holdings; (f) promote greater farm mechanization; (g) create a robust supply chain; (h) assure timely irrigation; and (i) enhance capacity building in agriculture.

14. The GoTN amended the APMC Act on February 1, 2017. The amendment approved the following provisions: (a) e-trading including billing, booking, contracting, negotiating, and information exchange through the Internet; (b) introduction of single point levy of market fee to avoid multiple taxation; and (c) new provision of unified single license to traders to enable them to trade in any market committee within the state. The amendment will enable Tamil Nadu to participate in the new electronic National Agriculture Market (eNAM) Platform of the GoI. Selected regulated markets have been taken for integration to the e-NAM platform.

15. The state has made significant investments in modernization of irrigation systems and introduced institutional and policy reforms through a series of state- and donor-sponsored projects,

including the World Bank supported Tamil Nadu Water Resources Consolidation Project (WRCP) concluded in 2004 and Tamil Nadu Irrigated Agriculture Modernization and Water-Bodies Restoration and Management Project (TN IAMWARMP) concluded in 2015. The GoTN 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 GoTN has also operationalized a decentralized, farmer-driven agricultural extension system through the Agricultural Technology Management Agency model.

16. The World Bank-supported TN IAMWARMP has made significant development impacts in the state by modernizing irrigation infrastructure; improving water use efficiency; enhancing yields and productivity of agriculture, livestock, and fisheries; diversifying into high-value crops; and also, introducing major institutional reforms through participatory irrigation management (PIM) and water users' associations (WUAs). Under the TN IAMWARMP, in total, over 5,000 tanks and irrigation supply canals were rehabilitated and modernized, and 2,800 WUAs were established, resulting in the expansion of fully irrigated area by 39 percent; water conveyance efficiency was improved by more than 30 percent; and the area under high-value crops has been doubled. Moreover, the TN IAMWARMP has made major contributions in improving the state's water resource planning and implementation capacities. These achievements and lessons learned during the implementation of the TN IAMWARMP provide a solid basis for further enhancing the performance of irrigated agriculture in the state as envisaged under the project.

17. The proposed project will bring the policy and institutional developments achieved under the TN IAMWARMP to a new level and will serve as the key vehicle for implementing the GoTN's current agenda in further enhancing water and agriculture productivity, bringing crop diversification to a new level, and improving farmers' links to markets and value addition through the implementation of the newly amended APMC Act. The project will also rehabilitate and modernize high-priority tank irrigation systems in more than 50 percent of the sub-basins of the state, which were not part of the TN IAMWARMP.

C. Higher Level Objectives to which the Project Contributes

18. The project is fully consistent with World Bank Group's Country Partnership Strategy (CPS) for FY2013-17 (Report No. 76176-IN) discussed by the Executive Directors on April 11, 2013. In line with the pillar for 'Transformation', the project promotes inclusive rural growth, development and dissemination of new agricultural technologies, climate-resilient agriculture, enhanced market links for small and marginal farmers, and improved water and natural resource management (Outcome 2.4). Further, the project will have a positive impact in terms of environmental protection and reduced greenhouse gas (GHG) emissions by disseminating high-efficiency irrigation systems and promoting diversification into high-value crops, which significantly reduce water consumption (Outcomes 2.5 and 2.6).

19. The project will contribute to the 'Inclusion' pillar of the CPS by enhancing the livelihoods of small and marginal farmers through crop diversification and enhanced market access (Outcome 3.6) and, also by improving disaster management abilities of the GoTN and local communities through enhanced design and restoration of irrigation infrastructure with better flood protection features (Outcome 3.8). The project is also aligned with findings of the Systematic Country

Diagnostic (under preparation) in FY18 regarding the importance of resource efficiency in agriculture.

20. The project will directly contribute to the achievement of 5 out of 17 United Nations Sustainable Development Goals: (a) Goal 2 - End hunger, achieve food security and improved nutrition and promote sustainable agriculture; (b) Goal 6 - Ensure availability and sustainable management of water and sanitation; (c) Goal 8 - Promote sustained, inclusive and sustainable economic growth; (d) Goal 9 - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation; and (e) Goal 13 – Take urgent action to combat climate change and its impacts and reduce GHG effects of agriculture production.

21. The project will closely collaborate with the International Finance Corporation to strengthen the activities of private sector agribusiness entrepreneurs and promote an enabling investment climate for private businesses through various trainings and advocacy activities. The project will also coordinate with other World Bank-supported projects in Tamil Nadu and at the national level, including the Tamil Nadu Rural Transformation Project, National Hydrology Project, and National Groundwater Improvement Project to ensure synergy and enhance long-term project impact.

II. PROJECT DEVELOPMENT OBJECTIVES

A. PDO

22. The Project Development Objective (PDO) is to enhance productivity and climate resilience of irrigated agriculture, improve water management, and increase market opportunities for farmers and agro-entrepreneurs in selected sub-basin areas of Tamil Nadu.

B. Project Beneficiaries

23. The direct beneficiaries of the project are farmers, WUAs, farmer producer organizations (FPOs)⁵, and agribusiness entrepreneurs, fishermen and fish farmers. An estimated 500,000 people are expected to benefit directly from the project. They will benefit from improved and modernized tank irrigation systems, adoption and dissemination of advanced technologies on modern agriculture and water management techniques and practices, and agriculture diversification, and those who sell their agriculture produces at local and regional markets improved under the project will also be benefited. Also, a large number of technical and managerial staff of participating line departments and agencies will benefit from the project through training and capacity-building activities.

24. The project interventions will focus on 66 sub-basins (of a total of 127 sub-basins in Tamil Nadu), which are spread throughout the state (see Project Area in Annex 5).

⁵Farmer Producer Organization (FPO) is a legal entity formed by primary producers, viz. farmers, milk producers, fishermen, etc. FPO can be a farmer producer company (FPC), a cooperative society or any other legal form which provides for sharing of profits/benefits among the members. In some forms like farmer producer companies, institutions of primary producers can also become member of FPO.

25. The project will actively promote gender inclusion and women’s participation in all key project interventions to ensure they benefit from the project appropriately. The project will ensure that women are fully engaged in activities of WUAs and represented in FPOs and livestock and other alternative livelihood sources.

C. PDO Level Results Indicators

26. The key results indicators to assess project outcomes are:

- (a) Area provided with improved irrigation and drainage services (resilience and water use efficiency);⁶
- (b) Increase in agriculture productivity (productivity);
- (c) Increase in areas cultivated for non-paddy crops (diversification and value added);
- (d) Area under climate-resilient technologies and practices (resilience);
- (e) Share of selected commodities sold through new marketing channels⁷ (increased market opportunities); and
- (f) Total number of project beneficiaries (including number of female beneficiaries).

27. The Results Framework and Monitoring arrangements are presented in section VII.

III. PROJECT DESCRIPTION

28. The project design includes a number of innovative aspects that build on lessons learned from the TN IAMWARMP and good practices of similar tank rehabilitation and agriculture development projects in India and other countries. These innovative aspects include improved designs 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 movement toward climate-resilient agriculture with relevant agriculture-water-related investments and substantial improvements of the PIM practices by beneficiaries and extensive application of ICT-based technologies for improved water resource management and better link of farmers to markets.⁸

29. The project will bring in greater resilience to agriculture production systems and will generate significant adaptation and mitigation co-benefits to climate change through multiple channels of interventions, including the following: (a) rehabilitation and modernization of irrigation tanks covering more than 50 percent of state sub-basins will significantly improve the availability and reliability of irrigation water for farming communities making them less prone to

⁶ Reduction in partially irrigated and gap areas.

⁷ This includes FPOs, e-Negotiable Warehouse Receipt.

⁸ These include, among others, the studies of sensor-based big data analytic platform for automated irrigation management and canal automation (Subcomponent A.1), ICT-based agricultural extension model (*e-Velanmai*) (Subcomponent B.3), and Enterprise Information Management System (EIMS) (Subcomponent A.1).

climatic hazards; (b) improved design of irrigation tanks will provide greater flood control features;⁹ (c) major expansion in high-efficiency irrigation systems (micro-irrigation), resource conservation technologies (system of rice intensification [SRI] and sustainable sugarcane initiative [SSI]), and improved agriculture practices will reduce water usage and stabilize crop yields; and (d) diversification into high-value crops and improved market access by farmers will increase sustainability and profitability of their businesses.¹⁰

30. The project will also have significant positive nutritional impacts for the state's population through diversification (into high-value pulses, millet, vegetables, and fruits) and enhancement of dairy and fisheries sectors. The expected increases in pulse production under the project will provide high levels of fiber, protein, and minerals, especially iron and zinc to consumers in the state. Also, by promoting grain millets and sorghum as complementary staple food to rice, the project will contribute to reductions in diabetes among the state's population. Further, major expansions of the horticulture program under the project will contribute to increased consumption of fruits and vegetables, milk and dairy products, rich vitamin A, low-fat protein (fish), calcium, and magnesium.

31. The project is expected to bring increased agriculture productivity, diversification, resilience, and enhanced market access by farming communities in more than half of the total state sub-basins and enhanced nutrition for the population through the institutional strengthening of statewide water resource planning and management organizations, modernizing tank irrigation systems, promoting farmer-led participatory irrigation systems and climate-resilient technologies, and improving farmers' access to markets. These would eventually bring inclusive rural growth and mainstreaming of climate-resilient resource conservation technologies and practices and enhance market access by farmers in the state. The detailed description of project interventions, outcomes, and impacts are shown in a detailed results chain diagram in section VII.

A. Project Components

32. The project interventions are grouped into four main components, including Component A: Irrigation and Water Management; Component B: Agriculture Productivity Enhancement, Diversification, Improved Livelihoods, Marketing, and Value Addition; Component C: Project Management Support; and Component Z: Contingency Response. The project activities will cover 66 sub-basins and other parts of the state according to design (individual components will cover different geographic areas). The individual components are summarized in the following paragraphs. The detailed project descriptions are in Annex 1 and in other supplementary appendices available in the project files.

⁹ The improved tank rehabilitation designs proposed under the project will bring greater flood protection features. The evidence is that during devastating floods of November–December 2015, a significant number of tanks were damaged in the state, whereas most of the tanks rehabilitated under the TN IAMWARMP withstood without damages.

¹⁰ Climate and Disasters Risk Screening Report (May 2016) and Climate Change Mitigation Assessment (November 2016) prepared for the project laid out in detail the key climate risks faced by the project and adaptation and mitigation measures to climate change and expected benefits from project interventions.

Component A: Irrigation and Water Management (Total Cost:US\$352.8 million, of which IBRD:US\$246.9 million)

33. This component would address irrigation and water management in a holistic manner by covering both supply and demand simultaneously. It consists of four subcomponents: Subcomponent A.1: Institutional Strengthening and Capacity Building for Water Management; Subcomponent A.2: Irrigation Systems Modernization; Subcomponent A.3: Participatory Irrigation Management; and Subcomponent A.4: Convergence for Improved Service Delivery.

Subcomponent A.1: Institutional Strengthening and Capacity Building for Water Management

34. This subcomponent aims to assist the GoTN in addressing the needs for: (a) integrated water resources planning, decision making, and management in a basin context; (b) enhancing knowledge base and instruments; and (c) improving sustainability of water sector assets. This will be achieved by strengthening the Water Resources Department (WRD) and related agencies for water resources management, including the State Water Resources Management Agency (SWARMA), Institute for Water Studies (IWS), and the State Ground & Surface Water Resources Data Center (SG&SWDC). This will include technical assistance, equipment, services, and institutional infrastructure to support data collection and analysis; building of a modern knowledge base; development of modern ICT-enabled knowledge products and services; and training; policy analysis; and partnerships to support awareness-building; institutional synergy; and decision support. This will include modernizing sub-basin planning and scenario analysis to be used in the design, preparation, and monitoring of multi-sectoral investments in this project.

35. The activities will build upon the earlier TN IAMWARMP investments, local and global innovations in ICT and analytical tools including support for the rollout of the EIMS into its activities, and the strong local expertise available to support these aspects. An e-WRD App¹¹ will be developed to facilitate customized access for the technical staff and WUA and public access to relevant data services, documents, and mapping services that draw upon curated data and real-time information from in-situ monitoring and earth observation. A pilot for monitoring services will be implemented to support improved water resources and irrigated agriculture management.

Subcomponent A.2: Irrigation Systems Modernization

36. This subcomponent aims to rehabilitate and modernize the irrigation infrastructure, including 4,800 tanks¹² and 477 anicuts (check dams), focusing on improving bulk water delivery to irrigation systems and improving water use efficiency at farm levels covering about 543,000 ha of land in 66 sub-basins. This intervention will bring in more than 160,000 ha of currently partially irrigated (and gap area) lands into full irrigation. Subcomponent activities will be based on individual sub-basin development plans (SBDPs) for reviving traditional water bodies (tanks),

¹¹ E-Water Resource Department.

¹² Most of the tanks are under 10 m height. A tank with a height between 10 m and 15 m and categorized as a large dam by the International Commission on Large Dams (ICOLD) will not be included. A tank with a height between 10 m and 15 m and any of the following features is categorized as a large dam by the ICOLD:

- (a) The capacity exceeds 1 million m³.
- (b) The discharge capacity of its spillway exceeds 2,000 m³ per second.
- (c) Its crest length exceeds 500 m.

including improvement of supply channels, repairs of sluices and weirs, and strengthening of bunds.

37. Rehabilitation of tank systems will be supplemented by on-farm development (OFD) works and development of groundwater recharge structures to improve the availability of water across the system. The aim is to improve irrigation water delivery to farmers to the tail end of the distribution system by empowering the WUA farmer members to directly participate in executing the OFD works. Irrigation tanks and structures damaged by the November–December 2015 floods will be rehabilitated on a priority basis, including through retroactive financing.

38. Under this subcomponent, the project will generate significant adaptation co-benefits (improved supplemental irrigation in gap-areas and enhanced flood protection features in rehabilitated tanks) and mitigation co-benefits to climate change (reduced electricity usage in shallow tube wells with pumps by farmers¹³ due to improved water availability through surface irrigation).

39. The subcomponent will finance civil works, equipment, consultancies, and incremental operational costs associated with modernization of the schemes, and the work will be carried out by the WRD with the direct involvement of the WUAs.

Subcomponent A.3: Participatory Irrigation Management

40. This subcomponent aims to improve farmers' (water users') involvement in the management and operation of the irrigation system. For this purpose, the project would work toward integrating the Participatory Irrigation Management (PIM) practices into the operations of the WRD. The subcomponent will assist in establishing and strengthening WUAs, including operationalizing the WUAs to undertake operation and maintenance (O&M) of field channels and equitable water distribution within their command areas. In total, the project will support the creation of 3,200 new WUAs and will also provide support for the elections of new office bearers of the existing WUAs and systematic training and capacity-building assistance to newly established WUAs.¹⁴

41. Under this subcomponent, the project will finance equipment, expert consultants, consultancies, field staff for mobilization of farmers, training for the WRD and WUAs, and operating cost to support: (a) mainstreaming of the PIM approach within the WRD and (b) establishing of new WUAs under the Tamil Nadu Irrigated Agriculture Modernization Project (TNIAMP) and strengthening their capacities on O&M and water management.

Subcomponent A.4: Convergence for Improved Service Delivery

42. The convergence for service delivery by all departments involved in the water sector is critical and will be promoted by establishing and strengthening the Single Window Information

¹³ Currently, farmers in the project area get more than half of their irrigation water through tube wells due to insufficient and seasonal water supply by surface irrigation.

¹⁴ The capacity building for the currently operating WUAs will be carried out using the state funds. The project will provide a core orientation training for all newly elected officers of the existing WUAs as well as intensive O&M and water management training on a pilot basis.

and Knowledge Centers (SWIKCs) in selected model villages, providing administrative and operation cost support for the field staff, and facilitating Community Collaborative Water Management (CCWM) at the village level, which was successfully pioneered along with the Center of Excellence in Change (CEC) in the TN IAMWARMP. The CCWM will sensitize the community about the water balance and SMART (specific, measurable, attainable, realistic, and timely) agriculture in the model villages and enable them to draw up a community-level action plan for sustainable and optimum use of water. Model villages will be created in each sub-basin through the establishment of the SWIKCs. Extensive capacity building for officials and community and team-building support will be initiated and formalized to ensure sustainable convergence.

43. This subcomponent will finance equipment, rental support for the SWIKCs, and training and operating cost required to carry out the key activities described above.

Component B: Agriculture Productivity Enhancement, Diversification, Improved Livelihoods, Marketing, and Value Addition (Total Cost:US\$95.6 million, of which IBRD: US\$65.9 million)

44. This component will aim to increase the productivity and diversification of agriculture production systems, promote alternative livelihood income sources, and generate improved value addition in postharvest management by adopting a value chain approach. Smallholder producers in project sub-basins will be facilitated to take advantage of the rapidly changing market demand for agricultural commodities to increase production and manage the risks associated with climate change. The component will provide incentives for capital investments, through unlocking opportunities for crowding-in private sector investments. The component consists of three subcomponents: Subcomponent B.1: Agriculture Intensification and Diversification; Subcomponent B.2: Improved Alternative Livelihood Sources through Livestock and Inland Fisheries; and Subcomponent B.3: Agriculture Marketing, Value Addition and Postharvest Management.

Subcomponent B.1: Agriculture Intensification and Diversification

45. This subcomponent aims to promote climate-resilient and sustainable crop production systems through sustainable intensification and diversification by implementing large-scale programs of demonstrations, awareness building, and training activities as well as productive investments in resource-saving technologies such as micro-irrigation systems. Climate risk resilience will be built into the agriculture production systems by promoting cultivation of high-yielding, short-duration crop varieties/hybrids and complementary agronomic practices and the enhanced ability to withstand expected adverse climate change impacts. By investing in the adoption of resource conservation technologies and practices (SRI, SSI, integrated soil fertility and nutrient management [ISFNM], micro-irrigation, and use of new drought-resistant seed varieties), the project activities will produce a significant amount of adaptation co-benefits to climate change. Also, scaling up of alternate wetting and drying (AWD) practices under SRI (on

55,500 ha) and improved agronomic practices and technologies (on 160,000 ha)¹⁵ will produce mitigation benefits.

46. **Sustainable intensification** of cropping systems will be achieved through promotion of high-productivity and resource conservation technologies including SRI and SSI, precision farming with micro-irrigation, ISFNM, integrated pest management (IPM), and organic farming techniques. For wide-scale adoption of the already proven technologies, the project will ensure the availability of high-quality seeds and other critical inputs. The project is expected to increase the yield of rice, maize, and pulses by 18–20 percent by project closure. Resource conservation technologies such as SRI and SSI (which reduce average water usage by 35 percent and increase yields by 22 percent per ha) will be promoted on 75,000 ha of demonstrations with a total expected impact area of approximately 300,000 ha.

47. **Accelerated diversification** from a mono crop paddy system to mixed cropping including high-value crops (fruits, vegetables, and spices), pulses, oilseeds, and millets will be achieved through promotion of modern technologies, better linking of farmers to markets, postharvest management, and value addition. Enhanced diversification will lead to higher farmer income and reduced vulnerability to external shocks such as weather and price volatility. A promotion of high-value crops through micro-irrigation support system will be carried out on approximately 12,000 ha. Climate risk resilience will be built into agriculture production systems by promoting new crop and agronomic practices suitable for local agro-ecological conditions and farm ponds and the ability to withstand biotic and abiotic stress due to climate change.

48. Under this subcomponent, the project will finance civil works, equipment, consultancies, and incremental operational costs associated with (a) upgrading and dissemination of technologies and management practices for crops and horticulture through demonstrations, training, and capacity building of producers and line department staff and (b) provision of financial support to promote demand-driven micro-irrigation schemes.

Subcomponent B.2: Improving Alternative Livelihood Sources through Livestock and Inland Fisheries

49. This subcomponent aims to diversify and increase farmers' income through the enhanced performance of livestock (focusing on dairy) and inland fisheries (aquaculture) sectors. In addition to generating additional income for farmers, these interventions will also safeguard farmers' livelihoods against potential reductions in yield or crop failure due to climate hazards. Under this subcomponent, the project activities will produce adaptation co-benefits to climate change by improved feeding and breeding practices and enhanced silage production in dairy farming and climate-resilient modern technologies in inland fisheries.

50. **Livestock interventions** aim to improve the productivity of dairy animals through adoption of sustainable and climate-resilient animal husbandry technologies. Dissemination of technology will be carried out through dairy interest groups (DIGs) with a focus on women. Other activities will include strengthening of input supply, extension, and service delivery systems; infrastructure strengthening; and capacity building in breeding and disease surveillance. The

¹⁵ These practices will lead to soil carbon sequestration due to increased organic matter inputs.

activities will focus on strengthening of breeding programs, artificial insemination (AI) network, fodder development and preservation, disease surveillance, calf management, and mastitis control. The AI coverage will be expanded through the existing AI network of the Animal Husbandry Department (AHD) as well as establishing new AI centers. In total, 1.1 million AIs will be performed during the project period, which is expected to produce about 115,000 genetically improved milk animals to the dairy herd. Sexed semen will be piloted on a limited scale. Development of perennial and seasonal fodder will be promoted on 6,300 ha, and innovative fodder preservation techniques will be demonstrated. Field veterinary institutions and Animal Disease Intelligence Units (ADIUs) of the AHD will be strengthened to enhance the efficiency of disease surveillance, and the ICT infrastructures will be established for an enhanced management information system (MIS). Tamil Nadu Veterinary and Animal Sciences University (TANUVAS) will undertake an innovative and climate-resilient validation trial in supplementing critical nutrients and production of mineral salt licks by the DIGs on an entrepreneurial mode. AHD officers will undergo capacity development programs in critical areas of knowledge gap. Two indicators (project end) were defined: (a) increase in average daily milk production per animal by 25 percent from the baseline and (b) production of additional 160,000 genetically improved female calves from the AI network.

51. **Fisheries interventions** will aim at improving fish productivity in tanks and ponds through demonstrations of climate-resilient modern technology packages, improved tank fisheries management, enhanced production models using fast-growing fish varieties through pure-line fish seed production, introduction of suitably formulated fish feed using locally available ingredients, and promotion of innovative technologies like cage fish culture and facilitation of better market links. In total, the project will promote good aquaculture practices (GAPs) on 25,100 ha of effective water spread areas and support participation of fish farmers in value chains. Productivity enhancement of fisheries in irrigation tanks will be promoted through the adoption of culture-cum-capture models, and support will also be provided by investing into the development of value chains and the establishment of fish kiosks.

52. Under this subcomponent, the project will finance civil works, equipment, consultancies, and incremental operational costs associated with upgrade of technology, breed quality, and management practices of dairy and fisheries through demonstrations, training, and capacity building of producers and line department staff and the upgrade of certain research and extension infrastructures.

Subcomponent B.3: Agriculture Marketing, Value Addition, and Postharvest Management

53. This subcomponent focuses on enhancing farmers' links to markets through postharvest management and value addition activities by establishing commodity groups (CGs) and farmer producer organizations (FPOs), integrating commercial value chains, and facilitating public-private partnerships (PPPs). Specific interventions envisaged are (a) setting up CGs; (b) setting up FPOs; (c) supporting existing FPOs in business expansion; (d) supporting productive postharvest management infrastructure; (e) supporting agriculture enterprise development; (f) modernization, automation, and digitization of traditional market channels; and (g) supporting studies, management strengthening, and innovations for improved service delivery and results. The project will assist in the establishment and operation of around 80 new FPOs and will also provide capacity-building support for 40 existing FPOs, benefiting an estimated 45,000 FPO members.

54. Under this subcomponent, the project will finance civil works, equipment, consultancies, and incremental operational costs associated with (a) training and capacity building of producers and line department staff, (b) hiring services of consulting firms/nongovernmental organizations (NGOs) to mobilize and organize farmers and establish FPOs as well as provide technical assistance and market linkages services to these FPOs, (c) providing grants for demand-driven investments to FPOs, (d) hiring services of consulting firms/NGOs to provide business advisory, credit facilitation, and market facilitation services to agro-entrepreneurs; and (e) supporting innovations in traditional marketing arrangement.

55. Component B will be supported by innovative ICT applications, including (a) use of innovative ICT-based approaches to support extension services like through video and mobile phones based on peer-to-peer learning and modernizing local markets through digitalization of their records and operations; (b) support to *e-Velanmai*, crop optimization, and geo-tagging to build localized problem-solving knowledge services; (c) launch of Smart Agri-Marketing Hub under the project, that will introduce the next generation practices for modernization, automation, and digitization of regulated markets through mobile and wireless platforms; (d) monitoring of FPOs and farmers through cell phone apps; and (e) provision of market analytic and commodity price information to farmers.

Component C: Project Management Support (Total Cost: US\$7.4 million, of which IBRD: US\$5.2 million)

56. The Multi-Disciplinary Project Unit (MDPU) established under the TN IAMWARMP will serve as the management and coordination unit for the project, with need-based modifications. The MDPU will coordinate and catalyze departments for the preparation and implementation of their respective project budget, SBDPs, and implementation progress reports. The MDPU will provide knowledge support on monitoring and evaluation (M&E), social and environmental safeguards, procurement, and fiduciary-related actions of the departments/implementing agencies (IAs) involved in the project.

