

Document of  
The World Bank

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IMPLEMENTATION COMPLETION AND RESULTS REPORT  
(TF-56519, TF-56520, TF-56521 and TF-56522)

ON A

GLOBAL ENVIRONMENTAL FACILITY GRANT

IN THE AMOUNT OF US\$6.9 MILLION

TO THE

THE KINGDOM OF THAILAND, THE PEOPLE'S REPUBLIC OF CHINA,  
THE SOCIALIST REPUBLIC OF VIETNAM, AND  
THE UNITED NATIONS' FOOD AND AGRICULTURE ORGANIZATION

FOR A

LIVESTOCK WASTE MANAGEMENT IN EAST ASIA PROJECT

June 26, 2012

Social, Environment and Rural Development Sector Unit  
Sustainable Development Department  
East Asia and Pacific Region

## CURRENCY EQUIVALENTS

(Exchange Rate Effective June 26, 2012)

Currency Unit	=	Local Currencies
US\$1	=	Yuan 6.36
US\$1	=	TBH 31.81
US\$1	=	VND 20,925

## FISCAL YEAR

January 1 – December 31 for China, Vietnam, FAO  
October 1 – September 30 for Thailand

## ABBREVIATIONS AND ACRONYMS

AD	Anaerobic digestion	MARD	Ministry of Agriculture and Rural Development (Vietnam)
ADB	Asian Development Bank	MOA	Ministry of Agriculture (China)
AWI	Area Wide Integration	MOAC	Ministry of Agriculture and Cooperatives (Thailand)
BOD	Biological Oxygen Demand	MOF	Ministry of Finance (China, Thailand, Vietnam)
CAS	Country Assistance Strategy	MONRE	Ministry of Natural Resources and the Environment (Thailand, Vietnam)
CDM	Clean Development Mechanism	MTR	Mid-term review
CER	Certified Emission Reduction	N	Nitrate or Nitrogen
COD	Chemical Oxygen Demand	NCB	National Competitive Bidding
COP	Code of Practice	NPV	Net Present Value
CoSiMo	Cost of Compliance Simulation Model	NSC	National Steering Committee
DLD	Department of Livestock Development (Thailand)	O&M	Operation and maintenance
DST	Decision Support Tool	OCC	Opportunity Cost of Capital
EMP	Environmental Management Plan	OP	Operational Program
EMDP	Ethnic Minority Development Plan	P	Phosphate or Phosphorus
ERDI	Energy Research Development Institute of Chiangmai University (Thailand)	PAD	Project Appraisal Document
ESW	Economic and Sector Work	PCD	Pollution Control Department (Thailand)
FAO	Food and Agriculture Organization of the United Nations	PDO	Project Development Objective
FIRR	Financial Internal Rate of Return	PIP	Project Implementation Plan
FM	Financial Management	PIU	Project Implementation Unit (Vietnam)
FMR	Financial Monitoring Report	PLG	Project Leading Group (China)

GEF	Global Environment Facility	PLO	Provincial Livestock Office (Thailand)
GEO	Global Environment Objective	PMO	Project Management Office
GHG	Greenhouse gas	QAG	Quality Assurance Group
GIS	Geographic Information System	RCG	Regional Coordination Group
GMI	Global Methane Initiative (=M <sub>2</sub> M)	RFO	Regional Facilitation Office
IBRD	International Bank for Reconstruction and Development	RPF	Resettlement Policy Framework
ICR	Implementation Completion and Results Report	SEMD	Strategy for Ethnic Minority Development
INT	Institutional Integrity	SEPA	State Environmental Protection Agency (China)
IO	Intermediate Outcome	SPP	Standing Pig Population
IP	Implementation Progress	STRAW	Support for the Treatment and Recycling of Animal Waste
ISR	Implementation Status and Results	TAO	Tambon Administrative Organization (Thailand)
IW	International Waters	tCO <sub>2</sub> e	Carbon Dioxide equivalent
IWLEARN	International Waters Learning Exchange and Resource Network	UNDP	United Nations Development Program
LEAD	Livestock, Environment and Development Initiative of FAO	USEPA	United States Environmental Protection Agency
M&E	Monitoring and Evaluation		

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**EAST ASIA AND PACIFIC**  
**Livestock Waste Management in East Asia Project**