57. Individual project components (and subcomponents) will be implemented by the Departments of Water Resources (Lead Agency), Agriculture, Agriculture Engineering, Horticulture, Animal Husbandry, Fisheries, and Agriculture Marketing and Tamil Nadu Agricultural University (TNAU), TANUVAS, and Tamil Nadu Fisheries University (TNFU). Each participating department will establish a Project Coordination Unit (PCU) to oversee the implementation of their activities.

58. Under this component, the project will finance (a) the establishment and operations of the MDPU; and (b) setting up of an M&E system for the project and contracting of an external M&E agency to monitor the project activities and impact. This component will also finance dedicated staffing for the project activities, consultancies, training and related material, office equipment, and incremental operational costs.

Component Z: Contingency Response (US\$0 million)

59. This zero-cost component will finance eligible expenditures under the Contingent Emergency Response (CER) to provide immediate response to an eligible crisis or emergency as

needed in Tamil Nadu. This contingency facility can be triggered through formal declaration of an emergency by the government authority and upon a formal request from the GoTN to the World Bank through the Department of Economic Affairs (DEA). In such cases, funds from an unallocated category or other project components will be reallocated to finance emergency response expenditures to meet an eligible crisis or emergency, as needed. The CER would include mitigation, recovery, and reconstruction following natural disasters, such as severe droughts, floods, disease outbreaks, and landslides, among others. Implementation of this subcomponent will follow a detailed Contingent Emergency Response Implementation Plan (CERIP), subject to World Bank approval, that will be prepared, as the case may be, for each eligible crisis or emergency. The PIP shall include a CER Annex. As a condition of disbursement for this component, Tamil Nadu shall prepare and submit a Contingent Emergency Response Implementation Plan (CERIP) in form and substance satisfactory to the Bank.

B. Project Cost and Financing

60. The project will be financed through Investment Project Financing (IPF) over a period of seven years. The total project cost is expected to be US\$455.8 million, of which the World Bank will finance US\$318.0 million (69.8 percent of total project cost) through an IBRD loan and the GoTN will finance US\$136.3 million (29.9 percent) while beneficiary contribution will amount to US\$1.5 million (0.3 percent). An IPF was selected as the lending instrument, given that the investments are well defined and will be implemented over a specific period. The project will also finance, on retroactive basis, rehabilitation and modernization of tanks and other irrigation infrastructures damaged by the November–December 2015 floods (civil works), project consultancies, the MDPU operating cost (including staff), and also other activities associated with agribusiness development for the projects.¹⁶

Table 1. Project Cost by Component (US\$, millions)

Project Components	IBRD	GoTN	Beneficiaries	Total
A: Irrigation and Water Management				
1. Institutional Strengthening and Capacity Building for Water Management	5.5	2.4	0.0	7.9
2. Irrigation Systems Modernization	229.6	98.4	0.0	328.0
3. Participatory Irrigation Management	8.6	3.7	0.0	12.3
4. Convergence for Improved Service Delivery	3.2	1.4	0.0	4.6
Subtotal	246.9	105.9	0.0	352.8
B: Agriculture Productivity Enhancement, Diversification, Improved Livelihoods, Marketing, and Value Addition				
1. Agriculture Intensification and Diversification	43.7	18.7	0.2	62.6
2. Improving Alternative Livelihood Sources through Livestock and Inland Fisheries	9.1	3.9	0.0	13.0
3. Agriculture Marketing, Value Addition, and Postharvest Management	13.1	5.6	1.3	19.8
Subtotal	65.9	28.2	1.5	95.6
C: Project Management Support	5.2	2.2	0.0	7.4
Z: Contingency Response	0.0	0.0	0.0	0.0
TOTAL PROJECT COST	318.0	136.3	1.5	455.8

¹⁶ The project will finance, on retroactive basis, the eligible costs incurred during a period of time as defined in the Loan Agreement.

C. Lessons Learned and Reflected in the Project Design

61. The project design benefited from the World Bank's recent experiences in the implementation of a number of tank system rehabilitation projects (Tamil Nadu, Andhra Pradesh, Orissa, and Karnataka) and agriculture competitiveness projects (Maharashtra, Assam, and Rajasthan) in India as well as other similar projects in the region and beyond, and it was also supported by relevant studies and events. Some of the key lessons reflected in the project design are as follows:

- **Identifying the key constraints and addressing them through well-tested technical solutions are important factors for project success.** Water shortages for most of the year, in particular during dry seasons, and weak link of farmers to markets have been identified as key constraints limiting the productivity increase and crop diversification. During the implementation of the TN IAMWARMP, cost-effective rehabilitation of tank systems coupled with institutional strengthening of the WUAs proved to be an effective approach. On the other hand, limited interventions in improving the market link of farmers (such as supporting commodity interest groups and improved market information through *e-Velanmai*) showed that there is a need to improve the legal and institutional framework for market access, promote higher level of farmer organizations such as FPOs, and take advantage of the latest development of information technology [IT] in enhancing farmers' access to the market. Based on this analysis, the new project focuses on the rehabilitation and modernization of high-priority irrigation tanks through the application of well-tested low-cost technical solutions. Also, the project design accorded a high priority to interventions aimed at improving the farmers' access to the markets using the latest developments in ICTs and increasing value additions through the promotion of the farmer producer groups and FPOs.
- **Integration of water and agriculture investment is essential for sustained improvement of agriculture productivity.** Strong links between agriculture investments and irrigation and drainage investments are critical for improving agricultural productivity. The project will, therefore, support coordinated interventions in multiple sectors (irrigation, agriculture, horticulture, agriculture marketing, livestock, and inland fisheries) to sustainably augment the overall project impacts. This convergence of multiple sectors is reflected on the project not only at the department level but also at the grassroots level, as a model village where trained line department representatives come together at the local level to coordinate their interventions with the population and work effectively as a team.
- **Properly integrating the project activities into the GoTN's own programs will improve government ownership and long-term sustainability of the project and will also help mainstream innovations within public sector institutions.** By effectively embedding the project activities within the operations of line departments, the project will act as a catalyst in promoting sector-wide policy improvements and reforms (such as mainstreaming of the PIM activities into the regular functions of the WRD and implementing government reforms in agriculture marketing). Also,

housing, in the MDPU, mid-level and senior technical staff from participating IAs as focal points of line departments will improve the coordination mechanism among multiple agencies. The critical convergence between ten sectoral departments and agencies, especially at the cutting edge, is specifically targeted by a transformative bottom-up capacity-building approach.

- **It is critical to closely involve the WUAs in the O&M of the irrigation system to strengthen ownership and sustainability.** Building on the valuable lessons learned from the previous TN IAMWARMP, the PIM and strengthening of the WUAs are the main focus of the project.
- **The WUAs need to be strengthened focusing on water management areas.** All engagements for the WUAs, for example, training on O&M and financial management (FM), need to be combined with the improvement of water management, including equitable irrigation water distribution. The proposed project emphasizes on water management in the training of the WUAs. Despite the initial capacity-building measures implemented under the TNIAMWARMP, challenges remain with respect to the core WUA operations such as O&M and water management in their command areas. The interventions planned under Subcomponent A.3 will focus on building ownership of the WUAs to engage in O&M of their command areas, including strengthening farmers to ensure timely service delivery of irrigation to farm fields in the TNIAM tank sub-basins as well as building the long-term viability of the WUAs in the state.

IV. IMPLEMENTATION

A. Institutional and Implementation Arrangements

62. The implementation arrangement of the project is fully integrated within the existing structures of participating line departments and agencies at state and district levels to ensure strong government ownership and long-term sustainability of project impacts. In case of gaps in specific technical skills and institutional capacity, the project will engage outside (national and international) expertise.

63. A Project Empowered Committee (PEC) chaired by the Chief Secretary and comprising the Principal Secretaries/Secretaries to the GoTN for Finance, Public Works, Agriculture, Animal Husbandry, and Fisheries will provide policy directions and guidance, promote interagency coordination, resolve major implementation issues, and review and approve major project proposals.

64. The MDPU, headed by a Project Director, will provide operational management support and coordination. The MDPU will have representation in all disciplines that are part of the project and in procurement, FM, and safeguards aspects. These would include external specialists and other technical personnel deputed from line departments and agencies. Currently, several specialists deputed by the participating line departments and agencies work in the MDPU. Additional specialists in environment, social development, media and

communications, market intelligence, geographic information system (GIS), and other areas will be recruited when the project becomes effective.

65. Individual interventions and activities will be implemented by ten line departments and agencies. The lead IA will be the WRD under the administrative jurisdiction of Principal Secretary, Public Works Department (PWD). Other IAs will be the Departments of Agriculture, Agricultural Engineering, Agricultural Marketing and Agribusiness, Horticulture, Animal Husbandry, and Fisheries, TNAU, TANUVAS and TNFU. A PCU will be established in each participating line department and agency to oversee the implementation of their specific activities. The key functions of each PCU will be to prepare, implement, and monitor their annual work plans (AWPs) and coordinate with the MDPU. The PCU will consist of a nodal officer and other staff in technical, procurement, finance, and safeguards areas.

66. **Implementation of Subcomponents A.1, A.3, and A.4.** These three subcomponents will be primarily implemented by the WRD with support from other participating agencies in the formation and capacity building of the WUAs. The PIM Wing in the office of the Engineer-in-Chief (E-in-C) will lead the efforts in the formation, capacity building, and monitoring of performance of the WUAs. Synergies with other participating agencies will be pursued. The PIM Wing will recruit individuals, experts, and field-level staff for mobilizing and assisting in training farmer members of the WUAs. The WRD will be establishing the SWIKCs, which will be managed by the WUAs. Utilization of ICT platforms will be integrated across the WRD offices and central and regional PIM Wings for direct use by the WUA members. The SWaRMA and the IWS under the WRD will be responsible for policy analysis, expanding knowledge base, and providing technical support for water resource management. Further, extensive change management interventions and training to tackle service delivery and convergence challenges will be carried out at all levels.

67. Implementation of Subcomponent A.2 and Component B constitutes the bulk of project investments involving modernization of tank systems, anicuts, water distribution canals, and OFD, as well as demonstration and dissemination of improved technologies related to agriculture, horticulture, animal husbandry, and fisheries; organization of farmers into CGs and FPOs; training of staff, farmers, and fishers; renovation of markets; promotion of market links; and agribusiness development. These tasks will be organized at the sub-basin level.

68. For each sub-basin (or a cluster of sub-basins where the command areas are small), one Executive Engineer of the WRD will be designated as a Nodal Officer. A team of specialists deputed at the field level by the participating agencies will work with the Nodal Officer and will prepare SBDPs. A Nodal Officer in the WRD will monitor and facilitate tank-related investments (Subcomponents A.2, A.3, and A.4).

69. The process of preparing the SBDPs, covering engineering and agriculture (crops, horticulture, livestock, and fishery) aspects, developed and refined under the TN IAMWARMP will be followed. The plans will be prepared in a participatory manner, with the involvement of the field staff of all the IAs, WUAs, and other stakeholders in a joint walk-through of the irrigation infrastructure and consultation sessions in several villages in the sub-

basin irrigation commands. Requirements for modernization of irrigation infrastructure will be tailored to meet the needs of crop, horticulture, livestock, and fish production. The specific crop, horticulture, dairy, and fish production interventions appropriate for the sub-basin will be identified, and the agricultural, horticultural, dairy and fish production, and on-farm irrigation technology options, marketing strategies, and other interventions will be prioritized.

70. Each SBDP will be sent to the District Collector and nodal cells of the line departments for their review and inputs. These plans and designs will be then submitted by the respective line agencies to the MDPU for ensuring the multidisciplinary and integrated nature of the SBDPs. The MDPU acts as facilitator and assists the sub-basin groups in preparing comprehensive plans.

71. Implementation of various activities contained in the SBDPs will be the responsibility of the concerned IA. The MDPU will monitor the implementation of an integrated development plan through monthly and quarterly progress reports. Individual departmental physical and financial progress will be monitored by the PCUs and reported to the MDPU. The MDPU will also oversee the work of the M&E consultancy. Monitoring of project outputs and outcomes will be undertaken by an independent consultant under the guidance and supervision of the MDPU in addition to line agency internal monitoring and reporting systems

72. The Agriculture Marketing and Agribusiness Department (AMAD) will be responsible for organizing farmers into CGs and FPOs using service providers. It will also launch Smart Agri-Marketing Hub to introduce the next generation practices for modernization, automation, and digitization of regulated markets through mobile and wireless platforms; carry out modernization of selected markets; and provide infrastructure and logistic support to producer companies, farmers, and agri-entrepreneurs. The MDPU will coordinate implementation of the project activities in collaboration with all the participating agencies and will also be responsible for M&E, compiling project reports, and disseminating fiduciary and safeguards compliance requirements.

73. Detailed implementation arrangements are described in Annex 2 and the implementation support plan is presented in Annex 3.

B. Results Monitoring and Evaluation

74. A comprehensive results M&E system will be adopted, which would consist of (a) impact evaluations utilizing the data from baseline, midterm, and end-of-project surveys and other published data and information; (b) ICT-based system for monitoring of project implementation; and (c) a reporting system on monthly, semiannual, and annual reporting. The project will also adopt a system to record beneficiary feedback and monitoring of progress of project activities. The system will also monitor gender inclusion in project activities.

75. An M&E specialist at the MDPU will be appointed to coordinate monitoring activities by the line departments and to oversee activities by the M&E agency.

76. A results-based M&E system would monitor project implementation using the following methods and tools: (a) Results Framework derived from clearly identified goals, objectives,

outputs, and activities with corresponding indicators, means of verification, and key assumptions; (b) M&E strategy regarding information requirements, tools, and methodologies for data collection, analysis, and reporting; (c) comprehensive M&E plan with clear roles and responsibilities with respect to data collection and reporting; and (d) internal and external periodic assessments and evaluations, which include baseline studies, beneficiary assessments, midterm evaluations, ex post evaluation, and impact evaluations. The Nodal Officers in participating line departments will be responsible for process and performance monitoring of individual activities and will consolidate and analyze all M&E data provided by the field-level offices. The Nodal Officers will monitor all field-level activities, identify issues, and propose needed actions for the PCU/management to address them. The PCU will produce monthly reports for their state management and the MDPU.

C. Sustainability

77. The project sustainability was assessed with regard to technical, institutional, financial, social, and environmental aspects, and the necessary design provisions have been incorporated to address the issues.

78. **Technical sustainability** of the irrigation infrastructure depends on an optimal rehabilitation strategy and the presence of effective O&M arrangements as part of the rehabilitated system. The project design reflects some of the best practice designs in India and other countries and also relies on low-cost effective rehabilitation strategies suited to traditional tank irrigations. The project is providing innovative technical support to the WUA farmers on rotational water supply, integrating O&M practices into daily farming activities in a collaborative and participatory manner. Based on these interventions, the project aims to advance farmers' direct engagement in rehabilitation and operation of tank irrigation systems through strengthened WUAs in the project areas. The WUAs, which meet certain criteria, will directly participate in rehabilitation of OFD works below tank systems by executing community-based contracts. The state is also committed to provide the necessary funds to the respective departments to take up the required essential maintenance.

79. **Institutional sustainability** will be ensured through mainstreaming the SWaRMA and PIM activities into regular structures of the WRD and also through the establishment and strengthening of the WUAs in the project areas. The WUAs will be an integral part of all rehabilitation and modernization processes through their close involvements at all stages of rehabilitation works. The project implementation will be anchored within the GoTN departments and agencies, giving them full responsibility for project implementation and management, thereby not only improving public sector service delivery, but also building capacity and experience within these departments and agencies as well as integrating a culture within the WRD of directly engaging with farmers within the tank command area.

80. **Financial sustainability.** The project aims to train and support in initiating practices of regular collection of the WUA subscription fees of utilization for regular system maintenance and operations as well as other WUA activities. The project investments in critical marketing infrastructure, organizing farmers into FPOs, greater diversification into high-value crops, and improved farmer-market links would enhance the financial sustainability of farmers and instill confidence in potential investors in the sector, including collaboration with International Finance

Corporation, by alleviating some of the key produce quality and marketing constraints they currently face. The project will benefit from the GoTN and GoI’s strong commitment to fostering agriculture development through sustainable productivity growth and diversification toward high-value food and shifting focus beyond farming toward marketing, postharvest value addition, and agribusiness development.

81. **Social and environmental sustainability.** Selected activities (livestock, fisheries, employment opportunities from civil works, marketing, and agribusiness activities) will target women, landless, and other vulnerable groups. Safeguards action plans will mitigate/minimize potential negative impacts of the project, and also, participatory groundwater management will promote effective sharing and utilization of groundwater in overexploited areas.

V. KEY RISKS

A. Overall Risk Rating and Explanation of Key Risks

82. The overall risk rating for the project is considered as Moderate, as shown below:

Risk Category	Rating
1. Political and Governance	Low
2. Macroeconomic	Low
3. Sector Strategies and Policies	Moderate
4. Technical Design of Project or Program	Moderate
5. Institutional Capacity for Implementation and Sustainability	Moderate
6. Fiduciary	Moderate
7. Environment and Social	Moderate
8. Stakeholders	Low
9. Other	Low
OVERALL	Moderate

83. The main risks associated with the project and the proposed mitigating measures are as follows:

- **Weak government commitment to institutional reforms including proper devolution of management of irrigation systems of the command area to the WUAs.** The implementation of irrigation and water sector reforms has been uneven and at times slow, in particular in the areas of mainstreaming PIM into the WRD, sustained support to the formation and strengthening of the WUAs, and operationalizing the SWaRMA. This risk will be addressed by strong commitments shown thus far by the GoTN to strengthen the WUAs, establish a permanent PIM Wing within the WRD, regularize the functions of the SWaRMA, and organize wide-ranging capacity-building activities at the WRD and its allied agencies and institutions.

- **Insufficient government support and capacity for O&M of the rehabilitated and modernized irrigation systems.** It was noted that basic maintenance of some of the rehabilitated works under the earlier project such as removal of thick vegetation from tank bunds and canal banks and maintenance of canal banks, flood embankments, and mechanical fixtures were not appropriately carried out. To mitigate these risks, the project will strengthen institutional capacity through targeted training to carry out core O&M responsibilities, including the provision of required funds.
- **Coordination challenges of multiple implementation agencies.** The institutional and capacity risks associated with the coordination of multiple line departments and agencies during implementation will be minimized through retaining and utilizing the existing capacities created under the TNIAMWARMP. Notwithstanding the extensive experience and capacities gained under the previous project, the capacities of the IAs will be strengthened during implementation.
- **Government capacities in implementing fiduciary, safeguards, and innovative aspects of the project; promoting climate-smart agriculture; and enhancing farmers' access to market.** The GoTN, through its recent policies on tackling climate change threats (State Action Plan on Climate Change) and developing agriculture and water sectors (State's Vision 2023 Strategy), has made clear political commitments in these areas. During project preparation, the GoTN has shown a strong commitment to implement agriculture marketing reforms for integrating Tamil Nadu producers in the National Agriculture Marketing platform. Extensive training of project staff in procurement, FM, and environmental and social safeguards will be carried out.

VI. APPRAISAL SUMMARY

A. Economic and Financial Analysis

84. **Economic benefits.** The main benefits of the proposed project are expected to come from (a) increase in area under production and productivity increases associated with improved irrigation systems; (b) diversification from food grains into high-value agriculture and livestock and fisheries activities; and (c) improved marketing, postharvest management, and value addition. In addition to the increases in productivity and production of higher-value crops, it is expected that establishing the CGs and FPOs and facilitating PPPs will lead to increased incomes of beneficiaries due to (a) higher prices for the agricultural produce through better aggregation and new market channels, also resulting from improved market information; (b) potentially reduced input prices resulting from procurement by the FPOs in bulk; and (c) increased value addition through Farmer Common Service Centers (FCSCs) created by the FPOs for postharvest activities, including cleaning, grading, sorting, and processing. Furthermore, the project will support productive postharvest management infrastructure.

85. In addition, there will be significant benefits coming from improved resilience to climate change and positive nutritional effects associated with the diversification of production systems toward high-value agriculture crops and livestock and fisheries activities. It is expected that substantial employment will be generated due to the increased area under crop production and the resulting opportunities for on-farm labor, particularly for the landless poor who are mainly

employed in agriculture as wage workers, as well as the handling, processing, and marketing of incremental production. The investments in irrigation modernization and rehabilitation works will generate further employment opportunities during project implementation.

86. Major potential economic benefits also accrue through flood protection with regard to avoided losses and damages associated with the failure of tanks that may be affected without rehabilitation, including (a) avoided repair costs of tanks breached as a result of floods, (b) on-farm benefits through avoided losses in agricultural production (including livestock and fisheries), (c) additional downstream benefits through avoided flood damage to dwellings and other infrastructure (for example, roads, bridges, and irrigation structures), and (d) avoided losses of human lives.

87. **Economic viability and sensitivity analysis.** The economic internal rate of return (EIRR) of the project over a 20-year period for the base case is 25.4 percent with a net present value (NPV) of INR 24.38 billion (US\$363.8 million) at a discount rate of 10 percent. The results of the sensitivity analysis show that the project remains economically viable also in the case of adverse changes in project costs and benefits. A reduction in project benefits by 40 percent results in an EIRR of 13.3 percent while an increase in project costs by 20 percent combined with a reduction in project benefits by 20 percent and a one-year delay of benefits reduces the EIRR to 12.5 percent.

88. Putting a monetary value on the potential GHG mitigation benefits with regard to reductions in GHG emissions and increased carbon sequestration, which is estimated at 5.7 million tons of CO₂ equivalent (tCO₂e) over the project life of 20 years, the base case EIRR increases to 26.2 percent, assuming a price per tCO₂e of US\$30, which has been suggested for the analysis of other World Bank funded projects. Thus, expected reduction in GHG emissions will increase the overall economic and financial benefits of the project.

89. The financial analysis has been carried out for the 7 agricultural crops, 15 horticultural crops, and fodder crops presented in Tables 4.2 and 4.3, as well as for the livestock and fisheries interventions described above. The detailed crop and enterprise budgets are presented in the project File and summarized in Annex 4, providing an overview of the production system including the key production parameters, farmer organization, investments, and marketing channel. The analysis shows considerable increases in gross margin, net profit, and return to family and total labor for all crops analyzed (see Annex 4 for details).

90. **Fiscal impact.** The GoTN's contribution to the project amounts to 29.9 percent of the project investment costs (INR 8955 million or US\$136.3 million). This contribution represents around 1.2 percent of the estimated government budget for the departments and TNAU involved in the project over the seven-year implementation period (based on the total combined average annual budgets for the last three years). In addition, it is estimated that the Government would have to bear around 80 percent of the O&M cost of the tanks and irrigation structures rehabilitated under the project amounting to around INR 866 million (US\$13.1 million) annually at full development, while the WUAs would have to cover the remaining 20 percent. The Government's estimated share of annual O&M costs at full development represents around 3.1 percent of the average annual budget of the WRD over the last three years. In the medium to long term, a substantial positive fiscal impact of the project is expected, mainly due to (a) increased output, income, and employment, also resulting in increased tax revenues and (b) multiplier effects due to

increased disposable income of project beneficiaries, resulting in increased demand for goods and services. Some foreign exchange earnings/savings can also be expected from an increase in exports and/or a reduction in imports.

B. Technical

91. The project focuses on rehabilitation and modernization of tank irrigation systems covering almost 50 percent of the state (areas not covered by the TN IAMWARMP) and envisages a series of innovative aspects including improved designs of irrigation infrastructure, third-party technical supervision, 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 movement toward climate-resilient agriculture with relevant agriculture-water-related investments and substantial improvement of the PIM practices by beneficiaries. Improved resilience of agriculture production systems will be achieved through higher water use efficiency, increased adoption of sustainable technologies and practices, and enhanced diversification of production systems. Activities under the project will be duly complemented by experiments in the use of innovative ICT and new media technologies for enhanced efficiencies and faster turnaround time for delivering services to project beneficiaries.

92. The rehabilitation and improvement of tank irrigation systems involves small remedial and upgrading measures and often does not involve major revision of the design standards of existing structures. The WRD (lead IA) has substantial experience in implementing such programs under two successive World Bank financed projects (TN IAMWARMP and WRCP). However, hydrological assessment will be carried out for each sub-basin to ensure that they meet the national design codes of India and are in line with international good practices. The hydrological assessment will include water availability and quality assessment and estimation of design flood. Based on the findings of the hydrological assessment, if any surplus weir/spillways have insufficient capacity to pass the design floods, the necessary modifications will be introduced to meet the required standards.

C. Financial Management

93. The FM arrangements have been assessed to be adequate to account for and report on the project expenditures. The project will largely be implemented by the participating line departments and agencies, and based on the experience of the recently closed TN IAMWARMP, the FM arrangements will, to a large extent, rely on the GoTN's systems for budgeting, funds flow, accounting, internal control, and external audit with project specific arrangements agreed for (a) financial support to FPO's and (b) activities to be carried out by the three universities, that is TNAU, TNFU and TANUVAS.