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<b>A. Basic Information</b>			
Country:	East Asia and Pacific	Project Name:	Livestock Waste Management in East Asia Project
Project ID:	P079610	L/C/TF Number(s):	TF-56519,TF-56520,TF-56521,TF-56522
ICR Date:	06/26/2012	ICR Type:	Core ICR
Lending Instrument:	SIL	Borrower:	CHINA, THAILAND, VIETNAM, FAO
Original Total Commitment:	USD 7.00M	Disbursed Amount:	USD 6.86M
Revised Amount:	USD 6.86M		
<b>Environmental Category: B</b>		<b>Global Focal Area: I</b>	
<b>Implementing Agencies:</b>			
Food and Agriculture Organization of the United Nations (FAO)			
Department of Livestock Development, Ministry of Agriculture and Cooperatives, Thailand			
Department of Agriculture, Guangdong Province, China			
Ministry of Natural Resources and Environment, Vietnam			
<b>Cofinanciers and Other External Partners:</b>			

<b>B. Key Dates</b>				
Process	Date	Process	Original Date	Revised / Actual Date(s)
Concept Review:	10/08/2003	Effectiveness:	09/06/2006	09/12/2006
Appraisal:	07/01/2005	Restructuring(s):		
Approval:	03/21/2006	Mid-term Review:	01/15/2009	01/20/2009
		Closing:	12/31/2010	12/31/2011

<b>C. Ratings Summary</b>	
<b>C.1 Performance Rating by ICR</b>	
Outcomes:	Satisfactory
Risk to Global Environment Outcome	Low or Negligible
Bank Performance:	Satisfactory
Borrower Performance:	Satisfactory

<b>C.2 Detailed Ratings of Bank and Borrower Performance</b>			
<b>Bank</b>	<b>Ratings</b>	<b>Borrower</b>	<b>Ratings</b>
Quality at Entry:	Satisfactory	Government:	Satisfactory
Quality of Supervision:	Satisfactory	Implementing Agency/Agencies:	Satisfactory
<b>Overall Bank Performance:</b>	Satisfactory	<b>Overall Borrower Performance:</b>	Satisfactory

<b>C.3 Quality at Entry and Implementation Performance Indicators</b>			
<b>Implementation Performance</b>	<b>Indicators</b>	<b>QAG Assessments (if any)</b>	<b>Rating</b>
Potential Problem Project at any time (Yes/No):	No	Quality at Entry (QEA):	None
Problem Project at any time (Yes/No):	No	Quality of Supervision (QSA):	None
GEO rating before Closing/Inactive status	Satisfactory		

<b>D. Sector and Theme Codes</b>		
	<b>Original</b>	<b>Actual</b>
<b>Sector Code (as % of total Bank financing)</b>		
Agricultural extension and research	1	10
Animal production	69	60
Central government administration	20	20
Sub-national government administration	10	10
<b>Theme Code (as % of total Bank financing)</b>		
Pollution management and environmental health	40	40
Rural policies and institutions	40	40
Rural services and infrastructure	20	20



<b>E. Bank Staff</b>		
<b>Positions</b>	<b>At ICR</b>	<b>At Approval</b>
Vice President:	Pamela Cox	Jeffrey S. Gutman
Country Director:	John A. Roome	David R. Dollar
Sector Manager:	Magdolna Lovei	Mark D. Wilson
Project Team Leader:	Jiang Ru	Weiguo Zhou
ICR Team Leader:	Jiang Ru	
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## F. Results Framework Analysis

### Global Environment Objectives (GEO) and Key Indicators(as approved)

The overall Project development objective is to reduce the major negative environmental and health impacts of rapidly increasing concentrated livestock production on the open waters and thus on the people of East Asia. Its global environment objective is to reduce livestock-induced, land-based pollution and environmental degradation of the South China Sea.

### Revised Global Environment Objectives (as approved by original approving authority) and Key Indicators and reasons/justifications

#### (a) GEO Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
<b>Indicator 1 :</b>	National (Guangdong in China) SPP (standing pig population) implementing improved (level 1 and level 2) livestock waste management practices			
Value (quantitative or Qualitative)	35% in China (Guangdong); 25% in Thailand; and 35% in Vietnam	50% in China (Guandong); 40% in Thailand; and 50% in Vietnam.		China: 55% Thailand: 40% Vietnam: 55%
Date achieved	08/01/2005	12/31/2010		12/31/2011
Comments (incl. % achievement)	The values achieved are 110%, 100% and 110% respectively against the target values for China (Guangdong), Thailand and Vietnam at the time of their respective project closing dates: China 12/31/2010; Vietnam, 6/30/2011; and Thailand 12/31/2011.			
<b>Indicator 2 :</b>	Spatial distribution plans for livestock production and nutrient management plans for livestock waste developed and implemented.			
Value (quantitative or Qualitative)	No such plans existed in Guangdong, Thailand and Vietnam.	Outlined, drafted, tested, revised, completed/implemented respectively in Years 1 to 5 by each country (Guangdong for China).		Developed and implemented.
Date achieved	08/01/2005	12/31/2010		12/31/2011
Comments (incl. % achievement)	Spatial distribution plans developed in the 3 countries and implemented first in selected areas by their respective closing dates. Implementation is ongoing. Nutrient management plans for livestock waste was integrated in farm specific mini-PIPs.			
<b>Indicator 3 :</b>	Reduced livestock production-related emissions of pollutants in surface water systems in the project areas.			
Value	None	Based on M&E		Monitored in an

(quantitative or Qualitative)				orderly, organized and effective manner.
Date achieved	08/01/2005	12/31/2010		12/31/2011
Comments (incl. % achievement)	No targets were set due to the project's programmatic approach. Achieved emission reductions were more effectively than the appraisal's benchmark option (152%, 58% and 280% more effective for P, N and BOD). Monitoring done by professional entities.			

**(b) Intermediate Outcome Indicator(s)**

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
<b>Indicator 1 :</b>	Requests for project intervention received from farmers and local communities outside demonstration sites.			
Value (quantitative or Qualitative)	None	0, 10, 50, 100, 200 in Years 1 to 5.		A total of 679 requests received.
Date achieved	08/01/2005	12/31/2010		12/31/2011
Comments (incl. % achievement)	Over 300% achieved. The demand for project participation was very high in all three countries.			
<b>Indicator 2 :</b>	Reduction in nitrogen, phosphorus, BOD, COD and E. Coli bacteria discharge on demonstration sites once the livestock waste management systems were established.			
Value (quantitative or Qualitative)	None	Meet national standards for Guangdong and Thailand, 80% for Vietnam in Year 5.		Achieved in all three countries.
Date achieved	08/01/2005	12/31/2010		12/31/2011
Comments (incl. % achievement)	100% achieved for all three countries. Note that 80% reduction was used for Vietnam at appraisal as the country had no national standards on livestock waste discharges.			
<b>Indicator 3 :</b>	Number of standing pig populations covered by farms adopting level 2 livestock waste management systems with project support.			
Value (quantitative or Qualitative)	0	92,000, 203,000 and 122,000 respectively for Guangdong, Thailand and Vietnam in Year 5.		262000, 286000 and 105000 respectively for Guangdong, Thailand and Vietnam at the time of their respective closing dates.
Date achieved	08/01/2005	12/31/2010		12/31/2011

Comments (incl. % achievement)	Achieved 285%, 141% and 86% respectively for Guangdong, Thailand and Vietnam. In total, the overall targeted value was surpassed by 57%. Low achievement in Vietnam was due to high project subsidies needed to mobilize farm participation.			
<b>Indicator 4 :</b>	A replication strategy is developed by each country.			
Value (quantitative or Qualitative)	None	Finalized in Year 5 by each country.		Finalized by all three countries.
Date achieved	08/01/2005	12/31/2010		12/31/2011
Comments (incl. % achievement)	100% achieved. The Replication Strategy reports were submitted by the three countries' respective closing dates.			
<b>Indicator 5 :</b>	Public awareness campaign on environmental and human health issues related to livestock production to reach local population in project areas.			
Value (quantitative or Qualitative)	0	50% in Year 5.		75% in Year 5.
Date achieved	08/01/2005	12/31/2010		12/31/2011
Comments (incl. % achievement)	150% achieved. Campaigns were carried out effectively and in various forms to reach local population in project areas and beyond including: brochures, posters, training, TV programs, documentaries, DVD, operations manuals, newsletters, project websites.			
<b>Indicator 6 :</b>	Overall human health risk posed by pathogens, antibiotics and other residues at discharge level reduced.			
Value (quantitative or Qualitative)	100%	50% in Year 5		Overall human health risk posed by pathogens was reduced by about 80%.
Date achieved	08/01/2005	12/31/2010		12/31/2011
Comments (incl. % achievement)	Partially achieved. Based on surveys/monitoring, pathogens related health risk was greatly reduced at discharge level in all three countries. However, the project had no impact on the use of antibiotics and other residues in animal feeds, as was planned.			
<b>Indicator 7 :</b>	Number of project staff trained, number of workshop and study tours carried out.			
Value (quantitative or Qualitative)	None	Based on Master Plans		Completed in accordance with the Master Plans.
Date achieved	08/01/2005	12/31/2010		12/31/2011
Comments (incl. % achievement)	Over 100% achieved with additional funding from Global Methane Initiative (GMI) and the governments of the three countries.			
<b>Indicator 8 :</b>	M&E system in place and number of periodic evaluations of project outputs and impacts carried out.			
Value (quantitative or Qualitative)	0	2 in each year and in each country.		In total, 31, 20 and 12 reports prepared respectively by