94. The project would be budgeted by project components and by sub-basins (which are the unit for planning) in the GoTN budget. This will facilitate accounting by components using mainstream government accounting systems. The annual budget would be supported by a detailed AWP of department, which will be reviewed and approved by the MDPU before submission to the Finance Department. With the withdrawal of letter-of-credit mechanism with effect from April 1, 2016, by the GoTN, all payments, including those to contractors, will be made by the treasury electronically to the vendors/contractors. The project will provide quarterly interim unaudited

financial reports based on reports from the treasury, except for activities executed by the three universities and FPO's. Fund transfer (grants) to the universities and FPO's will be treated as advance and considered as expenditure based on expenditure/utilization reports from the entities. The expenditure reports from treasury, duly reconciled with the annual expenditure reports from the Accountant General and adjusted to reflect the annual expenditure reports from participating institutions, will form the basis of annual financial statements.

Audit. The Comptroller and Auditor General of India (C&AG), through its offices in Tamil Nadu, will be the external auditor for the project activities carried out by line departments, while the audit of TNAU, TNFU and TANUVAS will be carried out by the Local Fund Audit Department (LFAD), according to standard terms of reference (TOR) agreed with the C&AG, DEA, and the World Bank. The audit reports will be submitted to the World Bank within nine months of the close of each financial year.

D. Procurement

95. Procurement for the proposed project will be carried out in accordance with the World Bank's Procurement Regulations for Borrowers for Goods, Works, Non-Consulting and Consulting Services, dated July 1, 2016, and applicable to IPF, hereinafter referred to as 'Regulations'. The project will be subject to World Bank's Anticorruption Guidelines, dated October 15, 2006, and revised in January 2011 and as of July 1, 2016. Most of the civil works would involve National Competitive Bidding (NCB), but a few packages may also involve the use of International Competitive Bidding (ICB). The project will pilot the use of the e-procurement system (National Informatics Centre [NIC] platform) for ICB/very large NCB procurement (that is, estimated cost \geq INR 50 million). The project uses the online tool STEP (Systematic Tracking of Exchanges in Procurement).

96. **Procurement risk assessment.** The MDPU established under the TN IAMWARMP will serve as the management and coordination unit for the new project. Many of the officials of the MDPU and other ten line departments and agencies responsible for implementation of different components/subcomponents were also involved in the previous project, and they are very familiar with World Bank procurement procedures and have gained substantial experience in project implementation. However, because this project involves many new and innovative aspects in particular, those related to promoting climate-smart agriculture, enhancing farmers' access to market, this will be more challenging than was under the TN IAMWARMP. Apart from delays in the procurement process, contract management delays and disputes are potential problem areas.

97. **Project procurement strategy.** According to the requirement of the Regulations, a Project Procurement Strategy Document (PPSD) has been developed. Extensive market analysis has been carried out for different packages of procurement, and based on the findings; decisions on packages and lots are made for civil works to ensure adequate participation of bidders. Consultancy contracts are also framed based on market research, and packaging of the same with regard to the scope of services and period are decided. Based on the draft PPSD, the Procurement Plan is prepared to set out the selection methods to be followed by the borrower during project implementation in the procurement of goods, works, and non-consulting and consulting services financed by the World Bank. The project's Procurement Plan has been developed.

E. Social (including Safeguards)

Gender/Women Empowerment

98. The project has a strong focus on social development and gender, and to further enhance women empowerment, the lessons from the TN IAMWARMP will be used. Even though, the earlier project did not have a gender strategy (and, specifically targeted gender action plans), with gender disaggregated data and case studies, a large number of women benefited from their active participation in CBIGOs such as WUAs CGs of farmers, and model-village-based convergence for improved service delivery, CCWM, horticulture, fisheries, and livestock development. According to the Implementation Completion and Results Report (ICRR) of the TN IAMWARMP, a large number of women also benefited from SSIs, vegetable nurseries and gardening, and the linkages to marketing activities provided by agribusiness and knowledge centers.

99. To further enhance the emphasis on gender and to improve women's empowerment, the project is preparing a Strategy and Action Plan for Gender and Empowerment (SAPGE). This is particularly so because the project's focus on model-village-based convergence for improved service delivery, CCWM, horticulture, livestock development, and inland fisheries as alternative livelihood sources with emphasis also on training for relevant skills development provides excellent opportunities for the empowerment of women. The SAPGE will facilitate social mobilization and organization of women-oriented CBIGOs that will also be horizontally linked and vertically federated to provide social mobility and sustainability for women's empowerment. Particular attention will be paid to ensure that landholding women were included as members in the WUAs, and where there is a large number of such women, a separate WUA will be formed for them. An added advantage of this is the opportunity that it provides for citizen engagement and beneficiary feedback mechanism, a corporate requirement of the World Bank. Through these CBIGOs, as means to women's empowerment, action plans will be developed to provide increased access to resources such as water and land for agriculture and allied activities, productive assets, institutional credits, market and training for skills related to effective use of natural resources, improved agriculture, and allied activities. Such an access will be further complemented by skills improvement for the management of CBIGOs focusing on informed participation, collective decision making, and maintenance of records.

100. These specific targeted activities will be complemented with the analysis of women's time use to determine labor and time requirements to introduce time-saving technologies for tasks performed by women and also a strategy to ensure equitable intra-household income. These concerns stem from the recognition that among all aspects of women empowerment, the most relevant are (a) increasing women's access to and control over resources—primarily incomes and (b) reducing time and labor constraints. The SAPGE of the project is expected to address all these aspects of women's empowerment and monitor their impacts and outcomes based on gender-disaggregated data and indicators.

101. In view of major nutritional issues faced by rural and urban population (discussed in earlier sections), the project will implement actions to improve nutrition outcomes through income improvements, dietary diversity, improving the availability of high-nutrient and low-cost foods, reducing physical/quality losses, and empowering women. Pathways to nutrition would also include the use of additional income and nonmarketable and periodic surplus crops, milk, and fish

produced for family consumption. Nutrition awareness programs and nutrition education would be used to enhance dietary consumption effects and the potential for the demand of nutritious diet. The project would prepare a nutrition profile of the project beneficiary families and use it as a baseline to monitor the improvement in the consumption of nutritious diet.

Citizen Engagement

102. The process of citizen engagement in the project began with beneficiary/stakeholder consultation that took place as part of project preparation. The process of social mobilization to facilitate the formation of CBIGOs such as the WUAs, CGs of farmers, FPOs, and community-based organizations (CBOs) of livestock and fisheries group provide an excellent platform for citizen engagement and policy support system. This platform, through the process of beneficiary participation, would help discuss strategies and action plans related to water deficit to ensure optimum use of water, access to resources, productive assets, market, technology and skills improvement, sources of income and livelihoods, converged service delivery centering on model-villages, and so on. The process of such citizen engagement would also provide the base for what could be called multisector convergence and vision.

Social Safeguards

103. A detailed Environmental and Social Impact Assessment (ESIA) has been completed to assess the potential social and environmental impacts of the project. According to the ESIA, there are scheduled tribes who live in districts covered by the project, but because they do not live in project intervention areas, the project will not have any adverse impacts on them. The scheduled tribes do not own or have access to any land and assets in project sub-basins. Hence, the World Bank's OP 4.10 on Indigenous Peoples is not triggered. The project will not acquire any private land and other such assets under the provisions of the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation & Resettlement (RFCTLAR&R) Act.

104. The ESIA consultation indicated that there may be encroachments on some water bodies and irrigation tanks in project areas. The main strategy of the project to deal with encroachment would be that it will exclude from project scope those irrigation tanks, where encroachment took place, thus avoiding any adverse social risks. Nevertheless, to deal with exceptional cases, where rehabilitation of irrigation tanks with encroachment is deemed inevitable, the World Bank's OP 4.12 on Involuntary Resettlement has been triggered and also, a Resettlement Policy Framework (RPF) has been prepared to address the potential involuntary resettlement and land acquisition issues. Before any rehabilitation work starts in tanks and anicuts, the project will undertake public and participatory social screening involving all those who have a stake in water-bodies and tank irrigation systems to identify encroachments and to exclude the tanks where such encroachments have taken place. Similarly, the project will also undertake social screening to ensure that public land under different tenure system that are required for rehabilitation and modernization of selected weekly farmers market are not under any public and/or private use. The concerned line department will ensure that such social screenings are completed before undertaking any civil works. If the process of social screening indicates adverse social impacts, RAPs would be prepared in accordance with the RPF with adequate budgetary provisions.

105. To ensure that the process of social safeguards is appropriately implemented in accordance with the ESIA and RPF, the WRD/PWD had agreed to create an institutional arrangement, which would involve designation of an Assistant Engineer as the Nodal Officer for each sub-basin and an Executive Engineer for each region, who would coordinate social safeguards related activities in each region. In addition, another Executive Engineer will be designated as the Nodal Officer for social safeguards in the office of the E-in-C, WRD/PWD but based in Tiruchirapalli. The project, with support of the World Bank, will organize orientation programs on social safeguards that would also include the process of social screening, preparation of Rehabilitation Action Plans (RAPs), and the structure and processes of the project-based Grievance Redress Mechanism (GRM) and also the World Bank's Grievance Redress Service (GRS) in accordance with the RPF for these Engineers designated as Nodal Officers for social safeguards.

F. Environment (including Safeguards)

106. The ESIA has been completed covering a sample of 12 sub-basins across two to three agro-climatic zones, while keeping in mind the representativeness of the geographic spread of the project. The safeguards policies on Environmental Assessment (OP4.01), Natural Habitats (OP4.04), Pest Management (OP4.09), and Involuntary Resettlement (OP4.12) have been triggered.

107. The ESIA has identified potential environmental impacts and risks due to proposed investments under the project. These include the risks of improper construction management and disposal of silt and other solid wastes, increased use of agrochemicals, particularly, pesticides for enhancing crop intensity, productivity, and diversification into horticulture. Other investments on improving agri-marketing and postharvest management infrastructure as well as investments on value addition and value chains would pose only limited impacts and risks. These would also primarily be on the issues of waste generation and disposal and construction management. The project provides a good opportunity to improve the energy efficiency by promoting green building norms (for example, warehouses and agri-markets) with the adoption of renewable energy options where feasible. The assessment found that there are no irreversible and significant impacts that cannot be managed or mitigated. Given the wide geographical spread of proposed investments, no cumulative impacts are envisaged. The ESIA includes an Environmental and Social Management Framework (ESMF) for activities that are not yet decided. The ESMF, among others, includes a negative list of activities that the project will not finance, a screening criteria for sub-projects, mitigation measures, a pest management plan, monitoring indicators, and a capacity-building plan. All these will help address any potential environmental impacts and risks and will also manage any residual risks.

108. For Phase 1 irrigation infrastructure rehabilitation related sub-projects, investment-specific Environmental Management Plans (EMPs) have been prepared for all packages with an estimated investment cost of INR 60 million or higher (which constitutes 10% of all Phase 1 packages) by Water Resource Department. For the remaining 90% of sub-projects with investment costs lower than the threshold of INR 60 million, an ESMF with its own set of mitigation measures and best practice guidelines will be applicable to address and mitigate any potential adverse environmental impacts. This is because significant, irreversible and/or cumulative environmental impacts and risks are not envisaged from sub-projects below this investment threshold. This is primarily, as the earth/silt/soil removed for rehabilitation will be used within the bunds of irrigation tanks and

related infrastructure. This is a specific arrangement for Phase 1 and based on the implementation experience and monitoring of safeguards issues in the first phase, the threshold of INR 60 million will be revisited for subsequent phases.

109. Given that the project will invest in institutional strengthening, the ESIA has recommended strategies to mainstream environmental safeguards in the working of these institutions. A full-time Environmental Expert will be engaged in the MDPU to support the implementation of the ESMF and EMPs. In addition, the Environmental Expert will also coordinate safeguards activities with the line departments, along with providing the necessary environmental safeguards training to all concerned stakeholders of the project. This will be important for the working of the WUAs and the proposed FPOs. In addition to the range of tools provided under the ESMF, a set of best practice guides on enhancing energy and water efficiency and health and safety measures will also be part of the safeguards strategies in the ESMF. Given the attention to climate-induced vulnerabilities of marginal and small farmers, the ESMF will propose measures to introduce and scale up climate-smart agricultural practices.

110. A GHG appraisal of the TNIAMP was carried out using the ex-ante carbon-balance tool (EX-ACT), which quantifies the net carbon balance with regard to tCO₂e, resulting from GHGs emitted or sequestered as a result of the project compared to the without-project scenario. The project leads to estimated annual climate change mitigation benefits of 284,000 tCO₂e when compared to a business-as-usual baseline scenario. This is equivalent to annually reduced GHG emissions per hectare of 1.3 tCO₂e. After 20 years, a time frame commonly used for project GHG accounting in agriculture, GHG mitigation benefits amounting to a reduction of 5.7 million tCO₂e will be generated. In addition to the achievement of the directly targeted PDOs, the TNIAMP also provides intermediate GHG emission reductions as a co-benefit of the project implementation.

111. **Consultations and disclosure.** Consultations with stakeholders including farmers, line departments, NGOs, local bodies, and CBOs were undertaken during the preparation of the ESIA/ESMF report. The final ESIA/ESMF report, incorporating comments from the stakeholders, has been disclosed in-country by the MDPU and in the World Bank's InfoShop on March 21, 2017.

G. Grievance Redress Mechanism

112. The project will establish a multi-level feedback mechanism and GRM, including the structures and processes at different levels. Grievances related to various aspects of participatory irrigation and water management will be at the regional level of the Chief Engineers of the WRD while grievances related to other project activities will be redressed by the District Collector. In addition to these, there will be a departmental state-level GRM.

113. The structure and processes of these mechanisms, including their scope, memberships, procedures for receiving, documenting grievances received, decisions to redress, communication of redress, periodicity of meetings to redress, and multi-level public disclosure, were finalized and included in the ESMF.

H. World Bank Grievance Redress

114. Communities and individuals who believe that they are adversely affected by a World Bank (WB) supported project may submit complaints to existing project-level grievance redress mechanisms or the WB's Grievance Redress Service (GRS). The GRS ensures that complaints received are promptly reviewed in order to address project-related concerns. Project affected communities and individuals may submit their complaint to the WB's independent Inspection Panel which determines whether harm occurred, or could occur, as a result of WB non-compliance with its policies and procedures. Complaints may be submitted at any time after concerns have been brought directly to the World Bank's attention, and Bank Management has been given an opportunity to respond. For information on how to submit complaints to the World Bank's corporate Grievance Redress Service (GRS), please visit <http://www.worldbank.org/GRS>. For information on how to submit complaints to the World Bank Inspection Panel, please visit www.inspectionpanel.org.

VII. RESULTS FRAMEWORK AND MONITORING

Country: India

Project Name: Tamil Nadu Irrigated Agriculture Modernization Project (P158522)

Results Framework

Project Development Objectives

PDO Statement

The Project Development Objective (PDO) is to enhance productivity and climate resilience of irrigated agriculture, improve water management, and increase market opportunities for farmers and agro-entrepreneurs in selected sub-basin areas of Tamil Nadu.

These results are at | Project Level

Project Development Objective Indicators

Indicator Name	Baseline	Cumulative Target Values										
		YR1	YR2	YR3	YR4	YR5	YR6	YR7	YR8	YR9	End Target	
1. Area provided with new/improved irrigation or drainage services (Hectare(Ha))	0.00	1600.00	16000.00	56000.00	88000.00	112000.00	136000.00	160000.00				160000.00
2.A. Yields of agriculture crops (Number)												
i). Rice	3390.00	3750.00	3850.00	3950.00	4050.00	4150.00	4200.00	4250.00				4250.00

(Number - Sub-Type: Breakdown)											
ii). Maize (Number - Sub-Type: Breakdown)	4943.00	5400.00	5560.00	5720.00	5880.00	6040.00	6150.00	6200.00			6200.00
iii). Pulses (Number - Sub-Type: Breakdown)	520.00	540.00	550.00	560.00	570.00	580.00	590.00	600.00			600.00
2B. Yields of horticulture crops (Number)											
i). Vegetables (Brinjal, Bhendi & Tomato) (Number - Sub-Type: Breakdown)	9.22	10.50	10.95	11.40	11.86	12.31	12.65	12.76			12.76
ii). Tissue Culture Banana (Number - Sub-Type: Breakdown)	42.00	50.00	52.60	55.20	57.80	60.40	62.00	63.00			63.00
3. Area under climate-resilient technologies (SRI, resource-conserving technology, etc.) (Hectare(Ha))	0.00	15000.00	30000.00	45000.00	50000.00	60000.00	70000.00	75000.00			75000.00

4. Area under non-paddy crops (Hectare(Ha))		10000.00	15000.00	25000.00	35000.00	50000.00	60000.00	75000.00			75000.00
5. Share of selected commodities sold through new marketing channels (Percentage)		0.00	1.00	5.00	10.00	15.00	20.00	20.00			20.00
6.A. Project Beneficiaries (including female) (Number)		5000.00	50000.00	100000.00	200000.00	300000.00	400000.00	500000.00			500000.00
6.B. Female Project Beneficiaries (Number)		2250.00	22500.00	45000.00	90000.00	135000.00	180000.00	225000.00			225000.00

Intermediate Results Indicators

Indicator Name	Baseline	Cumulative Target Values									
		YR1	YR2	YR3	YR4	YR5	YR6	YR7	YR8	YR9	End Target
1. Staff trained in water resources planning and management, improved service delivery both within WRD & allied	0.00	50.00	200.00	400.00	550.00	700.00	850.00	1000.00			1000.00

departments and agencies. (Number)											
2. Sub-basin development plans jointly prepared, agreed and under Implementation by multiple agencies. (Number)	0.00	18.00	36.00	56.00	66.00	66.00	66.00	66.00			
3. Tank irrigation systems modernized (Number)	59.00	150.00	350.00	1100.00	2000.00	3000.00	4000.00	4800.00			4800.00
4. Staffing and operationalizing PIM Wing in E-in-C office and regional offices (Number)	13.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00			24.00
5. Operational water users' associations created and/or strengthened (Number)											
5.A. Operational water users' associations created	0.00	0.00	800.00	800.00	1600.00	2400.00	3200.00				3200.00

(Number - Sub-Type: Supplemental)											
5.B. i. WUAs undertaking OFD works (Percentage - Sub-Type: Supplemental)	0.00	0.00	0.00	25.00	25.00	25.00	25.00	25.00			25.00
5.B. ii. WUAs conducting rotational water supply or utilizing other water management practice (Number - Sub-Type: Supplemental)	0.00	0.00	0.00	100.00	200.00	300.00	400.00	500.00			500.00
6. Multi Sectoral Convergence and Vision building trainings, with officers etc. and community involvement on a single platform. (Number)	0.00	18.00	36.00	56.00	66.00	132.00	132.00	132.00			
7. Area under micro irrigation (Hectare(Ha))	0.00	1500.00	4000.00	6000.00	8000.00	10000.00	12000.00	12000.00			12000.00

8. Area under improved agronomic practices (Hectare(Ha))	0.00	5000.00	30000.00	60000.00	70000.00	90000.00	100000.00	100000.00			100000.00
9. Area covered by IPM/INM/Organic farming. (Hectare(Ha))	0.00	1000.00	2500.00	3500.00	5000.00	7000.00	8000.00	8000.00			8000.00
10. Increase in milk productivity by dairy cow (Liter)	5.00	0.00	0.00	5.25	5.50	5.75	6.00	6.25			6.25
11. Production of heifer calves (Number)		0.00	20000.00	41000.00	73000.00	116000.00	160000.00	160000.00			160000.00
12. Area under improved fish production (Hectare(Ha))	0.00	0.00	0.00	10800.00	14400.00	18000.00	21600.00	25100.00			25100.00
13. Number of FPOs formed and strengthened (Number)	0.00	0.00	20.00	40.00	70.00	90.00	120.00	120.00			120.00
14. MDPU adequately staffed and functioning effectively (Number)	27.00	55.00	55.00	55.00	55.00	55.00	55.00	55.00			55.00

Indicator Description

Project Development Objective Indicators

Indicator Name	Description (indicator definition etc.)	Frequency	Data Source / Methodology	Responsibility for Data Collection
1. Area provided with new/improved irrigation or drainage services	Reduction in partially irrigated and gap areas.	Annually	Revenue Department	Line Department and MDPU
2.A. Yields of agriculture crops	Unit of Measure: kg/ha. Base line is average of previous 5 years.	Annually	Departmental reports	Line departments
i). Rice	kg/ha	Annually	Departmental reports	Line departments
ii). Maize	kg/ha	Annually	Departmental reports	Line department
iii). Pulses	kg/ha	Annually	Departmental reports	Line departments
2B. Yields of horticulture crops	Unit of Measure: MT/Ha. Average of Previous 5 years	Annually	Departmental Reports	Line departments
i). Vegetables (Brinjal, Bhendi & Tomato)	MT/Ha	Annually	Departmental Reports	Line departments
ii). Tissue Culture Banana	MT/Ha	Annually	Departmental Reports	Line departments
3. Area under climate-resilient technologies (SRI, resource-conserving technology, etc.)	No description provided.	Annually	Departmental Reports	Line departments
4. Area under non-paddy crops	No description provided.	Annually	Departmental Reports	Line departments
5. Share of selected commodities sold through new marketing channels	This includes FPOs, e-Negotiable Warehouse Receipt.	Annually	Departmental reports	Line departments
6.A. Project Beneficiaries (including female)	No description provided.	Annually	Departmental reports	Line departments

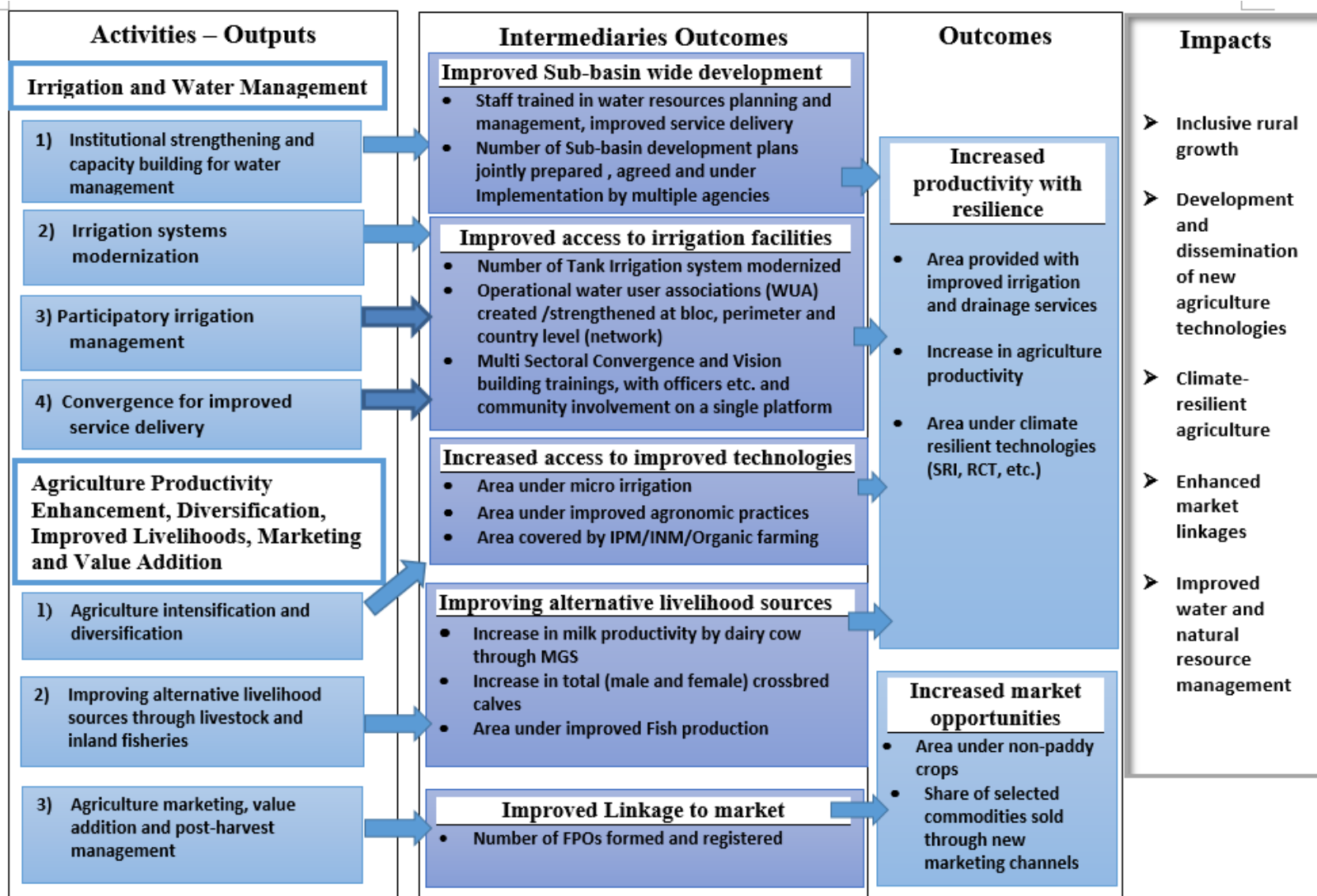
6.B. Female Project Beneficiaries	No description provided.	Annually	Departmental reports	Line departments
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Intermediate Results Indicators

Indicator Name	Description (indicator definition etc.)	Frequency	Data Source / Methodology	Responsibility for Data Collection
1. Staff trained in water resources planning and management, improved service delivery both within WRD & allied departments and agencies.	No description provided.	Annually	Annual Reporting	Line department
2. Sub-basin development plans jointly prepared, agreed and under Implementation by multiple agencies.	For the year 5, 6 and 7, updating of sub-basin development plans and implemented.	Annually	Annual Reporting	Line department and MDPU
3. Tank irrigation systems modernized	No description provided.	Half Yearly	Annual Reporting	WRD
4. Staffing and operationalizing PIM Wing in E-in-C office and regional offices	No description provided.	Annually	Annual Reporting	WRD
5. Operational water users' associations created and/or strengthened	No description provided.	No description provided.	No description provided.	No description provided.
5.A. Operational water users' associations created	No description provided.	Annually	Annual reporting	WRD
5.B. i. WUAs undertaking OFD works	No description provided.	Annually	Annual reporting	WRD PIM Wing
5.B. ii. WUAs conducting rotational water supply or	No description provided.	Annually	Annual reporting	WRD PIM Wing

utilizing other water management practice				
6. Multi Sectoral Convergence and Vision building trainings, with officers etc. and community involvement on a single platform.	No description provided.	Annual	Annual Reporting	WRD and Line department
7. Area under micro irrigation	No description provided.	Annually	Departmental report	Line department
8. Area under improved agronomic practices	No description provided.	Annually	Departmental report	Line department
9. Area covered by IPM/INM/Organic farming.	No description provided.	Annually	Departmental report	Line department
10. Increase in milk productivity by dairy cow	Unit of Measure: Lts / cow / Day Baseline data is based on the TN IAMWARMP baseline plus 10 percent.	Annually	Sample milk recording	AHD
11. Production of heifer calves	No description provided.	Annually	AHD records	AHD
12. Area under improved fish production	No description provided.	Annually	Fisheries Department records	Fisheries Department
13. Number of FPOs formed and strengthened	No description provided.	Annually	Departmental report	Department of Agriculture Marketing
14. MDPU adequately staffed and functioning effectively	No description provided.	Annual	Annual report	MDPU

Figure 1. Results Chain of the TNIAMP



ANNEX 1: DETAILED PROJECT DESCRIPTION

Country: India

Tamil Nadu Irrigated Agriculture Modernization Project (P158522)

A. Project Development Objective, Beneficiaries, and Key Results Indicators

1. The PDO is to enhance productivity and climate resilience of irrigated agriculture, improve water management and increase market opportunities for farmers and agro-entrepreneurs in selected sub-basin areas of Tamil Nadu. The key results indicators for assessing the project outcomes are

- (a) Area provided with improved irrigation and drainage services (ha) (resilience and water productivity);¹⁷
- (b) Increase in agricultural productivity (productivity);
- (c) Increase in areas cultivated for non-paddy crops (diversification and value added);
- (d) Area under climate-resilient technologies and practices (resilience);
- (e) Share of selected commodities sold through new marketing channels¹⁸ (increased market opportunities); and
- (f) Total number of project beneficiaries (including number of female beneficiaries).