				China, Thailand and Vietnam.
Date achieved	08/01/2005	12/31/2010		12/31/2011
Comments (incl. % achievement)	Over 300%, 200% and 120% achieved in China, Thailand and Vietnam by the respective closing dates. Monitoring reports, periodic evaluations carried out, monitoring results reported in semi-annual progress reports. Overall evaluation done in country ICRs.			
<b>Indicator 9 :</b>	Decision support tools (DST) and related training packages delivered by the Regional Facilitation Office (RFO).			
Value (quantitative or Qualitative)	None	0, 2, 5, 6, 6 in Years 1 to 5 respectively.		3 DSTs and 4 training packages delivered.
Date achieved	08/01/2005	12/31/2010		12/31/2011
Comments (incl. % achievement)	Partially achieved. STRAW (Support for Treatment and Recycling of Animal Waste), not done by June 30, 2011, is being finalized by FAO with its own funding. A draft available. Spatial Planning served in Thailand as FAO got no request from China, Vietnam.			
<b>Indicator 10 :</b>	Networks of government officials, private sector industries, scientists and farmers established and operating in Vietnam, Thailand and China, as well as other countries bordering the South China Sea.			
Value (quantitative or Qualitative)	None	Operating in Year 5.		Operating in China, Thailand, Vietnam and some other countries.
Date achieved	08/01/2005	12/31/2010		12/31/2011
Comments (incl. % achievement)	Country-specific networks, organized and established by the PMOs were operating in various forms. A regional network was established by the FAO including additional 7 countries. All 3 countries participated in GEF funded regional/global networks.			
<b>Indicator 11 :</b>	Requests for support for training and extension programs received from other countries, and provinces in China.			
Value (quantitative or Qualitative)	None	0, 1, 3, 5, 5 in Years 1 to 5 respectively		A cumulative total of 22 by Year 5.
Date achieved	08/01/2005	12/31/2010		12/31/2011
Comments (incl. % achievement)	Over 150% achieved. Many countries including Cambodia, Indonesia, Laos, Malaysia, the Philippines, Singapore and South Korea, as well as 15 provinces in China requested support for training and extension programs.			

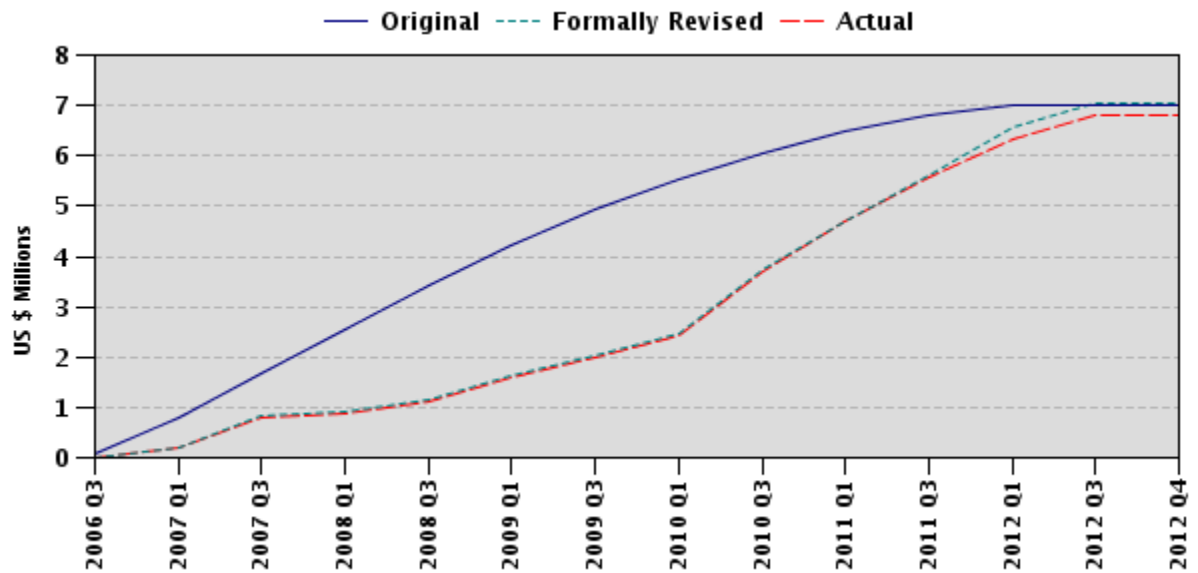
## G. Ratings of Project Performance in ISRs