2. The main project beneficiaries are farmers, the WUAs, FPOs, and other agro-entrepreneurs.

B. Components' Description

3. The project activities are grouped into four components as Component A: Irrigation and Water Management; Component B: Agriculture Productivity Enhancement, Diversification, Improved Livelihoods, Marketing, and Value Addition; Component C: Project Management Support; and Component Z: Contingency Response. The individual components are described in detail in the following paragraphs.

Component A: Irrigation and Water Management

4. The objective of this component is to improve agriculture water management, covering both supply and demand aspects. It consists of four interrelated subcomponents¹⁹: Subcomponent A.1: Institutional Strengthening and Capacity Building for Water Management; Subcomponent A.2: Irrigation Systems Modernization; Subcomponent A.3: Participatory Irrigation Management; and Subcomponent A.4: Convergence for Improved Service Delivery. The support envisaged

¹⁷Reduction in partially irrigated and gap areas.

¹⁸ This includes FPOs, e-Negotiable Warehouse Receipts.

¹⁹ Sub-components of A.1-A4 will be implemented by WRD in conjunction with SWARMA, IWS and SG&SWDC.

under the project would cover policy and institutional improvements, capacity building, and investments in irrigation infrastructure.

Subcomponent A.1: Institutional Strengthening and Capacity Building for Water Management

5. This subcomponent will support the institutional strengthening and capacity-building activities for the WRD and its allied organizations dealing with water resources management with a view to strengthen the state's capacity for multi-sectoral planning, development, and sustainable management of water resources. The subcomponent will finance (a) training for both within the WRD and allied departments and agencies for strengthening the state's capacity of water resources planning and management, (b) technical assistance for studies of ICT-based modern technologies and river basin master plans; and (c) experts, consultants, equipment, and operating expenses.

6. **Strengthening of the WRD.** The project intends to contribute to modernizing the WRD technically and institutionally to carry out its mandate through support for institutional infrastructure, ICT equipment modernization (for example, videoconferencing), special studies, training (including regular technical forums), and partnership facilitation.

7. The project will also assist the WRD in modernizing its information management, including support for the rollout of the Enterprise Information Management System (EIMS) into its activities, commissioned during the TN IAMWARMP. An innovative mobile application (e-WRD) will be developed to provide customized data visualization, map, and document access platforms to various stakeholders (for example, the WRD staff, other government officials, WUAs, farmers, and the general public) using information from the EIMS and other data and mapping services and documents from the WRD, SWaRMA, IWS, and SG&SWDC, as well as from other sources (for example, other departments, United Nations agencies, earth observation, and crowdsourcing).

8. O&M of irrigation infrastructure till the sluice is the responsibility of the WRD while O&M of distribution systems after the sluice is the responsibility of the WUAs. The project will improve the information and analytical tools and capacity for system operation through improved system monitoring, use of forecasting information as supported by the National Hydrology Project and other activities, and tools to enhance decision support as well as improved maintenance, including improved budgeting in the EIMS, timely repair/modernization of systems, and enhanced PIM under Subcomponent A.3 to sustain the service delivery. For the maintenance of the tank system (till the sluice), the GoTN allocates maintenance funds for it. The GoTN has increased the allocation from INR 50 crores to INR 100 crores per year in 2015–2016, which is considered a sufficient amount. The project will support the updating of norms for O&M, improved estimation of O&M real needs with actual allocations, and systems to improve O&M benchmarking under this subcomponent.

9. The project will also assist the WRD in piloting real-time monitoring system services for canal irrigation management. This will also be combined with other real-time data being developed under other financing (for example, Dam Rehabilitation and Improvement Project and National Hydrology Project) to monitor key reservoirs, tanks, rivers, climate, water quality, groundwater, and so on, as well as a growing array of powerful curated data and analytical services in the public domain, including earth observation, so that they can be visualized and analyzed jointly.

10. **Strengthening of the SWaRMA, IWS, and Groundwater wings.** The project will provide support to synergize and modernize the work of the key water resources institutions in the state, especially the SWaRMA, IWS, and the SG&SWDC. This should help improve the way data are collected, analyzed, and stored; the way knowledge products are developed; and the way the data and knowledge products and services are made more accessible to support public-domain awareness and targeted benchmarking and decision support for planning and real-time operations and support policy, water auditing, integrated water resources planning and allocation, and strategy development.

11. The activities will not only support the overall state activities related to integrated water resources planning and management, but also facilitate targeted project-related activities, especially related to multi-sectoral sub-basin planning, data and analytical services, targeted knowledge products and training, application of modern geospatial technologies, interfacing with academia, and special studies.

Subcomponent A.2: Irrigation Systems Modernization

12. To secure water in tank systems, the related infrastructure needs to be improved. The modernization of irrigation infrastructures will be undertaken at the tank level as well as in command areas and will entail rehabilitation and modernization of about 4,800 tanks,²⁰ 477 anicuts (check dams) and supply channels and construction of artificial recharge well structures in 66 sub-basins covering 543,000 ha of land. Specific activities will emerge from the SBDPs tailored to local conditions and focusing on reviving the traditional water bodies (tanks) that are either part of or outside the state's irrigation system network. The subcomponent will finance civil works, equipment, consultancies, and incremental operational costs associated with modernization of the schemes, and the work will be carried out by the WRD with direct involvement of the WUAs. The expected works²¹ will include the modernization of control structures (diversion weirs), supply channels, and cross-masonry structures; construction of recharge well structures; strengthening and upgrade of tank bunds; installation of flow measurement devices; upgrade of distribution systems; improvement of irrigation and drainage canals; and introduction of modern quality testing devices.

13. The modernization works are planned to be executed in four phases. Initially, 18 sub-basins have been selected for rehabilitation in Phase I. In addition, rehabilitation works in 7 sub-basins (including 59 breached tanks) in Chennai region damaged by the 2015 floods will be undertaken on priority through retroactive financing. The designs and cost estimates for the rehabilitation of flood-affected tank systems in these 18 sub-basins of Phase 1 and 7 flood-affected sub-basins have been completed.

²⁰ Most of the tanks are under 10 m height. A tank with a height between 10 m and 15 m and categorized as a large dam by the ICOLD will not be included. A tank with a height between 10 m and 15 m and any of the following features is categorized as a large dam by the ICOLD:

- (a) The capacity exceeds 1 million m³.
- (b) The discharge capacity of its spillway exceeds 2,000 m³ per second.
- (c) Its crest length exceeds 500 m.

²¹ Considering economic and environmental perspectives, desilting of the tank will be limited only to remove silt from the tank bed to use for raising and strengthening the tank bund during the rehabilitation of the tank bund in such a way that sufficient area upstream of sluices is desilted on priority to ensure free flow of water toward the sluices.

14. **OFD works.** Improved irrigation water delivery to farmers is envisaged through OFD works. These works will comprise concrete lining of the irrigation channel in a short reach downstream of the irrigation sluice, desilting of irrigation channels, construction in concrete of a measuring device of cut-throat flume type, and concrete lining of the channel in a short reach beyond the measuring device and in short reaches of the parent and off-taking channels at the off-take locations as well as in the vulnerable reaches restricting the total lined length to about 35 m. These will be listed as a separate item in the DPRs. The cost estimates of OFD works will be prepared separately, and the works will be carried out either by WRD or by the qualified WUAs under direct contracting arrangements. In the case of contract with WUAs, the detailed implementation guidelines and sample contract documents will be prepared. These contracts with WUAs should be listed in procurement plans for the Project and will be subject to prior or post review by the World Bank as agreed in the plans. This OFD will be combined with the improvement of water management, including proper water distribution in the tank systems.

15. To ensure high quality of rehabilitation works, an O.K. card system will be introduced through the enforcement of specifications and ensuring construction quality with the involvement of WUAs. Specified frequency quality control tests will be conducted and documented by the WRD. In addition, a third-party construction quality consultancy will be hired. State-of-the-art non-nuclear density testing devices, procured under the TN IAMWARMP, will be deployed for on-site determination of compaction parameters. Mobile quality control laboratories of the WRD will be utilized for expediting the testing of inputs and outputs.

16. The key design improvement aspects of the rehabilitation works are (a) selective canal lining of field channels for the faster and more responsive distribution of water from the tank to downstream command area; (b) provision of measuring devices after the sluice of the tank, which is necessary not only for improving water efficiency but also for enabling the WUAs to control and manage water; (c) assurance of construction quality control, which enhances long-term durability of infrastructure and decreases life cycle cost through O.K. card and the third-party construction quality consultancy; (d) execution of the OFD works entrusted to qualified WUAs to rehabilitate distributary field channels and facilitate O&M activities; and (e) provision of artificial recharge structures for recharging the aquifer.

17. **O&M.** Irrigation service delivery to farmers in Tamil Nadu involves a complex array of water infrastructure that varies by basin and includes tanks, anicuts (check dams), irrigation canal distribution systems, and associated drainage. All these require appropriate attention to O&M, and these are the responsibility of the WRD (till the sluice) and WUAs (distribution systems after the sluice). The project supports activities that improve O&M for irrigation systems in the state, especially in the targeted areas under Subcomponent A.1 and A.3.

Subcomponent A.3: Participatory Irrigation Management

18. Building on the achievements of the TN IAMWARMP, the project will work with the WUAs to strengthen the decentralized irrigation service delivery by improving farmer's participation in irrigation management focusing on operations, water management, and minor maintenance. The project will finance equipment, expert consultants, consultancies, training, and operating cost to support (a) mainstreaming of the PIM approach within the WRD and (b) establishing new WUAs under the TNIAMP and strengthening their capacities.

19. **Mainstreaming of the PIM activities within the WRD.** The project will support establishing a PIM Wing within the WRD that will operate as the main unit for all PIM- and WUA-related activities in the state. This intervention will focus on staffing, strengthening, and operationalizing a sustainable PIM model within the WRD at the E-in-C office as well as within the four regional WRD offices. The wing will focus on implementing and strengthening the Tamil Nadu Farmers' Management of Irrigation Systems (TNFMIS) Act 2000 in the project as well as managing capacity building for the WUAs. The wing will also be responsible for conducting the monitoring and performance assessments of the WUAs. The TNIAMP will support the PIM Wing in developing tools for monitoring, assessing, and conducting regular performance assessments of both the PIM staff as well as of the WUAs. The PIM Wing will coordinate and ensure regional offices are conducting assessments and running monitoring exercises on a regular basis.

20. **Establishing new WUAs under the TNIAMP and strengthening their capacities.** The project will assist in establishing and strengthening around 3,200 WUAs in the project areas, and the activities will include conducting elections and WUA mobilization and initial operational capacity building of new WUAs within the selected 66 sub-basins of the TNIAMP. Training of these WUAs will focus on orienting the WUAs on the PIM concept, roles and responsibilities of the WUAs and specific officer roles within the WUA, water-saving techniques, opening of bank account, and other WUA functional aspects. These modules have already been prepared and executed by the Tamil Nadu Irrigation Management Training Institute (IMTI) in partnership with the CEC under the TN IAMWARMP. The PIM Wing at the E-in-C office and the regional PIM Wings will coordinate these activities. Initially, the PIM Wing will need to hold elections for the WUAs in a phased manner. There will be four phases, and each phase will elect 800 new WUAs for a total of 3,200 WUAs.

21. Maintenance of *ayacut* (command area) is a responsibility of the WUAs. The main financial sources to support this are: (a) O&M fund created from the contribution collected, (b) funds received as the WUA share of the fishery auction amount of the tank, (c) funds raised out of the foreshore plantation, (d) income raised from lending out community farming equipment provided to the WUA, and (e) membership fees. To aim to become financially autonomous, the training provided to the WUAs includes preparing the O&M budget, collecting the WUA subscription fees, and effectively carrying out maintenance activities in the command area.

22. **Capacity strengthening of the existing WUAs.** The project will support conducting elections one time and provide orientation training to the newly elected office bearers. This activity will also aim to launch a pilot for the existing WUAs to undergo intensive training on O&M of field channels within their command areas. This pilot is important to ensure sustainable WUAs that focus on O&M of their field channels as well as incorporating their traditional practices of asset maintenance with new approaches to operation, focusing on water management and asset maintenance. This pilot will serve as a model for building the capacity of the WUAs to autonomously ensure sustainable O&M of the irrigation systems below the sluice within their command areas in the GoTN PWD irrigation tanks and will assist the GoTN to implement the '*Kudimaramath*²²' Government Order. These pilot WUAs will eventually be selected and trained

²² Asset management.

to become champions as well as peer trainers of new WUAs that will be formed in the TNIAMP areas.

Subcomponent A.4: Convergence for Improved Service Delivery

23. For efficient and effective service delivery to farmers, interventions of ten participating line departments and agencies will converge not only at the top level, but also at the grassroots level. The subcomponent will finance equipment, training, and operating cost for this purpose.

24. The SWIKC experimentally established in the TN IAMWARMP will be functioning as the fulcrum for all activities of the WUAs and other farmers and interest groups. The Model Village Concept²³ will be integrated with the SWIKC for facilitating the CCWM. The CCWM starts with sensitization of the community about the water situation through a joint walk attended by all stakeholders (farmers, larger village/tank community, village-level officials of Water Resources, Agriculture, Horticulture, Fisheries, Animal Husbandry, Agricultural Engineering, and Agriculture Marketing Departments, and other project participants), taking into account the availability of water from different sources and the water requirements for agriculture, horticulture, and livestock production; domestic and other uses; evaporation, seepage, and run off loss; and so on. This is followed by participatory site meetings for developing a vision for the village, preparing a tank/village-level water balance sheet (water budgeting), and cropping decision with the help of a decision support system (DSS). The chosen strategy adopted by the community by consensus will be the operational plan for that irrigation season and will be implemented by the community. The convergence of all ten departments plays a major role not only in apprising the DSS to the community but also in implementing the chosen cropping pattern under the operational plan during that season. The success of the CCWM depends on the implementation of the operational plan. This exercise will be repeated for every season by the WUA. These exercises are proposed with optimism to transform the mindset of the farmers for more meaningful participations as envisaged in the TNFMIS Act.

Component B: Agriculture Productivity Enhancement, Diversification, Improved Livelihoods, Marketing, and Value Addition

25. The objective of this component is to enable farmers in the project sub-basins to take advantage of the rapidly changing market demand for fruits, vegetables, milk, fish, pulses, and coarse cereals and enhance resilience of agriculture production systems for increasing production and managing risks associated with climate change. The market demand to inform investments for raising production and promoting diversification will emerge from rising disposable incomes and investments to modernize agriculture markets and agribusiness development. Component B activities will be spatially linked with investments under Component A for improving productive use of irrigation water. CGs of farmers anchored in the WUAs will be mobilized and federated as producer association/companies for undertaking commercial activities. These groups will be the focal points for dissemination of improved technologies for increasing crop, horticulture, livestock, and fish productivity.

²³ In a model village, trained line department representatives come together at the local level to coordinate their interventions with the population and work effectively as a team.

26. The component consists of three subcomponents: Subcomponent B.1: Agriculture Intensification and Diversification; Subcomponent B.2: Improving Alternative Livelihood Sources through Livestock and Inland Fisheries; and Subcomponent B.3: Agriculture Marketing, Value Addition, and Post-harvest Management. The IAs are the Departments of Agriculture, Horticulture, Agricultural Engineering, Animal Husbandry, Fisheries, and Agricultural Marketing and TNAU, TNFU and TANUVAS

Subcomponent B.1: Agriculture Intensification and Diversification

27. This subcomponent aims to increase the productivity of key crops and promote diversification from rice to high-value vegetables and fruits and other crops with high nutritional values yet with low water usage such as pulses, oilseeds, and millets. Climate risk resilience will be built into agriculture production systems by promoting the cultivation of high-yielding, short-duration crop varieties/hybrids and complementary agronomic practices and the ability to withstand expected biotic and abiotic stresses. The subcomponent will finance (a) materials, equipment, and farm machineries; (b) installation of micro-irrigation and farm ponds; (c) training and learning events and other forms of knowledge sharing associated with demonstration and field trials and dissemination of technologies, and so on; and (d) studies. The planned interventions are described in the following paragraphs.

28. **On-farm technology assessment, validation, and mainstreaming.** These activities to be implemented by TNAU will support testing, demonstration, and dissemination of promising crop husbandry practices and water management technologies. For productivity enhancement of rice, technology gaps resulting in low productivity will be identified and available technology options will be evaluated and demonstrated on about 55,500 ha, (DoA 40,500 & TNAU 15,000) which includes controlled AWD in 5,000 ha. Interventions for promoting cultivation of pulses will include mobilization of pulse producer groups and providing them with quality seed and production technologies through 5,000 ha of demonstrations. Pulse groups will also be trained in postharvest value addition. Besides, TNAU will also undertake quality seed production in pulses under farmers' participation approach on an area of 2,500 ha. Latest packages of practices for cultivation of groundnut and gingelly (sesame) will be evaluated and refined on about 600 ha. SSI will be taken up on about 750 ha. Precision farming techniques, namely use of elite/hybrid seeds, drip fertigation, and application of water soluble fertilizers, will be implemented for productivity enhancement of pulses, vegetables, and banana in an area of 1,500 ha. Productivity enhancement in red gram will be addressed under precision farming mode in sole crop and in cropping system approach on 2,000 ha.

29. Production of pesticide-free vegetables integrating use of disease- and pest-free seedlings, fertigation, water soluble fertilizers, and organic manures will be taken up on 5,000 ha. For yield maximization and quality enhancement of mango and pomegranate, high-tech and high-density planting with drip fertigation will be demonstrated on 400 ha.

30. To link productions at the farm level with market demands more effectively, a crop optimization ICT pilot will be undertaken. Further, the marketing intelligence work undertaken by the Domestic and Export Market Intelligence Cell at TNAU under the TN IAMWARMP will be strengthened and linked with farmers to provide price forecasts to farmers before the sowing of crops. The existing database of farmers will be expanded to cover farmers in project areas, who

will be provided with price and other relevant information through short message services or other methods.

31. Other activities include (a) training of farmers and line department staff; (b) strengthening of *e-Velanmai* platform²⁴ for two-way farmer-scientist interaction covering crops, horticulture, livestock, and fish production and promoting its extensive use by farmers through the Departments of Agriculture and Horticulture; (c) piloting of remote sensing and GIS application for geo-tagging, at selected sub-basins; and (d) GHG - SRI pilot studies

32. **Enhancing productivity and climate resilience of crop farming.** The activities aimed at enhancing productivity and climate resilience to be implemented by the Department of Agriculture will aim at (a) increasing cropping intensity and productivity, (b) promoting diversification to low water requiring crops, and (c) promoting use of improved farm implements and tools.

33. Increased productivity enhancement of rice will be achieved by adopting crop sequencing technologies (green manure- SRI paddy cropping- pulse growing) on 40,500 ha using high-yielding and short-duration improved variety/hybrid seeds of crops and appropriate production and protection practices. For raising maize productivity, cultivation of high-yielding and quality hybrid maize will be demonstrated on 7,500 ha.

34. Crop diversification will be achieved by increasing areas under pulses, minor millets, and oil seeds on about 36,000 ha (DoA 30,000 & TNAU 6,000). Water requirement of these crops is low, and pulses and groundnuts also improve soil fertility. Increased diversification through pulse production will be achieved by the introduction of high-yielding varieties of red gram, black gram, and green gram; provision of supplemental irrigation at critical stages of crop growth; introduction to IPM; and raising seed replacement rate by organizing demonstrations on 18,500 ha (DoA 12,500 & TNAU 6,000). Further, the area under nutritious millets will be expanded by demonstrating cultivation of improved seeds and production practices for ragi (finger millet), *samai* (little millet), *varagu* (kodo millet), *pani varagu* (proso millet), *Thinai* (fox tail millet), and *kuthiraivaali* (barnyard millet) on 11,000 ha.

35. For expanding areas under oilseeds, groundnut, gingelly, and so on, demonstrations will be organized on 6,500 ha. Special attention will be given to crop demonstrations for sustainability by organizing about 4,500 Farmers Field Schools (FFSs). About 1,500 vermicomposting units will be set up for promoting the use of organic manure and reducing dependence on chemical fertilizers, and income enhancement through the establishment of Eco-Friendly IPM Model Villages will be achieved in 300 villages. Special attention will be paid to produce quality seed of self-pollinated crops by organizing seed production demonstrations on pulses, groundnut, and millets in 500 seed villages.

36. Integrated crop management (ICM) demonstrations and farmer trainings will be the core project activity and the main vehicle for the dissemination of improved technologies to farmers. The ICM demonstrations will include the complete package of practices for a particular crop from land preparation to harvesting of the crop.

²⁴*e-Velanmai* means e-Agriculture. This is an ICT-based extension model to disseminate farm-specific agricultural technologies from the agricultural scientist to the needed farmers.

37. The demonstrations will focus on promoting high payoff interventions and reducing carbon and water footprint of cropping systems. Adoption of the demonstrated technologies will be systematically tracked and documented. Trainings and capacity-building activities by the Department of Agriculture will be organized for farmers and officers on the latest crop production technologies.

38. **Horticulture development.** The objective of the horticulture development program to be implemented by the Department of Horticulture is to accelerate diversification to high-value fruits, vegetables, and spices through the promotion of modern technologies and better farmers-markets links. Specific tank command areas with access to tube well irrigation will be selected to provide assured irrigation for horticulture crops. Horticulture production will be taken up on 45,025 ha (43,000 ha vegetables and 2,025 ha fruits, spices, and flowers). Increased productivity will be achieved by promoting (a) use of seeds of improved varieties and hybrids of brinjal, *bhendi*, green chilies, tomato, gourds, melons, onion, and tapioca, replacing traditional varieties and production practices; (b) adoption of appropriate agronomic practices and integrated methods of nutrient, pest, disease, and weed management; and (c) adoption of improved irrigation practices such as micro-irrigation with fertigation, protected cultivation, and use of mulches. New plantations of mango, guava, pomegranate, banana, spices, and flowers will cover 2,025 ha. Disease-free and healthy seedlings of high-yielding varieties of fruit crops, including tissue culture banana, will be planted.

39. To promote horticulture expansion, about 11,000 ha will be brought under micro-irrigation and fertigation for efficient use of water and fertilizers. Under the precision farming mode, experiments on improving fertilizer use efficiency, increasing productivity, and enhancing produce quality will be undertaken. The micro-irrigation drip and fertigation equipment will be provided to eligible farmers according to the details given in the Project Implementation Plan.

40. The project will also promote the protected cultivation of flowers and vegetables, including the construction of poly greenhouses (6,000 m²) and demonstration of mulching technology (844 ha). Support will also be provided for cultivation of niche vegetables like bell pepper, European cucumber, cherry tomato, lettuce, Chinese cabbage, leek, and celery and flowers like Dutch rose, carnation, *Gerbera*, *Dendrobium* and *Cymbidium* orchids and filler flowers like *limonium*. Gourd production in *pandals* will be promoted. Pesticide-free vegetable production will be taken up on 5,962 ha in 300 IPM villages.

41. The FFS mode will be organized for vegetable, fruit, and flower growers. Groups of farmers will be provided cluster-level training and taken on exposure visits outside and within Tamil Nadu.

Subcomponent B.2: Improving Alternative Livelihood Sources through Livestock and Inland Fisheries

42. This subcomponent aims to diversify and enhance farmers' income through livestock production and inland aquaculture (fisheries). In addition, to supplement the farm income, these activities will function as a diversification and safeguard mechanism against potential reductions in yield or crop failure due to climate hazards. The subcomponent will finance (a) formation of Dairy Interest Groups (DIGs) for technology dissemination; (b) increase in the breeding coverage through mobile AI network; (c) fodder development; (d) strengthening of the ICT, veterinary, and

diagnostic infrastructures of the AHD for efficient disease control and MIS; and (e) capacity-building activities for the AHD officers on critical areas of knowledge gap.

43. **Livestock development.** This set of activities, to be implemented by the AHD in collaboration with TANUVAS, will aim at improving the production potential of dairy cattle and adding considerable numbers of genetically improved milk animals to the state dairy herd. In addition, this subcomponent will demonstrate innovative and climate-resilient technologies in breeding, animal nutrition, and animal health.

44. The planned activities are the strengthening of the breeding program through AI network. Other activities include addressing infertility issues in productive cows and buffaloes, preventive health care and nutrition interventions aimed at improving the survival and growth rates of heifer calves born through improved AI coverage, fodder development and preservation, and infrastructure strengthening for disease surveillance and implementing mastitis control program. Additional new mobile AI centers will be established in each of the sub-basins that will be managed by trained local youth selected from among the group members as well as converting the existing AHD AI centers into mobile AI units. Around 1.14 million AIs are being planned under the project, and this activity will cater to the breeding needs of an additional 15 percent breeding cattle and buffalo population. Use of sexed semen will be demonstrated to the farmers in a limited way to showcase the impacts of producing large proportion (90 percent) of female calves from AI.

45. Fodder development will cover 6,300 ha, including cultivation of rain-fed fodder sorghum, leguminous fodder crops, irrigated and perennial fodders like Napier hybrid (CO 4 and CO 5), and fodder trees. Farmers will be trained to preserve fodder as silage. This is expected to contribute considerably to the fodder needs of the sub-basin dairy animals.

46. Farmer training, demonstrations, and extension program will be implemented through DIGs organized in conjunction with the activities of the WUAs. Activities such as infertility management, use of estrous synchronization techniques, mastitis control program, calf care management, and fodder development activities will be implemented through these dairy farmers' groups. About 132,000 farmers will be brought under the direct group activity, of which 30 percent will be women. This activity is expected to demonstrate better dairy farming practices to a large number of farmers resulting in sustained adoption and improvements in milk productivity.

47. The AHD will adopt the use of ICT-based MIS together with animal identification system under the planned GoI unique animal identification project. The TNIAMP will link this system to its MIS and will distribute animal identity cards to monitor livestock development activities. Existing software like the Information Network for Animal Productivity and Health developed by the National Dairy Development Board will be used to manage the information system through the provision of computer facilities of the AHD at the regional and field units. The AHD will strengthen selected ADIUs to enhance the efficiency of disease surveillance. Similarly, selected AHD institutions at the field level will receive veterinary equipment in improving better service delivery to the farmers. A capacity development program will be organized for the AHD officers in infertility management and mastitis control methods as a means to reduce antibiotic and drug residues in milk.

48. TANUVAS will validate the precision-balanced feeding technology and use of precision mineral feeding as ways to reduce GHG emissions. Required infrastructure will be established at the TANUVAS Research Station, and the mineral supplement will be produced and distributed to the farmers for demonstration and validation. This activity will be implemented through the DIGs for demonstrating visible impacts. Stringent pre- and post- data collection and appropriate GHG measurement and estimation techniques will be applied during the validation trial. In future, the farmers' groups will be linked to the Regional University Research and Training Centre to ensure continued availability of the mineral supplement at affordable price and promote adoption among farmers. After validation in the first phase, the technology will be scaled up with required adjustments.

49. In addition, TANUVAS together with the AHD and the dairy farmers' group will promote production of balanced and region-specific mineral mixture salt lick at the village level using low-cost production technologies, which could ensure availability of quality mineral supplements at lower cost in the villages itself. Selected DIGs will be selected and trained in the production of low-cost mineral salt licks, which could be marketed among the members at half the market price, and also provide an entrepreneurial and income generation activity for the farmers' group. Increase in average milk production per day per animal by 25 percent from the baseline and additional production of 160,000 genetically improved female crossbred calves at the project end were considered as subcomponent result indicators. Approved methods such as sample test day milk recording suggested by the International Committee on Animal Recording will be followed for impact/result documentation.

50. **Inland fisheries development.** This set of activities to be implemented by the Department of Fisheries (DoF) will promote Good Aquaculture Practices (GAPs) on the currently available aquatic resources (tanks and ponds) consisting of 25,100 ha effective water spread area (seasonal average of total water spread) in project areas and will support the participation of fish farmers in value chains.

51. Improved production models using fast-growing fish varieties will be implemented through pure-line fish seed production involving genetically improved farm *Tilapia*, Pangas, Amur carp, and *Jayanthi Rohu* with close collaboration between TNFU and the DoF. TNFU will produce improved seed and validate production performance. The DoF will undertake the multiplication of seed and supply to farmers. The project will also support the production and supply of quality fingerlings through private farms. For providing feed at a lower cost, the project will develop formulated fish feed using locally available ingredients. The diet formulation for specific fish species will be undertaken by TNFU. The project will also support fish feed production units operated by the Fish Farmers' Cooperative Society in the project areas.

52. The DoF and TNFU will implement culture-cum-capture models for irrigation tanks for maximizing productivity. Based on an assessment of the primary productivity and carrying capacity of water bodies, an appropriate level of stocking density, species composition, stocking size, and harvesting regime will be prescribed. Training will be provided to fishers/farmers and the extension officers. Demonstrations will also be organized for promotion of innovative climate-resilient technologies such as integrated recirculatory aquaculture in farm ponds, promotion of native high-value species (*Channa striata*) farming, and cage fish culture in open water in an environmentally sustainable manner.

53. To enhance the market links, the project will support investments in the development and enhancement of value chains, and support establishment of fish kiosks, and so on. The project will support food safety, which is one of the major issues in fish marketing. Training on product safety procedures will be provided to fishers, transporters, processors, handlers, wholesalers, and retailers. The subcomponent will focus on supporting producers and trading organizations in providing technical training to farmers and extension officers. The project will also support institutional capacity enhancement for quality control in fish feed and seed certification by strengthening knowledge and skills, and technical assistance will be provided for the training of key stakeholders. GAPs for fish farming and relevant technologies will be compiled and widely disseminated.

Subcomponent B.3: Agriculture Marketing, Value Addition, and Postharvest Management

54. This subcomponent, to be implemented by the Agriculture Marketing and Agribusiness Department (AMAD) in coordination with the Departments of Horticulture and Agriculture, aims to enhance farmers' links to markets through (a) improving farmer access to markets, (b) promoting agri-enterprises, and (c) institutional strengthening and capacity building. The subcomponent will finance (a) grants to FPOs, (b) expert consultants and consultancies for studies, (c) equipment, (d) training and capacity building, and (e) operating costs.

55. To improve farmers' access to market, the project will support (a) promoting alternative marketing channels through CGs and FPOs; (b) launching Smart Agri-Marketing Hub to introduce new generation of practices for modernization, automation, and digitization of regulated markets through mobile and wireless platforms; and (c) piloting and expanding the Negotiable Warehouse Receipts schemes.

56. The project will support the formation of CGs and establishment of FPOs based on the federation of the CGs. The project will also provide technical support to existing CGs and FPOs formed under the TN IAMWARMP and through the Small Farmer Agribusiness Consortium, the National Bank for Agriculture and Rural Development (NABARD), and Department of Horticulture. Farmer mobilization, formation of CGs, and federating CGs into FPOs through company registration and subsequent commercialization of FPOs will be carried out by support organizations/individual consultants and professional consultancy firms/formation of consortium to take care of both CGs and FPOs responsibility entrusted with the AMAD field officials. If individuals with necessary social mobilization skills are hired as support for the department to carry out this task, it is a part of the operating expenses. These support organizations will provide hand-holding and business facilitation support to FPOs for three years. The project will provide financial support to FPOs. These financial supports could be used to finance investments that could include storage sheds, drying yards, pack houses, FCSC office space and equipment, grading and sorting machines and postharvest equipment/materials and mechanization according to the FPO's business plans. Modalities for inviting, reviewing, and approving applications for productive investments, including eligibility criteria, are included in the Project Implementation Plan. The AMAD will sign grant agreements with the recipients of various grant recipients. The GoTN has amended the Regulated Market Act 1987 on February 15 2017 for integrating agriculture markets with the common electronic platform under the National Agriculture Market Scheme of the GoI. This amendment was facilitated during the project preparation process. In this context, the project will support the launch of Smart Agri-Marketing Hub to introduce next generation practices for

modernization, automation, and digitization of regulated markets through mobile and wireless platforms. The project will support the creation of 2–3 such hubs in selected regulated markets. The process will include (a) identification of regulated markets on specific selection criteria; (b) selection of a market architect for undertaking study and preparing a master plan for regulated market; (c) digitalization and automation plan of the selected regulated markets;(d) process flow mapping and designing of mobile application for facilitating auctions, logistics, settlement, and payment transaction; and (e) rolling out of the platform at the village level and 2–3 regulated markets. This will enable farmers to sell their agricultural produce through their mobile phones, reduce transaction costs and time, and improve the efficiency of regulated markets. These pilots will be directly implemented by AMAD. The experience and lessons learned from piloting these hubs will inform and influence the rollout of the eNAM platform across the state.

57. The AMAD will pilot an e-Negotiable Warehouse Receipt model for mitigating price risk for farmers who are accessing regulated markets and other storage points on the experience of the Maharashtra and Karnataka models. This will be carried out in collaboration with commercial banks (financial provider), professional collateral manager (operator), and selected go-downs and regulated markets (infrastructure provider). Pilot locations will be determined based on highest arrivals and growth potential. The activity will finance investment support for warehouse rehabilitation/development, coordination, farmers’ enrollment, and evaluation of the pilot. Both village-level (on-site) and regulated market-level (off-site) warehouses will be included in the activity.

58. The project will support the operation of the Agri-Business Promotion Facility (ABPF) to be established in the AMAD to foster backward and forward links in the value chains for agricultural products, facilitate access to finance for agribusiness entrepreneurs including specific value addition proposals, and also provide financial support for input supply/agro commodities procurement through banks. The key functions of the ABPF will be to (a) conduct various market studies and value chain analysis for major crops; (b) facilitate PPPs, forge direct buyer-seller relationships, and facilitate backward integration of agribusiness companies;(c) organize training, capacity-building, and other activities for agribusiness promotion; and (d) assist small and medium private entrepreneurs in developing business plans and proposals (not already done by an FPO consultant) to access government grant schemes and bank financing. It will provide business support and advisory to agri-entrepreneurs for two years. ABPF will encourage the PPP mechanism and facilitate crop-based approaches and disseminate and also pilot successful business models. This facility will provide management advice, financial planning, business networking, and links; implement business expansion plan; and provide other mentoring and management troubleshooting advice the beneficiaries might need. The detailed modalities for inviting, reviewing, and approving proposals from individual entrepreneurs, including eligibility criterion, are elaborated in the Project Implementation Plan. The AMAD will sign an agreement with a consortium of commercial banks to provide technical support to project beneficiaries to improve their access to finance.

59. The project will also provide support in strengthening the technical capacities of the AMAD staff, through hiring individual experts; trainings in agribusiness, agriculture marketing, supply chain management and other relevant areas; exposure and learning visits (domestic and international); and technical advisory services. The project will support incremental staff and operating costs.

Component C: Project Management Support

60. The MDPU established under the TN IAMWARMP will serve as the management and coordination unit for the project, with need-based modifications. The MDPU will be coordinating the departments for the preparation of the budget and catalyzing implementation of respective project budgets, SBDPs, and implementation progress reports. This component will finance M&E consultancy, equipment, and operating costs.

61. The MDPU will provide knowledge support on M&E, social and environmental safeguards, procurement, and fiduciary-related actions of the departments/IAs involved in the project besides capacity-building exercises of the staff of the MDPU and organizing orientation trainings to update field officers on various project issues.

62. This component will also support coordination of innovative application of ICT through several ways, including (a) needed enhancement of the GIS-enabled web-based Water Resources Information System and (b) continued support and necessary enhancement to the project MIS.

63. Individual project components (and subcomponents) will be implemented by the Departments of Water Resources (Lead Agency), Agriculture, Agriculture Engineering, Horticulture, Animal Husbandry, Fisheries, and Agriculture Marketing and Agribusiness, TNAU, TNFU, and TANUVAS in line with PIP.

Component Z: Contingency Response (US\$0 million)

64. This zero-cost component will finance eligible expenditures under the Contingent Emergency Response (CER) to provide immediate response to an eligible crisis or emergency as needed in Tamil Nadu. This contingency facility can be triggered through the formal declaration of an emergency by the government authority and upon a formal request from the GoTN to the World Bank through the DEA. In such cases, funds from an unallocated category or other project components will be reallocated to finance emergency response expenditures to meet an eligible crisis or emergency, as needed. The CER would include mitigation, recovery, and reconstruction following natural disasters such as severe droughts, floods, disease outbreaks, and landslides, among others. Implementation of this subcomponent will follow a detailed Contingent Emergency Response Implementation Plan (CERIP), subject to World Bank approval, that will be prepared as the case may be for each eligible crisis or emergency. The PIP shall include a CER Annex. As a condition of disbursement for this component, Tamil Nadu shall prepare and submit a CERIP in form and substance satisfactory to the Bank.

ANNEX 2: IMPLEMENTATION ARRANGEMENTS

COUNTRY: India

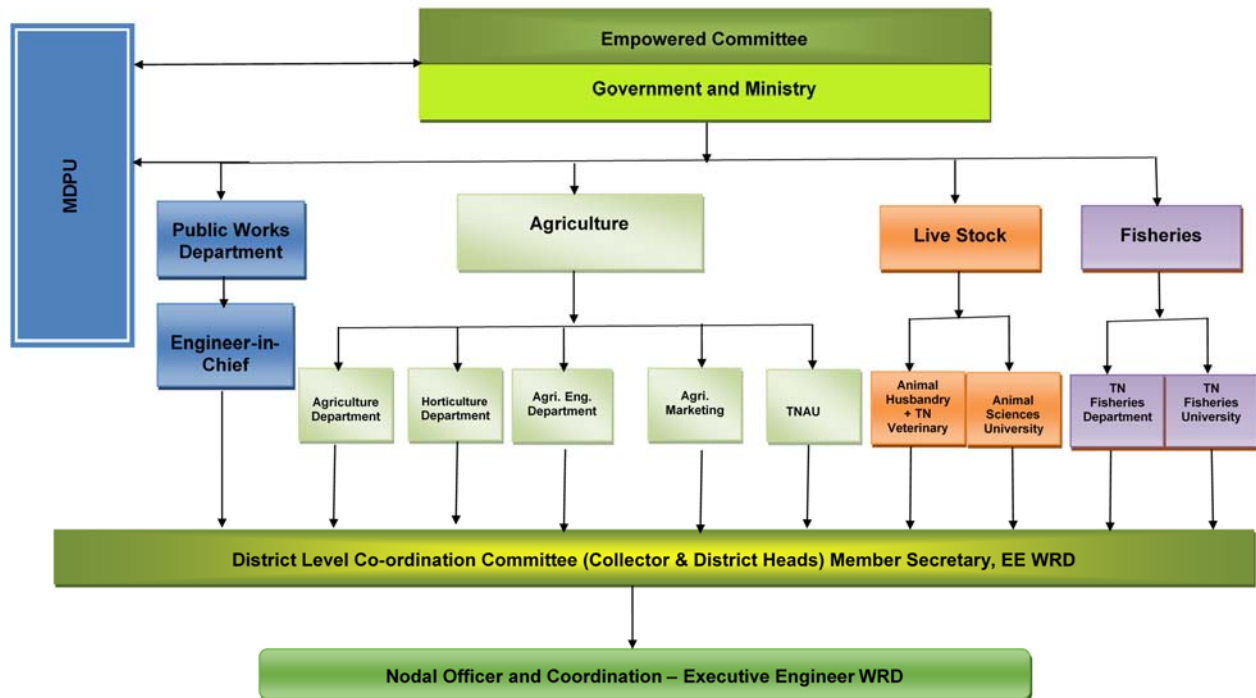
TAMIL NADU IRRIGATED AGRICULTURE MODERNIZATION PROJECT (P158522)

Project Institutional and Implementation Arrangements

1. The implementation arrangement of the project is fully integrated with the existing structures of participating line departments and agencies at the state and district levels to ensure strong project ownership by the GoTN and long-term sustainability of project impacts. In case of gaps in specific technical skills and institutional capacity, the project will engage outside (national and international) expertise.

2. The project management structure is described in the following paragraphs. As shown in the Organogram (figure 2.1), a Project Empowered Committee (PEC) chaired by the Chief Secretary and comprising the Principal Secretaries/Secretaries to the GoTN for Finance, Public Works, Agriculture, Animal Husbandry, and Fisheries will provide policy directions and guidance, promote interagency coordination, resolve major implementation issues, and review and approve major project proposals.

Figure 2.1. Organogram of Project Coordination



3. The MDPU, headed by the Project Director, is located in the WRD under the administrative control of the Principal Secretary, PWD. The MDPU provides operational management support and coordination. Nodal officers have been designated in all IAs for coordinating the implementation of project activities of their respective departments and agencies.

4. The MDPU will have representation in all disciplines that are part of the project and in procurement, FM, M&E, and safeguards aspects. These would include external specialists and the deputed line agency personnel. At present, several specialists deputed by the participating line departments and agencies work in the MDPU. Additional specialists in environment, social development, media and communications, market intelligence, GIS, and other areas will be recruited when the project becomes effective.

5. Individual interventions and activities will be implemented by ten line departments and agencies. The lead IA will be the WRD under the administrative jurisdiction of the Principal Secretary, PWD. Other IAs will be the Departments of Agriculture, Agriculture Engineering, Agriculture Marketing and Agribusiness, Horticulture, Animal Husbandry, and Fisheries, TNAU, TNFU, and TANUVAS. PCU have been established in all participating line departments and agencies to oversee the implementation of their specific activities. The key functions of each PCU are to prepare, implement, and monitor their AWP and coordinate with the MDPU. The PCU consists of a Nodal Officer and other staff in technical, procurement, finance, and safeguards areas, as needed.

6. **Implementation of Subcomponents A.1, A.3, and A.4.** These three subcomponents will be primarily executed by the WRD with support from other participating agencies in the formation and capacity building of the WUAs. The PIM Wing in the E-in-C's office will lead the efforts in formation and capacity building of the WUAs. Synergies with other participating agencies will be pursued. The PIM Wing will recruit individuals, experts, and civil society organizations (CSOs)/agencies for mobilizing the communities. The WUAs would be supported to create SWIKCs. Modernization of ICT across the WRD offices and select SWIKCs will be implemented by the E-in-C's office. The SWaRMA and the IWS under the WRD will be responsible for conducting policy analysis, expanding knowledge base, and providing technical support for water resource management. IMTI will undertake organizing capacity building and training of the department staff, WUAs, and farmers. Further, extensive change management interventions and training to tackle service delivery and convergence challenges will be carried out at all levels.

7. **Implementation of Subcomponent A.2 and Component B.** These components constitute the bulk of project investments involving modernization of tank systems, anicuts, water distribution canals, and OFD, as well as demonstration of improved technologies related to agriculture, horticulture, animal husbandry, and fisheries; organization of farmers into CGs and producer organizations/companies; training of staff, farmers, and fishers; renovation of markets; promotion of market links; and agribusiness development. These tasks will be organized at the sub-basin level.

8. An Executive Engineer of the WRD will be designated for each sub-basin (or a cluster of sub-basins where the command areas are small) as the Nodal Officer. A team of specialists deputed at the field level by the participating agencies will work with the Nodal Officer and prepare SBDPs. A nodal officer in the WRD will monitor and facilitate tank-related investments (Subcomponents A.2, A.3, and A.4).

9. The process of preparing the SBDPs, covering engineering and agriculture (crops, horticulture, livestock, fishery, and marketing) aspects, developed under the TN IAMWARMP, will be further refined and followed. The plans will be prepared in a participatory manner, with

the involvement of the field staff of all the IAs, WUAs, and other stakeholders in a joint walk-through of the irrigation infrastructure and consultation sessions in several villages in the sub-basin irrigation commands. Requirements of modernization of irrigation infrastructure are tailored to meet the needs of crop, horticulture, livestock, and fish production. Specific crop, horticulture, dairy, and fish production interventions appropriate for the sub-basin will be identified, and the specific agricultural, horticultural, dairy, and fish production and on-farm irrigation technology options, marketing strategies, and other interventions will be prioritized.

10. Each SBDP will be sent to the District Collector and PCUs of the participating departments and agencies for their review and inputs. These plans and designs will then be submitted by the respective line agencies to the MDPU for ensuring the multidisciplinary and integrated nature of the SBDPs. The MDPU acts as facilitator and will assist the sub-basin groups in preparing comprehensive plans.

11. Implementation of various activities contained in the SBDPs will be the responsibility of the concerned IA. The MDPU, through monthly and quarterly reports, will monitor the implementation of the integrated development plan. Individual departmental physical and financial progress will be monitored by the respective line departments and agencies and reported to the MDPU. The MDPU will also oversee the work of the M&E consultancy. Monitoring of project outputs and outcomes will be undertaken by an independent consultant under the guidance and supervision of the MDPU in addition to line agency internal monitoring and reporting systems.

12. Most of the physical investments are of an engineering nature, and all engineering designs will be subject to the technical sanction by the respective Regional Chief Engineer and the Chief Engineer (Plan Formulation). This process will be facilitated by the project cell located in the E-in-C's office.

13. In all aspects of plan preparation and implementation, participation of the private sector will be encouraged and suitable PPP models (for example, for market links) adopted for each sub-basin, including the active participation of CSOs/NGOs where there is strong presence of such organizations. On completion of activities in the sub-basin, an ICRR will be prepared.

14. The AMAD will be responsible for organizing farmers into CGs and larger producer groups and companies using service providers. It will also undertake modernization of selected markets and provide infrastructure and logistic support to producer companies, farmers, and agri-entrepreneurs.

15. Detailed organogram for the institutional arrangement required for the implementation, as described above, are available in the Project Implementation Plan.

Financial Management

16. Overall, project FM arrangements are adequate to account for and report on the project expenditure. The project envisages implementation by ten line departments/agencies: (i) WRD; (ii) Department of Agriculture; (iii) Department of Agriculture Engineering; (iv) AMAD; (v) Department of Horticulture; (vi) DoF; (vii) AHD; (viii) TNAU, (xi) TNFU; and (x) TANUVAS. Other than the activities to be carried out by the three universities and grants to FPO's all the line

departments operate under a common state FM framework, that is, budgeting, funds flow, internal control, accounting, reporting, and audit arrangements, which will be relied upon for the project FM arrangements.

17. **Budgeting.** The project activities would be budgeted under the respective demand for grants of line departments involved in the project; however, the AWP and budget proposals would be reviewed and approved by the MDPU before forwarding to the Department of Finance to ensure consistency and coordination of plans/budgets of the various departments. Consistent with the approach adopted in the closed TNIAMWARM project the project budget would be incorporated in the state budget by sub-basin using the minor head/subhead in the GoTN budget code. The budget provision proposed for the project for FY2017–18 is INR 710 million. This will be enhanced based on approved DPRs during the mid-year budget review process.

18. **Funds flow.** The GoTN has stopped the mechanism of Letter of Credit for PWD with effectiveness from April 1, 2016, and now, all payments are processed through the treasury and payments are made electronically. Analysis of payments in the initial phase of transition has indicated some delays in processing of payments, but these are not considered to be significant. Funds to universities and FPO's will be provided based on approved activity/business plans and agreement with FPO's and on submission of periodic financial reports.

19. **Accounting and internal control.** Books of accounts by the WRD and line departments will be maintained under the standard Government Accounting Systems, and monthly accounts will be rendered to the Auditor General (AG) (by the line departments through the treasury). While these are required to be reconciled with the AG (Account and Entitlements [A&E]) on a monthly basis, in actual practice, the reconciliation is only done on an annual basis. The annual financial statements would be prepared only after the reconciliation with the AG (A&E). Grants to the three universities and FPO's will be considered as advance for project purposes (even though the government accounting would record this as expenditure) and will be considered as expenditure only on receipt of quarterly expenditure and progress reports. Consistent with the practice under the closed TNIAMWARM project, the retention money on completed works contracts, which are accrued and accounted for as expenditure, will be considered as expenditure eligible for reimbursement.

20. The three universities will open a separate bank account for the project funds to keep it separate from the funds received from the GoTN funds for establishment costs and will consolidate the expenditures from their various field units and submit a consolidated report to the MDPU (through their respective administrative departments) on a quarterly basis.

21. **Finance staffing.** The staffing structure for the MDPU will include an Officer from the Treasury and Accounts Service (with professional qualification as a Chartered/ Cost Accountant), supported by a Superintendent from the WRD and two/three accountants either on deputation or on contract basis. The MDPU currently has one officer from the Treasury and Accounts Service deputed, and this arrangement is expected to continue. In each of the line departments, the Financial Advisor/Chief Accounts Officer will be responsible for financial reporting to the MDPU. Based on the experience of the TN IAMWARMP, an FM support consultant will be provided to some of the PCUs of the departments for coordination and collection of financial reports from

various sub-basins and District Development Offices, which at a peak are expected to be close to 500 disbursing units, and following up on addressing audit observations.

22. **Financial reporting.** The financial reporting (interim financial reports) under the project would be by the project components. These are closely linked to the budget codes agreed with the Department of Finance and would be based on the expenditures recorded by the treasury. AG (A&E) books of account. In line with adopting on state systems, withheld security deposits will be considered as eligible for reimbursement. The finance unit in the MDPU will have the responsibility of obtaining expenditure reports from the various line departments, validating it with the treasury reports (on a quarterly basis) and with the report from AG- A&E (on an annual basis) for preparing and submitting the consolidated interim and annual financial reports to the World Bank. The interim financial reports would be used as the basis for disbursement.

23. **Internal audit.** The project will have an internal audit to review that the internal control procedures (reconciliations, timely settlement of advances drawn, balances, sample physical verification of assets provided to WUA and grants to FPO's) and procurement procedures are being adhered to at the project level i.e by line departments at various levels including State, District, Divisions and identify bottlenecks, if any, in implementation.

24. **External audit.** The C&AG—who is considered as the acceptable auditor—through its offices in Tamil Nadu, will carry out the external audit of the project financial statements for the activities carried out by the line departments. For expenditures incurred by TNAU the audit will be carried out by the LFAD. The audits will be carried out according to the standard TOR for audit agreed between the DEA, C&AG, and the World Bank. The audit report will be submitted to the World Bank within nine months of the close of the financial year.

Table 2.1. Types of Audit Reports

IA	Audit	Auditor
GoTN Line Departments (other than TNAU, THFU and TANUVAS)	Project audit	C&AG
TNAU, TANUVAS and TNFU	Project audit	LFAD
Controller of Aid Accounts and Audit	Designated account	C&AG

Disbursements

25. **Disbursement arrangements.** Funds from the World Bank will be made available to the GoTN (through the GoI) under the standard terms of on-lending between the GoI and the states. The World Bank may provide an initial advance, which will be transferred by the GoI to the GoTN. The advance will be enhanced subsequently proportionate to the increased level of expenditure. Subsequent releases will be on reimbursement basis, based on the World Bank's share of eligible project expenditure.

Procurement

26. Procurement for the proposed project will be carried out in accordance with the World Bank's "Regulations". The project will be subject to the World Bank's Anticorruption Guidelines, dated October 15, 2006, and revised in January 2011 and July 2016.

27. **Project Procurement Strategy Development.** Extensive market analysis has been carried out for different packages of procurement and based on the findings, decisions on packages and lots are finalized for civil works to ensure adequate participation of bidders. Consultancy contracts are also framed based on market research and packaging of the same in terms of scope of services and period are decided. Based on the market experience, the project has also decided to implement (i) Government of India [GoI] procedure for procurement of Micro Irrigation; (ii) Government e Marketplace [GeM] and Framework Agreements for various Goods and Works procurement items. Based on risk and market analysis, the procurement plan has been prepared to set out the selection methods to be followed by the Borrower during project implementation in the procurement of goods, works, non-consulting and consulting services financed by the Bank as follows:

Departments	Category	Description	Approximate Estimated Cost / Duration / Section Methods and Market Approach Options
Water Resources Department	Works	Repairs to Tanks, Anicuts, Construction of Recharge wells, Improvements to Channel, Soil Testing etc.	US\$ 307 million Duration: 6-18 months RFB-National; RFQ-National
	Goods	Vehicles, Computers and accessories, Survey Equipment's, Lab testing equipment, software etc.	US\$ 23.5 million Duration: 3 months RFB-National, RFQ- National, Government e Marketplace; a few may be Direct Selection [DS]
	Consultancy	M&E, Internal Audit, Third party Technical Supervision, Environmental Assessment etc. and Research Activities, Capacity Building activities	US\$ 7.8 million Duration: 6-84 months QCBS, LCS, FBS, CQS, a few may be DS
Agriculture, Horticulture, TNAU	Goods	Quality seeds, Hybrid seeds, Micro Irrigation, Bio/Soluble Fertilizers, Micronutrients Nursery, Mulching sheets, Bio Boosters etc.	US\$ 54.70 million Duration: 3-12 months RFB-National, RFQ-National; GoI procedure for micro irrigation; Framework Agreements; Government e Marketplace; a few may be Direct Selection

	Consultancy	Impact study, Research activities, Capacity Building activities	US\$ 2.3 million Duration: 6-12 months QCBS, FBS, CQS, a few may be DS
Agri-Marketing	Works	Construction of Buildings for FPC, Repairs/Renovation of Regulated markets	US\$ 12.5 million Duration: 12-18 months RFB-National, RFQ- National
	Consultancy	Advisory Consultants, Market Chain and Value Chain Analysis, Regulated market automation, Capacity Building activities etc.	US\$ 4.7 million Duration: 6-36 months QCBS, FBS, CQS, a few may be Direct Selection [DS]
	Goods	Computers and accessories with installation, equipment needed for Regulated Market automation and FPCs etc.	US\$ 2.3 million Duration: 3-12 months RFB-National, RFQ-National; Government e Marketplace; a few may be Direct Selection
Agriculture Engineering Department [AED]	Works	Construction of Farm Ponds	US\$ 2.3 million Duration: 3-12 months RFB-National, RFQ-National; Framework Agreements; a few may be Direct Selection
Animal Husbandry Department [AHD]	Goods	Mineral Mixture, Mineral Licks, Fodder inputs, Drugs and Medicines, Veterinary Equipment, ICT, AI Inputs etc.	US\$ 5.5 million Duration: 3-12 months RFB-National, RFQ-National; Framework Agreements; a few may be Direct Selection
Fisheries Department	Works	Construction Fish Seed Farm /Breeders	US\$ 3.1 million Duration: 3-6 months RFQ-National, Framework Agreements
	Goods	Fish Feed, Fish kiosks,	US\$ 2.3 million Duration: 3-6 months RFQ-National, Framework Agreements
	Consultancy	Advice on different fish production models, etc.	US\$ 0.78 million Duration: 3-6 months QCBS, FBS, CQS, a few may be DS

Procurement and Contract Approaches:

Attribute	Selected Arrangement
Best and Final Offer [BAFO]	No
Negotiations	No

28. **STEP.** For all NCBs or larger consultancies, the project will implement STEP, a planning and tracking system, which would provide data on procurement activities and establish benchmarks. The details of the procurement activities, presently prepared in the Procurement Plan, would be transferred into the STEP system. Initial training on the operation of the STEP system has been provided to the procurement staffs of the IAs.

29. **E-procurement system.** The IAs will be using the NIC e-procurement system for all ICB/NCB procurements beyond a threshold of INR 50 million. The NIC e-procurement system assessment was carried out against the multilateral development banks' requirements and has been accepted for use for procurements under the World Bank funded projects. This is likely to increase the efficiency and transparency of procurement. All WRD packages are likely to use NCB.

30. **Procurement capacity.** The MDPU established under the previous project will serve as the management and coordination unit for the new project. Many of the officials of the MDPU and other ten line departments and agencies responsible for the implementation of different components/subcomponents were also involved in the last phase of the project and are conversant with World Bank procurement procedures and have gained substantial experience in the project implementation. However, as the project involves the implementation of new and innovative aspects, especially in those related to promoting climate-smart agriculture, enhancing farmers' access to market, and so on, this will be more challenging than the last project. Apart from delays in the procurement process, contract management delays and disputes are potential problem areas.

31. **Procurement planning.** For each contract to be financed by the loan, the different procurement methods or consultant selection methods to be used, the need for prequalification, estimated costs, prior review requirements, and timeframe will be reflected in the Procurement Plan to be agreed between the borrower and the World Bank team. The Procurement Plan, as agreed, will be uploaded in STEP. The Procurement Plan is currently being developed. Based on discussions with the GoTN, both the World Bank and the project have evolved and committed to the respective time frames for processing the procurement requirements at various stages.

32. **Retroactive financing.** The project has requested a retroactive financing of civil works, consultancies, and other eligible costs not exceeding 20 percent of total loan of US\$318.00 million. The payment made by the MDPU during the 12 months before the signing date for the contracts awarded following World Bank procurement procedures shall be eligible for retroactive financing.

33. **Procurement training.** Key staff may be sent for trainings at the Indian Institute of Management Lucknow/ASCI, Hyderabad/National Institute of Financial Management, Faridabad. The project could also avail of the free Massive Open Online Course on public procurement (www.procurementlearning.org) offered by the World Bank as well as the paid Professional Diploma in Public Procurement course delivered through the Charter of Public Procurement Studies.

34. **Procurement risk assessment.** Table 2.2 describes major procurement-related risks and the mitigation plan. The risk ratings have been decided based on both the probability of occurrence of various events as well as their likely impact. Based on the risk factors and mitigation measures,

the overall residual procurement risk rating for the project is determined as ‘Moderate’. The residual rating on procurement will be reviewed and updated periodically by the World Bank.

Table 2.2. Assessed Procurement Risks and Mitigation Measures (to be updated after PRAMS is completed)

Risk Factor	Initial Risk	Mitigation Measure	Completion Date	Residual Risk
Limited capacity and inefficiencies resulting in delays in procurement and contract management processes	Substantial	<ul style="list-style-type: none"> Use of skilled procurement staffs for handling procurement activities Monitoring through the Procurement Plan and quarterly reports Use of e-Procurement and contract management tools Participation in trainings and workshops 	Continuous from year 1	Moderate
Noncompliance with agreed procurement arrangements	Substantial	<ul style="list-style-type: none"> Training and hand-holding provided by the World Bank Prior and post reviews by the World Bank Internal and external audits 	Continuous from year 1	Moderate
External interference in the procurement process	Substantial	<ul style="list-style-type: none"> Disclosure of procurement-related information Appropriate handling of complaints 	Continuous from year 1	Moderate
Overall Risk	Substantial			Moderate

35. **Procurement methods.** Table 2.3 describes various procurement methods to be used for activities financed by the loan. These, along with agreed thresholds, will be reproduced in the Procurement Plan. The thresholds indicated in Table 2.3 apply to the initial 18-months of implementation period and are based on the procurement performance of the project; these thresholds may be subsequently modified.

Table 2.3. Procurement Methods

Procurement Approaches and Methods	Thresholds (US\$ Equivalent)
Open international (goods, IT, and non-consulting services)	>3 million
Open national (goods, IT, and non-consulting services)	>100,000 and up to 3 million
National request for quotation (goods/works)	Up to 100,000
Open international (works)	>40 million
Open national (works)	>100,000 and up to 40 million
Direct selection	No threshold; For goods/works/non-consulting services: According to paragraphs 6.8–6.10 of the Regulations; For consultants: According to paragraphs 7.13–7.15 of the Regulations
FA	For goods/works/non-consulting services: According to paragraphs 6.57–6.59 of the Regulations
Shortlist of national consultants	Up to 800,000

36. **Procurement prior-review thresholds.** The World Bank will prior review (thresholds are based on Moderate rating) the following contracts:

- (a) Works: All contracts more than US\$15 million equivalent

- (b) Goods and IT: All contracts more than US\$4 million equivalent
- (c) Non-consulting services: All contracts more than US\$4 million equivalent
- (d) Consultants: All contracts >US\$2 million equivalent for firms and >US\$400,000 equivalent for individuals

37. The above thresholds are for the initial 18-month implementation period; based on the procurement performance of the project, these thresholds may be subsequently modified. Even for large-value post review cases, the inputs of the World Bank on technical specifications/TOR will be obtained by the project. The prior review thresholds will also be indicated in the Procurement Plan. The Procurement Plan will be subsequently updated annually (or at any other time if required) and will reflect any change in the prior review thresholds. The prior review thresholds will be mutually reviewed during project implementation and modified based on the risk assessment.

38. In the case of contracts subject to prior review, the IA shall seek the World Bank's no objection before granting/agreeing to (a) an extension of the stipulated time for performance of a contract that either increases the contract price or has an impact on the planned completion of the project; (b) any substantial modification of the scope of works, goods, non-consulting services, or consulting services and other significant changes to the terms and conditions of the contract; (c) any variation order or amendment (except in cases of extreme urgency) that, singly or combined with all variation orders or amendments previously issued, increases the original contract amount by more than 15 percent; and (d) the proposed termination of the contract.

39. **National procurement procedure conditions.** National competition for the procurement of goods, works, and non-consulting services according to the established thresholds will be conducted in accordance with paragraphs 5.3–5.5 of Section V of the Regulations and the following provisions:

- (a) Only the model bidding documents agreed with the World Bank (and as amended from time to time) shall be used for bidding.
- (b) Invitations to bid shall be advertised in at least one widely circulated national daily newspaper (or on a widely-used website or electronic portal with free national and international access along with an abridged version of the said advertisement published in a widely circulated national daily, among others, giving the website/electronic portal details from which the details of the invitation to bid can be downloaded) at least 30 days before the deadline for the submission of bids.
- (c) No special preferences will be accorded to any bidder either for price or for other terms and conditions when competing with foreign bidders, state-owned enterprises, small-scale enterprises, or enterprises from any given state.
- (d) Extension of bid validity shall not be allowed with reference to contracts subject to the World Bank prior review without the prior concurrence of the World Bank (i) for the first request for extension if it is longer than four weeks and (ii) for all subsequent requests for extension irrespective of the period (such concurrence will be considered

by the World Bank only in cases of force majeure and circumstances beyond the control of the purchaser/employer).

- (e) Re-bidding shall not be carried out with reference to contracts subject to the World Bank prior review without the prior concurrence of the World Bank. The system of rejecting bids outside a predetermined margin or ‘bracket’ of prices shall not be used in the project.
- (f) To improve efficiency and transparency of small value purchases in Bank financed projects, the Bank has agreed to allow use of Government e-Market place (GeM) as follows: (i) Use of GeM is allowed in lieu of shopping up to US\$ 30,000 in catalog mode; (ii) Use of GeM is allowed in lieu of shopping up to US\$ 100,000, provided there are at least 3 suppliers for the item on GeM and the Purchaser uses RFQ (mini competition or bidding among suppliers) feature on GeM to discover the final price; (iii) In both above cases Borrowers will record their assessment on reasonableness of price; and (iv) GeM is not to be used in lieu of NCB..
- (g) No negotiations are conducted even with the lowest evaluated responsive bidders.

Table 2.4. Procurement Arrangement under the Contingent Emergency Response Component

Selection Methods	Procurement Regulations Clause Reference
Consulting services	
CQS	In accordance with Section VII, paragraphs 7.11 and 7.12 of the Regulations
FAs	In accordance with Section VII, paragraph 7.33 and Annex XV of the Regulations
Direct Selection	In accordance with Section VII, paragraphs 7.13–7.15 and 7.39 of the Regulations
Using a ‘pool of experts’ or a list of ‘preselected’ consulting firms may also be considered as an appropriate method for supporting counterpart agencies at various steps of project execution, including the procurement process and the preparation of TOR, shortlists, RFPs, and bidding documents. Remuneration and fees may be resolved at the time of pre-selection and prescribed in an FA.	
Procurement of goods, works, and non-consulting services	
RFQ	In accordance with Section VI, paragraph 6.7 and Annex XII paragraphs 5.1–5.3 of the Regulations
FAs	In accordance with Section VI, paragraphs 6.57–6.59 and Annex XV of the Regulations
Direct Selection	In accordance with Section VI, paragraph 6.8–6.10 of the Regulations
Simplification of pre- and post-qualification criteria. The pre- and post-qualification criteria requirements should be set so that to optimize the participation of available local or regional contractors and suppliers. In particular, the qualification requirements should match the qualifications of available and competent local and regional contractors and suppliers.	
Prequalified suppliers and contractors. Using lists of prequalified suppliers and contractors to whom periodic invitations are issued can also help accelerate the procurement process. Such approach would be consistent with Section VI, paragraphs 6.19–6.24 of the Regulations; but instead of being used for large and complex works or goods, it could be used for a large number of similar simple contracts of any size, as well as for procurement of commodities, per Section VI, paragraph 6.51 and Annex XII paragraphs 6.7 and 6.8 of the Regulations. Prequalification documents may use a simplified format that is acceptable to the World Bank. Suppliers and contractors would be asked to provide quotations for simple unit prices, as for commodities. Contracts should be awarded on a competitive basis and may be for a duration of up to two years, with a price escalation clause and the possibility of extension upon mutual agreement between the client and the supplier/contractor.	

40. **Domestic preference.** The provision of domestic preference will be applied in the evaluation of bids in accordance with Annex VI of the Regulations.

41. **Record keeping.** All records pertaining to the award of tenders, including bid notification, register pertaining to sale and receipt of bids, bid opening minutes, bid evaluation reports, and all correspondence pertaining to bid evaluation, communication sent to/with the World Bank in the process, bid securities, and approval of invitation/evaluation of bids would be retained by the IAs.

42. **Disclosure of procurement information.** The following documents shall be disclosed on the project/state websites: (a) a Procurement Plan and updates, (b) an invitation for bids for goods and works for all contracts, (c) request for expression of interest for selection/hiring of consulting services, (d) contract awards of goods and works procured following international and national procedures, (e) a list of contracts/purchase orders placed following shopping procedures on a quarterly basis, (f) a list of contracts following direct contracting (DC) on a quarterly basis, (g) a monthly financial and physical progress report of all contracts, and (h) an action taken report on the complaints received on a quarterly basis.

43. The following details shall be sent to the World Bank for publishing on the United Nations Development Business and the World Bank external website: (a) an invitation for bids for procurement of goods and works using open international procedures, (b) contract award details of all procurement of goods and works using open international procedure, and (c) a list of contracts/purchase orders placed following DC procedures on a quarterly basis.

44. Further, IAs will also publish on their websites any information required under the provisions of ‘suo moto’ disclosure as specified by the Right to Information Act.

45. **Oversight and monitoring by the World Bank.** All contracts not covered under prior review by the World Bank will be subject to post review during the implementation support missions (ISMs) and/or special post-review missions, including missions by consultants hired by the World Bank. To avoid doubts, the World Bank may conduct, at any time, Independent Procurement Reviews of all the contracts financed under the loan.

46. The high-risk and high-value procurements, if any, will be identified for increased contract management support and indicated in the Procurement Plan. The IA will develop key performance indicators (KPIs) for such identified contracts, and the KPIs would be monitored during actual execution of contracts. The World Bank team will provide additional due diligence and independent review of the contract performance of such identified procurements.

47. **Frequency of procurement supervision.** The World Bank will normally carry out ISMs, including review and support on procurement, on a semiannual basis. Mission frequency may be increased or decreased based on the procurement performance of the project.

Environmental and Social (including safeguards)

48. **Environmental management.** The proposed project will be implemented in 66 sub-basins of Tamil Nadu, including the areas experiencing droughts, floods, and other climate/natural shocks, particularly in coastal areas. Environment safeguard policies on Environment Assessment (OP4.01), Natural Habitats (OP4.04), and Pest Management (OP4.09) are triggered. An ESIA was

undertaken that identified the key risks associated with poor construction management and disposal of silt and other wastes and increased use of agro-chemicals, particularly pesticides. To reverse and manage any potential impacts, an ESMF has been developed and templates of EMPs for sub-projects on irrigation infrastructure rehabilitation have been prepared. The ESMF includes the following:

- A negative list of investments that the project will not finance
- A screening criteria for measuring the risk of sub-projects
- A Pest Management Plan, giving details of the process and action steps to improve pesticide use (procurement, handling, storage, use, and disposal)
- Template of the EMP for sub-projects on large irrigation infrastructure
- Environmental Codes of Practices and sector/theme-specific best practices
- An Integrated Pest and Nutrient Management approach for reducing the use of pesticides and other agro-chemicals
- An M&E strategy for safeguards
- A capacity-building and training plan for different stakeholders
- A communication strategy that will help the implementation of identified mitigation measures.

49. The ESIA was undertaken in a representative sample of 12 sub-basins covering all four agro-climatic zones of the state. The main objectives of the proposed Environmental Assessment were to (a) identify any potential, significant, long-term, and irreversible environmental impacts, including the identification of induced impacts, and (b) identify potential opportunities for enhancing environmental and social sustainability of project investments, including reducing GHG emissions, where possible. Consultations with key stakeholders were held as part of the Environmental Assessment at different locations. The ESIA does not envisage any irreversible, significant, and cumulative impacts, as the proposed investments are geographically widely spread out across the state.

50. The WRD, the primary IA, has developed some capacity in managing environmental impacts under the TN IAMWARMP, but needs further improvements when it comes to monitoring and reporting of environmental management aspects. Given that new engineers and officers would be in place, provisions have been made for providing adequate orientation and technical training for managing adverse environmental impacts and implementing recommended mitigation actions. The MDPU will hire a qualified and experienced full-time environmental expert to facilitate the implementation of the ESMF and adoption of EMPs. In addition, the E-in-C of the WRD will also have a qualified Environmental Engineer at headquarters and will designate Deputy Chief Engineer (DCE) as the Nodal Officer for the ESMF in each region. Similarly, for the line departments, the district Joint Director/Deputy

Director shall be designated as the Nodal Officer for safeguards. Based on the actual experience and requirement during implementation, additional support of external environmental experts to facilitate the implementation of mitigation actions will be taken. The MDPU will include a section on reporting on the suggested environmental indicators and on the progress of implementing the ESMF in the regular project progress reports every six months.

Social Development and Gender

51. The key beneficiaries of the project include farmers, female members of their families, and vulnerable sections of farming communities in the sub-basins. Mainstreaming of gender is one of the strengths of the project, and targeted focus of this would center on female members of the CBIGOs such as WUAs, CGs, FPOs, and those enjoying the benefits of Model Village-centered Convergence for Improved Service Delivery and also activities related to livestock development, fishery, and horticulture.

52. Because new CBIGOs are yet to be mobilized and organized and the existing ones are to be revived through fresh open and participatory processes of election and/or selection, no baseline data and actual cumulative number of project beneficiaries including by gender are available at present. Nevertheless, gender-disaggregated and other baseline data will be prepared as part of the organization of the CBIGOs and planning of project-related activities and monitored through the project implementation cycle. This will further increase project effectiveness and also project outcomes and outputs that would be measured through available quantitative cumulative data. The MDPU/E-in-C will have at least two Social Development Specialists as consultants to facilitate, plan, and monitor the social development and gender aspects of the project and document them for dissemination.

53. The beneficiary feedback/citizen engagement mechanism would be rooted on the CBIGOs. These CBIGOs would be horizontally linked at the levels of sub-basins and regions and federated at the project level. This would involve representatives of multi-level CBIGOs participating at project-level annual workshops to provide their feedback on project benefits and their impacts, particularly social impacts on women and suggestions for further improvement of the project effectiveness. In addition to the representatives of these CBIGOs, other beneficiaries of the project such as government and nongovernment stakeholders including those from the private sector related to agribusiness, marketing, training for skills development (TNAU, TNFU, and TANUVAS) will also participate in the feedback mechanism. The other key government stakeholders also include the SG&SWDC, SWaRMA, and the GoI's NABARD. Private sector entities include a chain of departmental stores also participating in marketing of agriculture/horticulture produce and products. All these stakeholders will actively participate in the project's annual beneficiary feedback workshops and provide feedback on project benefits and suggestions for further improvements, if necessary, so that the beneficiary feedback mechanism becomes an open and participatory process.

Social Safeguards

54. As far as social safeguards are concerned, the project will not trigger the World Bank's policy on Indigenous Peoples. The project, however, triggers the World Bank's policy on Involuntary Resettlement. The project will not resort to acquisition of private land and other assets under the provisions of the RFCTLAR&R Act. The policy is triggered primarily to deal with exceptional cases, where irrigation tanks with encroachment inevitably need rehabilitation, and the RPF has been prepared to deal with such circumstances. The sub-projects such as irrigation systems modernization will require land and to ensure that water-bodies/irrigation tanks are free from encroachments, public use, claims, and so on, the project would undertake public, participative, and transparent social screening involving all stakeholders, when the World Bank's social safeguard policies will also be explained. The WRD/PWD would designate an Assistant Engineer in each sub-basin, an Executive Engineer for each region, and another Executive Engineer located in Trichy but as a member of the E-in-C's office as the Nodal Officers for social safeguards. In addition, an Assistant Engineer in the Environmental Team will also be designated as Social Safeguards Nodal Officer. As part of institutional strengthening for social safeguards management, the project will also conduct training programs for staff of the PWD/WRD designated as Social Safeguards Nodal Officers at the levels of sub-basins, regions, and the headquarters. Such training programs will facilitate identification of vulnerable tanks, undertaking of public and participative social screening, their documentation and use for planning of sub-projects that require land, and inclusion of findings of social screening in DPRs/bid documents and preparation of RAPs, where required in accordance with the ESIA and RPF.

55. The initial ESIA was disclosed in-country on January 12, 2017, and the revised ESIA, RPF, and Pest Management Plan were disclosed on March 21, 2017, through InfoShop.

Grievance Redress Mechanism

56. The project will establish a multi-level feedback mechanism and GRM including the structures and processes at different levels. Grievances related to various aspects of participatory irrigation and water management will be at the regional level of Chief Engineers of the WRD while grievances related to other project activities will be redressed by the District Collector. In addition to these, there will be a departmental state-level GRM.

57. The structure and processes of these mechanisms including their scope, memberships, procedures for receiving, documenting grievances received, decisions to redress, communication of redress, periodicity of meetings to redress, right to resort to judicial system to seek redressal, and multi-level public disclosure have been included in the RPF that has been publicly disclosed.

World Bank Grievance Redress

58. Communities and individuals who believe that they are adversely affected by a World Bank (WB) supported project may submit complaints to existing project-level grievance redress mechanisms or the WB's Grievance Redress Service (GRS). The GRS ensures that complaints received are promptly reviewed in order to address project-related concerns.

Project affected communities and individuals may submit their complaint to the WB's independent Inspection Panel which determines whether harm occurred, or could occur, as a result of WB non-compliance with its policies and procedures. Complaints may be submitted at any time after concerns have been brought directly to the World Bank's attention, and Bank Management has been given an opportunity to respond. For information on how to submit complaints to the World Bank's corporate Grievance Redress Service (GRS), please visit <http://www.worldbank.org/GRS>. For information on how to submit complaints to the World Bank Inspection Panel, please visit www.inspectionpanel.org.

ANNEX 3: IMPLEMENTATION SUPPORT PLAN

COUNTRY: India

TAMIL NADU IRRIGATED AGRICULTURE MODERNIZATION PROJECT (P158522)

Strategy and Approach for Implementation Support

1. The World Bank's implementation support will focus on (a) monitoring the project implementation progress and evaluating results on the ground; (b) addressing the principal risks (technical, fiduciary, and environmental and social risks); and (c) providing the necessary technical advice in improving water management, agriculture production system, and postharvest management. The World Bank will review the project implementation and provide support on a regular basis. The project implementation will be reviewed by the World Bank's ISMs, conducted on a semiannual basis, or more frequently, as warranted. These will be complemented by visits by individual World Bank task team members, to follow up on specific issues, as needed.

2. **Technical.** The World Bank will provide required support through sector specialists and institutional specialists to the project on technical aspects. The implementation support will be provided through at least two ISMs in a year and through continuous exchange of correspondence and regular communication. Frequent use of telecommunication will be resorted to maintain close coordination among the World Bank team and the project staff.

3. **Procurement.** Implementation support will include (a) reviewing the procurement documents and providing timely no objection, (b) providing detailed guidance on the World Bank's Procurement Regulations to the project staff, (c) monitoring procurement progress against the detailed Procurement Plan, (d) review of contract management activities, and (e) identifying the capacity-building/training need for project staff and officials of the state power utilities on procurement processing and providing training, if required.

4. **Financial Management.** The ISM will review the project's FM system, including but not limited to accounting, reporting, and internal controls. The support will be provided through regular interactions, half-yearly ISMs, and thematic ISMs, if required.

5. **Environmental and social safeguards.** The World Bank safeguards specialists in the team will provide implementation support for monitoring the various activities for ensuring compliance with the World Bank's operational policies/procedures and the agreed readiness criteria for sub-projects related to environment and social safeguards aspects. The implementation support will be provided through regular interactions, half-yearly ISMs, and thematic review missions if required. The safeguard specialists will undertake field visits and also build the Project Management Unit capacity for safeguards management and implementation of mitigation action.

Implementation Support Plan and Resource Requirements

6. The project implementation support will be conducted through the following activities:

- At least two regular ISMs in a year during the project duration

- Intermediate technical missions by specialist, as needed
- Quarterly implementation progress reports (physical and financial progress) prepared by the MDPU
- A midterm review once the project is around halfway in project implementation/loan tenure, to review the progress and assess the need for any midcourse correction
- An ICRR at the end of the project to assess achievement toward the PDO and lessons learned

7. The Implementation Support Plan given in the tables below indicates the focus areas and skill needs required to provide implementation support during the initial and subsequent periods of the project. It will be reviewed regularly and updated as and when required during the implementation.

Table 3.1. Focus of Support to Project Implementation

Time	Focus	Skills Needed	Resource Estimate (US\$)
First 12 months (Year 1)	<ul style="list-style-type: none"> • Implementation arrangement • Validation of the Project Implementation Plan for year 1 • Quality control processes • FM systems functioning effectively • Procurement practices following the World Bank norms • Environment and social safeguards • Technical support on specifics of the Project Implementation Plan • M&E system and rollout of the EIMS 	<ul style="list-style-type: none"> • Water Resources Management Specialist • WUA Specialist • Construction Design Specialist • ICT Specialist • Agriculture Specialist • Fisheries Specialist • Livestock Specialist • Agribusiness Specialists • Social Safeguards • Environmental Safeguards • FM Specialist • Procurement Specialist • M&E Specialist 	230,000
Year 2	<ul style="list-style-type: none"> • Technical support for implementing activities per component and subcomponent • Routine FM and Procurement reviews • Management of safeguards and monitoring of implementation of safeguards-related measures • M&E • Adjustment of plan for implementing activities per component and subcomponent 	<ul style="list-style-type: none"> • Water Resources Management Specialist • WUA Specialist • Construction Design Specialist • ICT Specialist • Agriculture Specialist • Fisheries Specialist • Livestock Specialist • Agribusiness Specialists • Social Safeguards • Environmental Safeguards • FM Specialist • Procurement Specialist • M&E Specialist 	230,000

Time	Focus	Skills Needed	Resource Estimate (US\$)
Year 3	<ul style="list-style-type: none"> • Technical support for implementing • Routine FM and procurement reviews • Management of safeguards and monitoring of implementation of safeguards related measures • M&E • Conducting of midterm review 	<ul style="list-style-type: none"> • Water Resources Management Specialist • WUA Specialist • Construction Design Specialist • ICT Specialist • Agriculture Specialist • Fisheries Specialist • Livestock Specialist • Agribusiness Specialists • Social safeguards • Environmental Safeguards • FM Specialist • Procurement Specialist • M&E Specialist 	230,000
Years 4–6	<ul style="list-style-type: none"> • Adjustment to the Project Implementation Plan • FM and procurement reviews • Management of safeguards and monitoring of implementation of safeguards-related measures • M&E 	<ul style="list-style-type: none"> • Water Resources Management Specialist • WUA Specialist • Construction Design Specialist • ICT Specialist • Agriculture Specialist • Fisheries Specialist • Livestock Specialist • Agribusiness Specialists • Social Safeguards • Environmental Safeguards • FM Specialist • Procurement Specialist • M&E Specialist 	Year 4: 230,000 Year 5: 230,000 Year 6: 230,000
Year 7	<ul style="list-style-type: none"> • Technical support for implementing • Routine FM and procurement reviews • Management of safeguards and monitoring of implementation of safeguards-related measures • M&E • ICRR 	<ul style="list-style-type: none"> • Water Resources Management Specialist • WUA Specialist • Construction Design Specialist • ICT Specialist • Agriculture Specialist • Fisheries Specialist • Livestock Specialist • Agribusiness Specialists • Social Safeguards • Environmental Safeguards • FM Specialist • Procurement Specialist; • M&E Specialist • ICRR Task Team Leader and assessment team 	230,000
TOTAL COST			1,610,000

Table 3.2. Skills Mix Required

Skills Needed	Number of Staff Weeks	Number of Trips	Comments
Task Team Leader/Agriculture Economist	10	2	Based in Washington, DC
Co-Task Team Leader/Irrigation specialist	10	2	Based in Washington, DC
FM Specialist	4	2	Based in New Delhi
Procurement Specialist	4	2	Based in New Delhi
Agribusiness Specialist	4	2	Based in Washington, DC
WUA Specialist	4	2	Consultant, Based in the United Kingdom
Agriculture Specialist	4	2	Consultant, Based in New Delhi
Construction Design Specialist	6	2	Consultant, Based in New Delhi
Fisheries Specialist	4	2	Consultant, Based in Australia
Livestock Specialist	4	2	Consultant, Based in New Delhi
Water Resources Management Specialist	4	2	Based in New Delhi/Washington, DC
Agriculture/Irrigation Economist	6	2	FAO/World Bank CP
Environmental Safeguards Specialist	4	2	Based in New Delhi
Social Development Specialist	4	2	Based in New Delhi
ICT Specialist	2	2	Consultant, Based in New Delhi
M&E Specialist	4	2	—
Lawyer	2	1	Based in New Delhi
Operation Analyst	4	2	Based in Washington, DC
Team Assistant	10	—	Based in New Delhi
Team Assistant	10	—	Based in Washington, DC

Note: CP = Collaboration Program; FAO = Food and Agriculture Organization.

Table 3.3. Partners

Name	Institution/Country	Role
Vibhu Nayar	Principal Secretary, PWD, GoTN	Project Director
Takayuki Hagiwara	Chief, Asia and Pacific Service FAO Investment Centre, Rome, Italy	Technical support to the task team under the World Bank/FAO CP

ANNEX 4: ECONOMIC AND FINANCIAL ANALYSIS

Introduction

1. An Economic and Financial Analysis (EFA) of the project was undertaken to assess the economic soundness of the project and its likely impact on the beneficiaries. Specifically, the economic and financial impacts were estimated at two levels: (a) economic impact of the project from the point of view of society resulting from the overall investment project and (b) economic and financial impacts of tank rehabilitation and other productivity- and income-enhancing interventions on the primary beneficiaries, that is, small and marginal farmers.
2. A sensitivity analysis was conducted to assess the impact of changes in the main parameters affecting the economic outcome of the project as a result of (a) the main risks that have been identified in the project's risk analysis, (b) changes in project costs, and (c) changes in the expected benefits from improved irrigated agriculture and more diversified production systems.
3. The findings of the EFA are summarized in the following paragraphs. More details are provided in the EFA Appendix in the project file. The assumptions for the EFA provide an input into the GHG Assessment and both are linked to the project's Results Framework and its outcome indicators related to irrigated area, crop diversification, adoption of improved agronomic practices, and increased productivity, among others. It is expected that the EFA will be periodically updated as an integral part of the project's M&E system and as an input into the project evaluation at midterm and completion stages. Consequently, adequate financial and human resources for EFA during implementation have been included in the project design.

Project Area

4. The project will be implemented in 66 sub-basins that were not covered by the TN IAMWARMP in six agro-climatic zones. It is expected that, in total, 500,000 people primarily in poor and marginal farm households will benefit directly from the project. The modernization of irrigation infrastructure will focus on improving the bulk water delivery to irrigation systems through the rehabilitation and modernization of approximately 4,800 tanks, 477 anicuts, and supply channels and construction of artificial recharge well structures in 66 sub-basins covering 543,000 ha of land (see Table 4.1).

Rationale for Public Sector Financing

5. The expected project benefits will have significant public goods dimensions. The project will benefit large numbers of rural communities consisting of predominantly small and marginal farmers and the landless. Also, strengthening the capacities of government agencies and local community organizations such as WUAs dealing with agriculture, water, and related sectors will help the communities improve management of scarce resources and enhance the environment. Further, the expected policy and institutional reforms of the agriculture and water sectors are expected to promote improved performance of the sector and greater private sector investment, which will, in turn, spur broad economic growth and employment.

Table 4.1. Outreach and Phasing of Irrigation Modernization Investments in TNIAMP

Description		Unit	PY0	PY1		PY2	PY3	PY4	PY5	PY6	PY7	Total
			a	2017 ^b		2018	2019	2020	2021	2022	2023	
Number of sub-basins	New	Sub-basin	—	18		18	20	10				66
	Cumulative		—	18		36	56	66				66
Number of tanks rehabilitated	Annual	%	—	3		4	16	19	21	21	16	100
	Annual	Number	59	91		200	750	900	1,000	1,000	778	4,778
	Cumulative	Number	59	150		350	1,100	2,000	3,000	4,000	4,778	4,778
Average <i>ayacut</i> per tank	58.6	ha	—	—		—	—	—	—	—	—	—
<i>Ayacut</i> (total command area)	Annual	ha	—	8,793		11,724	43,966	52,759	58,621	58,621	45,607	280,093
	Cumulative	ha	—	8,793		20,517	64,483	117,243	175,864	234,486	280,093	280,093
Approximate average cost/ha	39,730	INR	—	—		—	—	—	—	—	—	—
	602	US\$	—	—		—	—	—	—	—	—	—
Approximate cost	Annual	INR, millions	—	349.4		465.8	1746.8	2096.1	2329.0	2329.0	1812.0	1,1128.2
	Cumulative	INR, Millions	—	349.4		815.2	2562.0	4658.1	6987.1	1	1,1128.2	1,1128.2
Gap area bridged	Annual	%	—	1		9	25	20	15	15	15	100
	Annual	ha	—	1,600		14,400	40,000	32,000	24,000	24,000	24,000	160,000
	Cumulative	ha	—	1,600		16,000	56,000	88,000	112,000	136,000	160,000	160,000
Increase in area fully irrigated	Annual	%	—	1		9	25	20	15	15	15	100
	Annual	ha	—	2,700		24,300	67,500	54,000	40,500	40,500	40,500	270,000
	Cumulative	ha	—	2,700		27,000	94,500	148,500	189,000	229,500	270,000	270,000
Number of anicuts rehabilitated	Annual	Number	—	15		20	75	90	100	100	77	477
	Cumulative	Number	—	15		35	110	200	300	400	477	477
Average <i>ayacut</i> per anicut	551.9	ha	—	—		—	—	—	—	—	—	—
<i>Ayacut</i>	Annual	ha	—	8,278		11,038	41,391	49,669	55,188	55,188	42,495	263,247
	Cumulative	ha	—	8,278		19,316	60,707	110,376	165,564	220,752	263,247	263,247
Approximate cost per ha	39,730	INR	—	—		—	—	—	—	—	—	—
Approximate cost	Annual	INR, millions	—	328.9		438.5	1644.5	1973.4	2192.6	2192.6	1688.3	1,0458.9
	Cumulative	INR, millions	—	328.9		767.4	2411.9	4385.3	6577.9	8770.6	1,0458.9	1,0458.9
Total <i>ayacut</i>	—	ha	—	—		—	—	—	—	—	—	543,340
Total cost	—	INR, millions	—	—		—	—	—	—	—	—	2,158.71
	—	US\$, millions	—	—		—	—	—	—	—	—	327.1

Note: a. Retroactive; b. ha and costs including PY0 investments.

Economic Analysis

6. **Economic benefits.** The main benefits of the proposed project are expected to come from (a) increase in area under production and productivity increases associated with improved irrigation systems; (b) diversification from food grains into high-value agriculture and livestock and fisheries activities; and (c) improved marketing, postharvest management, and value addition. In addition to the increases in productivity and production of higher-value crops, it is expected that establishing CGs and FPOs and facilitating PPPs will lead to increased incomes of beneficiaries due to (a) higher prices for the agricultural produce through better aggregation and new market channels, also resulting from improved market information; (b) potentially reduced input prices resulting from procurement by FPOs in bulk; and (c) increased value addition through FCSCs created by FPOs for postharvest activities, including cleaning grading, sorting, and processing. Furthermore, the project will support productive postharvest management infrastructure.

7. In addition, there will be significant benefits coming from improved resilience to climate change and positive nutritional effects associated with the diversification of production systems toward high-value agriculture crops and livestock and fisheries activities. It is expected that substantial employment will be generated due to the increased area under crop production and the resulting opportunities for on-farm labor, particularly for the landless poor who are mainly employed in agriculture as wage workers, as well as the handling, processing, and marketing of incremental production. The investments in irrigation modernization and rehabilitation works will generate further employment opportunities during the project implementation.

8. Major potential economic benefits also accrue through flood protection with regard to avoided losses and damages associated with the failure of tanks that may be affected without rehabilitation. These include (a) avoided repair costs of tanks breached as a result of floods; (b) on farm-benefits through avoided losses in agricultural production (including livestock and fisheries); (c) additional downstream benefits through avoided flood damage to dwellings and other infrastructure (for example, roads, bridges, and irrigation structures); and (d) avoided losses of human lives.

9. The economic analysis attempts to quantify the economic benefits resulting from Subcomponents A.2: Irrigation Systems Modernization; A.3: Participatory Irrigation Management; B.1: Agriculture Intensification and Diversification; B.2: Improving Alternative Livelihood Sources through Livestock and Inland Fisheries; and B.3: Agriculture Marketing, Value Addition, and Postharvest Management. No economic benefits have been calculated for Subcomponents A.1: Institutional Strengthening and Capacity Building for Water Management and A.4: Convergence for Improved Service Delivery, as well as Component C: Project Management Support, which are a precondition for the effective implementation of the project. However, the economic costs of all project subcomponents have been included in the overall project economic analysis. Given the uncertainties with estimating the potential benefits from flood protection, these were not included in the economic analysis; however, they were estimated separately on the basis of the assessment of the 2015 floods damages (see paragraph 16 and Table 4.7).

10. **Crop yields.** Table 4.2 provides an overview of the yield increases expected from the project for 23 major crops that have been analyzed.

Table 4.2. Overview of Crop Yield Assumptions (MT/ha)

Crop	Without Project (WOP)^a	With Project (WP)^b	Increase (%)
Agriculture Crops			
Paddy	3.39	4.25	25
Maize	4.94	6.20	26
Ragi	2.42	2.90	20
Minor millets	1.06	1.27	20
Pulses	0.52	0.60	15
Groundnut	2.45	2.83	16
Sugarcane	105.00	120.50	15
Horticulture and Tree Crops			
Brinjal	9.61	13.50	40
<i>Bhendi</i>	7.94	10.40	31
Tomato	13.02	18.50	42
Chilies - green	10.00	13.50	35
Chilies - dry	0.42	0.95	126
Onion	9.66	13.50	40
Gourds	12.00	17.00	42
Watermelon	30.00	42.00	40
Tuberose	15.00	19.00	27
Tapioca	33.86	42.00	24
Tissue Culture Banana	42.00	63.00	50
Mango	6.05	8.00	32
Guava	7.97	11.20	41
Pomegranate	7.20	9.00	25
AHD:			
Fodder crops	0.18	0.25	39

Note: a. Previous five years' average; b. In project year 7.

11. **Land use.** Table 4.3 shows the current land use within the targeted area (which is assumed to be the WOP scenario) as well as the assumptions for the land use if the project is implemented. It can be observed that the project, overall, would enable farmers to intensify cropping intensities, while increasing yields at the same time. Most of the increases in cultivated area are realized for horticulture, tree, and fodder crops while the cultivated rice area is reduced by 9 percent.

Table 4.3. Overview of Cultivated Area by Crop (Total Area per Year in ha)

Crop	Total per Year		Increase/Decrease	
	WOP	WP	(ha)	(%)
Agriculture Crops				
Paddy	349,117	317,070	-32,047	-9
Maize	27,025	30,500	3,475	13
Ragi	1,610	1,700	90	6
Minor millets	1,380	17,300	15,920	1,154
Pulses	43,125	58,400	15,275	35
Groundnut	20,930	27,150	6,220	30
Sugarcane	8,280	8280	-	-
Agriculture crops total	451,467	460,400	8,933	2

Crop	Total per Year		Increase/Decrease	
	WOP	WP	(ha)	(%)
Horticulture and Tree Crops				
Brinjal	9,775	47,800	38,025	389
<i>Bhendi</i>	10,580	47,900	37,320	353
Tomato	2,530	15,600	13,070	517
Chilies - green	3,565	6,750	3,185	89
Chilies - dry	85	220	135	159
Onion	60	660	600	1000
Gourds	2,070	6,600	4,530	219
Watermelon	120	4,280	4,160	3467
Tuberose	20	175	155	775
Tapioca	115	550	435	378
Tissue culture banana	4,370	3,000	-1,370	-31
Mango	690	1,500	810	117
Guava	750	1,100	350	47
Pomegranate	0	500	500	100
Horticulture/tree crops total	34,730	136,635	101,905	293
Agriculture/Horticulture/tree crops total	486,197	597,035	110,838	23
AHD:				
Fodder crops	9,200	58,362	49,162	534
TOTAL	495,397	655,397	160,000	32

12. **Impact on crop production.** As shown in Table 4.4, the project will result in considerable increases in crop production. While these increases are substantial for grains and pulses, they are particularly large for vegetables and fruits. Although a specific market analysis was not carried out, given the relatively small share of this incremental production of the total production in the state and the ever-increasing demand particularly in urban areas as a result of population increase and increases in income, it is safe to assume that incremental production resulting from the project will, in general, not depress producer prices. It is expected that the project will not only contribute to overall improved food security in Tamil Nadu but also to improved nutrition mainly through increased production and availability of nutrient-rich products, in particular, vegetables and fruits. These will be marginally consumed by producers themselves but more importantly by consumers in Tamil Nadu and neighboring states and also contribute to reducing some micronutrient deficiencies in India such as for Vitamin A.

Table 4.4. Estimated Project Impact on Crop Production

Crop	Total Production ^a (MT)		Incremental Production ^a	
	WOP	WP ^b	(MT)	(%) ^c
Agriculture Crops				
Paddy	1,183,507	1,347,548	164,041	14
Maize	133,504	189,100	55,596	42
Ragi	3,896	4,930	1,034	27
Minor millets	1,463	21,971	20,508	1,402
Pulses	22,425	35,040	12,615	56
Groundnut	51,279	76,835	25,556	50
Sugarcane	869,400	997,740	128,340	15
Horticulture and Tree Crops				
Brinjal	93,938	645,300	551,362	587
<i>Bhendi</i>	84,005	498,160	414,155	493
Tomato	32,941	288,600	255,659	776
Chilies - green	35,650	91,125	55,475	156

Crop	Total Production ^a (MT)		Incremental Production ^a	
	WOP	WP ^b	(MT)	(%) ^c
Chilies - dry	36	209	173	485
Onion (small)	580	8,910	8,330	1,437
Gourds	24,840	112,200	87,360	352
Watermelon	3600	179,760	176,160	4,893
Tuberose	300	3,325	3,025	1,008
Tapioca	3,894	23,100	19,206	493
Tissue culture banana	183,540	189,000	5,460	3
Mango	4,175	12,000	7,825	187
Guava	5,978	12,320	2	106
Pomegranate	0	4,500	4,500	100
AHD:				
Fodder crops	1,656	14,591	12,935	781

Note: a. Per year; b. At full development (Year 7); c. As percentage of WOP production.

13. **Livestock production.** The livestock interventions will target about 132,000 farm households in 66 sub-basins of which 30 percent will be women (39,600 female farmers). Assuming an average of two cows per farmer, the project will cover around 264,000 cows resulting in improved productivity and animal health and reduced infertility problems. Furthermore, the project's AI program will conduct a total of 1.1 million AIs during the project life, which are expected to result in a total of 115,000 improved heifers (female calves becoming productive). Benefits from increased milk production are estimated at US\$32.0 million during the project life while the incremental value of improved heifers during the same period amounts to US\$5.3 million. Other benefits of the project interventions estimated include reduction in mastitis and infertility incidences. These benefits have been reflected in the benefits from increased milk production and are, therefore, not added to the overall economic analysis. However, it is estimated that the expected reduction in mastitis incidences will accrue savings to the farmers valued at around US\$2.3 million while the infertility reduction program will result in savings of around US\$1.9 million during the project life. Table 4.5 provides an overview of the estimated benefits from the project's livestock program. Further details are provided in the Table 4.14. While the economic analysis is based on the total incremental value of dairy production, regardless whether milk is sold or domestically consumed, it should be noted that, if a household consumes 30 percent of the incremental milk produced through the project interventions, it corresponds to the Indian Council of Medical Research²⁵ recommended per capita milk consumption for meeting the protein requirements of two adults and two children in the family through milk, providing also a rich source of vitamins A, B, and D and calcium, phosphorous, zinc, potassium, iodine, and magnesium.

Table 4.5. Livestock Benefits - Summary

Number of farmers		132,000
- of which female farmers (30%)		39,600
Average number of cows per farmer		2
Total number of cows directly covered		264,000
Milk production		
Incremental net income during project life ^a	INR, million	1227.0
	US\$, thousands	18,314
Average incremental net income per farmer per year	INR	9,739

²⁵ Food and Nutrition Security Planning Commission, 2010. Dietary Guidelines of Indians.

	US\$	145.4
Heifer production		
Incremental value of improved heifers during project life	INR, crores	32.0
	US\$, thousands	4,776
Average incremental value of improved heifers per farmer per year	INR	433
	US\$	6.5
Mastitis prevention		
Total saving by mastitis prevention during project life	INR, crores	14.5
	US\$, thousands	2,163
Average saving from mastitis prevention in cows per farmer per year	INR	157
	US\$	2.3
Infertility reduction		
Total saving from animals with reduced infertility during project life	INR, crores	11.9
	US\$, thousands	1,773
Average saving from infertility reduction in cows per farmer per year	INR	129
	US\$	1.9
Total incremental livestock benefits during project life	INR, crores	172
	US\$, thousands	25,771
Average incremental livestock benefits per farmer per year	INR	10,372
	US\$	154.90

Note: a. Including income from calves, manure, and cull cow (proportional).

14. **Fisheries.** The project will promote aquaculture in 25,000 ha of tanks including 10,000 ha long seasonal tanks (with water availability > 6 months) and 15000 ha short seasonal tanks (with water availability < 6 months). Furthermore, aquaculture will be introduced in 1000 farm ponds (100 ha), including ponds excavated by the Agriculture Engineering Department in the sub-basins under the project, primarily for rainwater harvesting and storage. With an average pond area of 1,000 m², the total area of pond aquaculture amounts to 100 ha. The project will promote climate-resilient fish production systems including (a) introduction of fast-growing fish varieties, (b) establishment of fish hatcheries, (c) production of low-cost, quality fish feed, (d) promotion of suitable market links for better access to markets, and (e) promotion of increased fishing efficiency, by providing effective equipment. This will be complemented by related capacity building on aquaculture for farmers and institutions. At full development, annual fish production is estimated at 8,950 MT with an annual net profit, to the producers of around US\$7.2 million.

15. The increase in fish production is expected to contribute significantly to a more diversified and protein-rich diet of the targeted population. Table 4.6 provides an overview of the estimated benefits from the various fish production systems. Further details are provided in the Table 4.13. The project's support to fish seed production and establishment of fish kiosks to improve access to markets and ensure that nutritionally rich fish reaches the consumers in fresh condition and in a hygienic manner are a precondition for realizing the expected benefits. Therefore, benefits from these interventions have not been estimated separately.

Table 4.6. Fisheries Benefits – Summary

Description	Unit	Production System			Total
		Pond	Tank - Long Season	Tank - Short Season ^a	
Area	ha	100	10,000	15,000	25,100
Production per ha	kg	6,000	420	338	6,758
Total production per year	MT	600	4,200	5,070	9,870

Description	Unit	Production System			Total
		Pond	Tank - Long Season	Tank - Short Season ^a	
Total net profit per year	INR, thousands	31,260	251,000	268,333	550,593
	US\$, thousands	466	3,748	4,004	8,218

Note: a. Different production systems weighted.

16. **Benefits from flood protection.** These potential benefits are difficult to quantify in economic terms due to the uncertainties with regard to the occurrence of erratic weather events such as floods and difficulties estimating their impacts. However, an attempt was made to estimate benefits from flood protection based on the assessment of the 2015 floods damages and losses. The summary is presented in Table 4.7 while detailed calculations are provided in the project file. Based on the conservative assumption that a major flood with similar losses and damages occurs only once in four years and assuming that rehabilitation under the TNIAMP protects the tanks from damages as effectively as under the TN IAMWARMP, the estimated average annual damages and losses avoided amount to INR 7,470 million (US\$110 million).

Table 4.7. Estimated Flood Protection Benefits from Tank Rehabilitation

Description		INR, millions	US\$, millions
Estimation of damages from 2015 floods			
Number of tanks rehabilitated in affected districts under the TN IAMWARMP of which none breached	5,000	—	—
Number of tanks in affected TN IAMWARMP districts not rehabilitated	7,200	—	—
- of which no. of tanks that breached in 2015 floods	1,462	—	—
% of tanks not rehabilitated that breached	20.3	—	—
Total repair cost assessed for 1,462 tanks^a		7500.0	110.3
Estimation of avoided damages and losses due to the TNIAMP tank rehabilitation^b			
Estimated average annual avoided repair costs for tanks breached	—	1231.0	18.1
Estimated average annual crop loss and reclamation cost	—	1152.0	16.9
Estimated average annual value of livestock and poultry losses for new tanks breached	—	13.0	0.2
Estimated average annual value of fish loss in tanks affected	—	50.0	0.7
Estimated average value of dwellings damaged in a year (compensation)	—	4994.0	73.4
Estimated average annual government compensation for human lives lost ^c	—	31.0	0.5
Estimated total average annual damages and losses avoided	—	7471.0	109.9

Note: a. Based on Flood Rehabilitation and Damage Report 2015 by the Department of Agriculture;

b. Assumptions: Likelihood of major flood occurring in any given year: 25 percent. Estimated average percentage of tanks affected by major flood that breached: 20 percent.

c. Real value of human lives lost not estimated.

17. **Economic costs and assumptions.** The financial total project costs have been converted to economic costs, which exclude taxes and duties and price contingencies, using the Costab software. The analysis was carried out for a 20-year period, which is the estimated project life including the 7-year project implementation period. It is based on 2017 constant prices, and a discount rate of 10 percent was assumed. The Indian rupee was used as the unit of account and the official exchange rate of INR 66 to US\$1 (average January–April 2017) was applied when converting to U.S. dollars. The economic benefits were quantified on the basis of (a) crop, livestock, and fishery budgets prepared for the abovementioned crops and livestock/fishery activities and (b) the areas under cultivation as presented in Table 4.3 as well as the assumed

coverage of the livestock and fishery activities (see tables 4.5 and 4.6). Economic enterprise budgets were derived from the financial enterprise budgets (see Financial Analysis below) by including the imputed (opportunity) costs of family labor. While any taxes or subsidies were removed, a standard conversion factor of 1.0 was applied to all commodities and inputs, suggesting that their financial prices reflect economic values. All prices are current (April 2017) prices. Details are provided in the project file. The economic net profits per hectare or unit were subsequently multiplied by the project coverage presented in tables 4.3, 4.5, and 4.6 to determine the total benefits in the WP and WOP scenarios. The differences between the net benefits in the WP and WOP scenarios were then calculated to determine the economic impact of the changes in cropping patterns and crop yields, as well as changes in livestock and fisheries production as described above and in the Financial Analysis below. Net incremental benefits were calculated for each project year, taking into account net incremental income and total project costs and including O&M costs of tanks and irrigation structures rehabilitated under the project. It was assumed that O&M costs would amount to 5 percent of the cumulative investment costs under Subcomponent A.2 per year, and these costs will have to be incurred if the future benefits of the investment in irrigation are to be sustained.

18. **Economic viability and sensitivity analysis.** The EIRR of the project over a 20-year period for the base case is 25.4 percent with an NPV of INR 24.38 billion (US\$363.8 million) at a discount rate of 10 percent. The results of sensitivity analysis show that the project remains economically viable also in the case of adverse changes in project costs and benefits. A reduction in project benefits by 40 percent results in an EIRR of 13.3 percent while an increase in project costs by 20 percent combined with a reduction in project benefits by 20 percent and a one-year delay of benefits reduces the EIRR to 12.5 percent. Putting a monetary value on the potential GHG mitigation benefits with regard to reductions in GHG emissions and increased carbon sequestration, which is estimated at 5.7 million tCO_{2e} over the project life of 20 years, the base case EIRR increases to 27.0 percent, assuming a price per tCO_{2e} of US\$30, which has been suggested for the analysis of other World Bank-funded projects.

Table 4.8. EIRR and Sensitivity Analysis

Scenario			EIRR (%)	ENPV (US\$, thousands)	ENPV (INR, millions)
Base Case			25.4	363,841	24,377
Base Case (GHG) ^a			27.0	476,080	20,103
Changes (Base Case without GHG)			—	—	—
Project Costs	Incremental Benefits (%)	Benefits Delayed by	—	—	—
+20%	—	—	20.6	289,014	19,364
+40%	—	—	17.1	214,188	14,351
	-20	—	19.7	216,246	14,488
	-40	—	13.3	68,652	4,600
+20%	-20	—	15.5	141,420	9,475
+40%	-40	—	6.9	-81,001	-5,427
Base Case		1 year	19.7	20.2%	273,708
		2 years	16.3	16.7%	191,770
		3 years	13.6	13.9%	117,281
		1 year	12.5	69,314	4,644
+20%	-20	2 years	10.1	3,764	252
		3 years	8.1	-55,828	-3,740

Scenario			EIRR (%)	ENPV (US\$, thousands)	ENPV (INR, millions)
Switching values ^b			—	—	—
Costs	+	97%	—	—	—
Benefits	-	49%	—	—	—

Note: ENPV = Economic Net Present Value.

a. GHG mitigation benefits valued at US\$30/tCO₂e.

b. Percentage change in cost and/or benefit streams to obtain an EIRR of 9 percent, that is, economic viability threshold.

19. **Impact on employment.** Agricultural employment on the benefiting farms is expected to rise by about 6 percent or about 3.2 million person days per year at full development in year 8. This is equivalent to around 13,200 additional full-time jobs (at 240 person days per year). Considering the increase in total area under crop production by 32 percent, the increase is rather low, which is due to the large reduction in the area of paddy and the reduced labor requirements for SRI in the WP scenario. As can be seen from Table 4.9, it is estimated that family labor requirements are actually increasing by 19 percent while hired labor decreases by 1 percent. This breakdown is based on estimated share of hired/family labor in current crop budgets. For households with limited availability of family labor, it is expected that there is sufficient hired labor available, particularly among the landless poor who are mainly employed in agriculture as wage workers and who would thereby benefit from significant employment opportunities. In addition, it can be expected that substantial employment will also be generated for handling incremental production, processing, and marketing as well as during project implementation for rehabilitation of tanks and irrigation structures.

Table 4.9. Project Impact on Employment in Agriculture and Horticulture Crop Production

		Annual Employment			
		WOP	WP	Increase/Decrease	%
Family labor - person days	Thousands	17,632,660	20,996,635	3,363,975	19
Family labor - number of jobs ^a	Thousands	73,469	87,486	14,017	19
Hired labor - person days	Thousands	35,595,617	35,407,060	-188,557	-1
Hired labor - number of jobs ^a	Thousands	148,315	147,529	-786	-1
Total labor - person days	Thousands	53,228,277	56,403,695	3,175,418	6
Total labor - number of jobs^a	Thousands	221,784	235,015	13,231	6

Note: Based on estimated share of hired/family labor in current crop budgets.

a. At an average of 240 person days per year per job.

20. **Fiscal impact.** The Government's contribution to the project amounts to 29.9 percent of project investment costs (INR 8.99 billion or US\$136.3 million). This contribution represents around 1.2 percent of the estimated government budget for the departments and TNAU involved in the project over the seven-year implementation period (based on the total combined average annual budgets for the last three years). In addition, it is estimated that the Government would have to bear around 80 percent of the O&M cost of the tanks and irrigation structures rehabilitated under the project amounting to around INR 866 million (US\$13.1 million) annually at full development while the WUAs would have to cover the remaining 20 percent. The Government's estimated share of annual O&M costs at full development represents around 3.1 percent of the average annual budget of the WRD over the last three years. In the medium to long term, a

substantial positive fiscal impact of the project is expected, mainly due to (a) increased output, income, and employment, also resulting in increased tax revenues, and (b) multiplier effects due to increased disposable income of project beneficiaries, resulting in increased demand for goods and services. Some foreign exchange earnings/savings can also be expected from an increase in exports and/or a reduction in imports.

Financial Analysis

21. The financial analysis has been carried out for the seven agricultural crops, 15 horticultural crops, and fodder crops presented in tables 4.2 and 4.3, as well as for the livestock and fisheries interventions described above. The detailed crop and enterprise budgets are presented in the project file, providing an overview of the production system including the key production parameters, farmer organization, investments, and marketing channel. The main financial performance measures, including gross margin, net profit, return to family and total labor, and the return on investment are calculated for the present, Future Without Project (FWOP), and Future With Project (FWP) scenarios. If applicable, the investment costs, including required working capital and annual depreciation, are calculated. The main results are summarized in tables 4.10–4.14 below:

Table 4.10. Financial Analysis of Main Agriculture Crops

	Crop	Paddy	Maize	Finger Millet (Ragi)	Minor Millets	Pulses	Groundnut	Sugarcane
Production Period	(Months)	4	3	4	4	3	4	12
Output -quantity (kg)^a	FWOP	3,390	4,943	2,420	1,055	520	2,450	105,000
	FWP	4,250	6,200	2,900	1,270	600	2,825	120,500
	Increase (%)	25	25	20	20	15	15	15
Gross margin (INR)^b	FWOP	29,318	53,843	13,250	3,533	15,745	57,255	245,588
	FWP	45,545	71,882	22,933	5,915	25,535	81,161	351,336
	Increase (%)	55	34	73	67	62	42	43
Net profit (INR)^c	FWOP	27,896	53,177	12,611	2,918	15,128	56,183	243,179
	FWP	44,043	71,186	22,259	5,273	24,931	80,035	348,720
	Increase (%)	58	34	77	81	65	42	43
Return to family labor - per person day^d (INR)	FWOP	797	1,064	407	112	1,009	1,479	2,763
	FWP	1,421	1,695	824	211	2,078	2,354	5,535
	Increase (%)	78	59	103	88	106	59	100
Return to total labor - per person day^e (INR)	FWOP	376	682	272	171	539	648	1,292
	FWP	639	996	407	208	907	936	2,235
	Increase (%)	70	46	50	22	68	44	73

Note: a. Primary product; b. Output – total variable costs (including hired labor); c. Gross margin – interest charges – taxes – depreciation; d. Net profit / number of family labor days; e. (Net profit + cost of hired labor) / total number of labor days (hired and family).

Table 4.11. Financial Analysis of Main Horticulture Crops

	Crop	Brinjal	Bhendi	Tomato	Green Chilies	Gourds	TC Banana	Tuberos e
Production period	(months)	6	4	5	6	6	12	36
Output - quantity (kg)^a	FWOP	9,611	7,942	13,022	10,000	12,000	42,000	15,000
	FWP	13,500	10,400	18,500	13,500	17,000	63,000	19,000
	Increase (%)	40	31	42	35	42	50	27
Gross margin (INR)^b	FWOP	36,083	42,740	32,562	32,408	58,034	192,370	92,358
	FWP	95,825	67,477	122,250	116,108	103,502	388,876	132,010
	Increase (%)	166	58	275	258	78	102	43
Net profit (INR)^c	FWOP	35,389	42,271	31,831	31,417	57,355	187,203	54,691
	FWP	74,866	46,847	101,487	95,077	82,486	353,909	96,843
	Increase (%)	112	11	219	203	44	89	77
Return to family labor - per person day^d (INR)	FWOP	786	1,281	707	683	1,366	4,070	2,378
	FWP	1,920	1,378	2,537	2,319	2,229	10,409	4,842
	Increase (%)	144	8	259	240	63	156	104
Return to total labor - per person day^e (INR)	FWOP	409	584	385	398	707	1,442	1,046
	FWP	718	595	1,218	1,238	992	2,954	2,534
	Increase (%)	76	2	216	211	40	105	142

Note: a. Primary product; b. Output – total variable costs (including hired labor); c. Gross margin – interest charges – taxes – depreciation; d. Net profit / number of family labor days; e. (Net profit + cost of hired labor) / total number of labor days (hired and family).

Table 4.12. Financial Analysis of Main Tree Crops (Average during Production Cycle per Year)

	Crop	Mango	Guava	Pomegranate
Output -quantity (kg)^a	FWOP	6,049	7,968	7,200
	FWP	8,000	11,200	9,000
	Increase (%)	32	41	25
Gross margin (INR)^b	FWOP	42,135	63,770	85,100
	FWP	97,990	143,791	295,340
	Increase (%)	133	125	247
Net profit (INR)^c	FWOP	41,512	62,489	83,756
	FWP	91,126	135,153	278,222
	Increase (%)	120	116	232
Return to family labor - per person day^d (INR)	FWOP	1,258	2,155	2,538
	FWP	2,680	4,360	8,183
	Increase (%)	113	102	222
Return to total labor - per person day^e (INR)	FWOP	470	662	750
	FWP	680	1,056	1,655
	Increase (%)	45	60	121

Note: a. Primary product; b. Output – total variable costs (including hired labor); c. Gross margin – interest charges – taxes – depreciation; d. Net profit / number of family labor days; e. (Net profit + cost of hired labor) / total number of labor days (hired and family).

Table 4.13. Financial Analysis of Fisheries (per Area Unit and Production Period)

Production System	Pond	Tank - Long Season	Tank - Short Season ^a
Area (ha)	0.1	1	1
Production period (months)	5.5	12	6
Output - quantity (kg)	600	420	338
Output - revenue (INR)	66,000	42,000	33,778
Intermediate inputs (INR)	31,500	5,500	6,889
Gross margin (INR)^b	31,800	25,100	17,889
Net profit (INR)^c	31,260	25,100	17,889
Hired labor (person days)	9	54	30
Family labor (person days)	150	0	0
Return to family labor - - per person day^d (INR)	208	NA	NA
Return to Total Labor - per person day^e (INR)	214	676	896
Total area (ha)	100	10,000	15,000

Note: a. Different production systems weighted; b. Output – Total Variable Costs (including hired labor); c. Gross margin – interest charges – taxes – depreciation; d. Net profit / number of family labor days; e. (Net profit + cost of hired labor) / total number of labor days (hired and family).

Table 4.14. Financial Analysis of Livestock Production

Description	Unit	WOP	WP	Increase/Decrease
Average number of farmers	Number	132,000	—	—
Total number of cows per farmer	Number	2	—	—
Total number of cows directly covered	Number	264,000	—	—
Milk production				
Average milk yield per cow per year	kg	780	1,500	720
Value of milk per liter	INR	27	30	3.0
Value of milk per cow per year	INR	21,060	45,000	23,940
Total average revenue including other sources per year ^a	INR	33,138	60,745	27,607
Production cost per liter	INR	25.6	28.5	2.9
Production cost per cow per year	INR	19,949	42,687	22,738
Net income per cow per year	INR	13,189	18,058	4,869
Average net income per farmer per year	INR	26,378	36,117	9,739
Heifer production				
Total number of AIs carried out during project life ^b	Number	—	1,079,040	—
Average number of AIs required per calf produced	Number	—	3.30	—
Total number of calves produced	Number	—	326,982	—
Number of female calves produced	Number	—	163,491	—
Female calves becoming productive	%	—	70	—
	Number	—	114,443	—
Value of one heifer	INR	10,000	12,000	2,000
Incremental value of improved heifers	INR, millions	—	347	—
Average incremental value of improved heifers per farmer per year	INR	—	433	—
Mastitis prevention				
Mastitis incidence per year	%	30	—	—
Total clinical mastitis cases per year	Number	79,200	—	—
Number of animals to be intervened	Number	—	50,000	—
Number of subclinical cases expected to be intervened/saved	30%	—	15,000	—
Cost of one clinical mastitis case	INR	9,663	9,663	0
Total saving by mastitis prevention	INR, crores	—	14.5	—

Description	Unit	WOP	WP	Increase/ Decrease
Average saving from mastitis prevention per farmer per year	INR	—	157	—
Infertility reduction				
Infertility incidence per year	%	30	15	-15
Total infertility cases	Number	79,200	39,600	-39,600
Inter-calving period	Days	450	390	-60
Feeding and management costs during dry period per day	INR	50	50	0
Average saving from avoided feeding during dry period per animal	INR	—	3,000	—
Total saving from animals with reduced infertility	INR, crores	—	11.9	—
Average saving from infertility reduction per farmer per year	INR	—	129	—

Note: a. Including from calves, manure, and cull cow (proportional). b. AI.

Greenhouse Gas Appraisal

22. **A GHG appraisal** of the TNIAMP was carried out using the EX-ACT, which quantifies the net carbon balance with regard to tCO₂e, resulting from GHGs emitted or sequestered, as a result of the project compared to the WOP scenario. The project leads to estimated annual climate change mitigation benefits of 284,000 tCO₂e when compared to a business-as-usual baseline scenario. This is equivalent to annually reduced GHG emissions per hectare of 1.3 tCO₂e. After 20 years, a time frame commonly used for project GHG accounting in agriculture, GHG mitigation benefits amounting to a reduction of 5.7 million tCO₂e will be generated. In addition to the achievement of the directly targeted PDOs, the TNIAMP thus also provides intermediate GHG emission reductions as a co-benefit of project implementation.

23. **GHG impacts by project component.** The most sizeable GHG mitigation benefits are generated by the scaling up of AWD within flooded rice production systems. By limiting the total flooding period during the season, methane emissions are reduced by an estimated 486,000 tCO₂e per year. Improved land management practices on annual cropland are estimated to lead to soil carbon sequestration due to increased organic matter inputs. Annual GHG benefits are estimated at 54,000 tCO₂e. Increased fertilizer and pesticide consumption, however, leads to augmented GHG emissions of 269,000 tCO₂e per year. The project increases total consumed quantities of fertilizers due to increases in both the physically cropped area as well as the cropping intensity, defined as the number of cropping seasons per year. On average, in addition, the application rates of fertilizer products per cultivated hectare increase moderately due to project interventions. In this regard, strong variation between crop types exists. Fuel use for earth works as part of the rehabilitation and new establishment of tanks and other irrigation infrastructure is another contributor to GHG emissions of the project activities. An estimated 608 tCO₂e per year are emitted due to such fuel consumption for a period of eight years, while the construction of new irrigation systems leads to an additional 21,000 tCO₂e per year over the same period. Other less sizeable GHG impacts of the project actions stem from improved livestock feeding and breeding practices (GHG reductions of 23,000 tCO₂e/year) and the establishment of new perennial crop plantations (GHG reductions of 14,000 tCO₂e/year).

24. **Project impacts on GHG emissions intensity.** GHG emissions intensity is defined as the amount of GHG emissions per unit of agricultural output produced. In the context of increased food demand from an augmented population, GHG emissions intensity can identify whether the expansion of agricultural production is achieved through a sustainable intensification pathway. Due to the impacts of the project on GHG emissions per hectare, yield, and postharvest losses, 17 of the analyzed annual production systems reduce their GHG emissions intensity, while only one production system (dry chilies) worsens the ratio of GHG emissions to the output produced. For perennial cropping systems, instead, GHG emissions intensities worsen slightly, because most of the systems previously did not utilize any significant fertilizer quantities. Overall, the technology and production practices promoted by the TNIAMP can be characterized as strongly augmenting the efficiency of agricultural production and contributing to a sustainable intensification process. To identify the overall GHG mitigation benefits from reduced GHG emissions intensity, it can be stated that conventional production systems would have emitted an additional 1.88 million tCO_{2e} every year to produce the same level of output as the project-supported production systems. In general, all 23 production systems analyzed are expected to improve yields and reduce postharvest losses due to the project. Eleven annual production systems are expected to reduce GHG emissions per hectare on average by 0.99 tCO_{2e}/ha across systems, while seven annual production systems are expected to increase GHG emissions per hectare on average by 0.94 tCO_{2e}/ha. The overall reductions in GHG emissions intensity result from the combined impact of these processes.

25. Overall, the TNIAMP can thus be characterized as achieving moderate benefits with regard to the total net GHG emissions in the project area, when compared to the GHG emissions under the status quo. This result is achieved as a positive externality of targeting direct PDOs. While total net GHG emissions per year do not change radically, the project instead provides strong benefits in the form of reduced GHG emissions intensity of production. From a climate change mitigation viewpoint, the TNIAMP reaches ambitious objectives with regard to transforming production systems toward sustainable intensification. Following recent (2014) World Bank guidance, these benefits have been valued at a social value of carbon of US\$30 per tCO_{2e}. At full development, annual benefits are, therefore, valued at US\$8.5 million. (See Report “Climate Change Mitigation Assessment of the Tamil Nadu Irrigated Agriculture Modernization Project” in the project file for further details).

ANNEX 5: MAPS

Figure 5.1. Major River Basin Groups in Tamil Nadu



Figure 5.2. Sub-basins of TNIAMP