No.	Date ISR Archived	GEO	IP	Actual Disbursements (USD millions)
1	05/19/2006	Satisfactory	Satisfactory	0.00
2	06/25/2007	Satisfactory	Satisfactory	0.81
3	06/30/2008	Satisfactory	Satisfactory	1.45
4	06/30/2009	Satisfactory	Satisfactory	2.31
5	05/15/2010	Satisfactory	Moderately Satisfactory	3.93
6	06/13/2011	Satisfactory	Satisfactory	6.04

## H. Restructuring (if any)

Not Applicable

## I. Disbursement Profile



# 1. Project Context, Global Environment Objectives and Design

## 1.1 Context at Appraisal

1.1.1 **Country Background.** The project addresses one of the most significant and rapidly growing sources of land-based pollution of the South China Sea – environmentally unsustainable intensive and geographically-concentrated livestock production in China, Thailand and Vietnam. Without wide-scale preventive action, livestock production would become the single most important source of organic and chemical pollution of the main catchments that drain into the South China Sea, an international body of water that harbors the world’s most biologically diverse shallow-water marine ecosystems.

1.1.2 The East Asia region is the world leader in pig and poultry production, with China, Thailand and Vietnam accounting for over 53 percent of pig production and 28 percent of chicken production globally. These shares were expected to grow during project implementation and continue to do so over the coming decades, fuelled by a growing population, rising incomes and rapid urbanization. This, coupled with economic and technological evolution in the sector, has led to increasing concentration of livestock production, resulting in large-scale industrial production accounting for an increase of about 80 percent of the total livestock production in Asia since 1990. These intensive production farms are principally located around major urban centers that lie in, or close to, the coastal regions of the South China Sea.

1.1.3 Concentrated livestock production has become a major threat to human health, as evidenced by the Severe Acute Respiratory Syndrome and Avian Influenza outbreaks, and is also responsible for causing significant local, regional and global environmental damage, particularly to freshwater and marine aquatic systems. At appraisal, waste management practices in the three participating countries consisted of discharging directly, or indirectly, untreated wastes into streams and rivers that flow into the South China Sea. The main sector issues identified were:

- (a) the lack of demonstrated technical solutions with which to address the problem of nutrient imbalance associated with concentrated livestock production; and
- (b) the lack of policy instruments and replication strategies to promote sound livestock waste management practices.

1.1.4 **Rationale for Bank Assistance.** The project was consistent with the objectives of the Bank’s Country Assistance Strategies (CAS) in China, Thailand and Vietnam and in line with a global piece of analytic economic and sector work (ESW) being undertaken by the World Bank on livestock externalities. In line with the World Bank’s role as an Implementing Agency of the Global Environment Facility (GEF), the project was seen to contribute to the strategic priorities of the GEF’s International Waters (IW) Focal Area, in particular IW-1 which sought to catalyze financial resource mobilization for the implementation of reforms and which stressed reduction measures through elaboration of Trans-boundary Diagnostic Analysis and Strategic Action Plans, as well as IW-3, which promoted innovative demonstration of barrier removal to sustainable industrial livestock management. The project also fit with the objectives of the GEF Contaminant-based

Operational Program, whose goals were to demonstrate how to address land-based pollution; demonstrate ways to overcome barriers to best practice in limiting contamination of international waters; address an imminent and high priority threat, on which neighboring countries want to take collaborative action; underscore action towards pollution prevention versus remediation; leverage private investment; involve close cooperation with other GEF agencies; and show potential for regional and global replication. In addition, the project aims were aligned with the objectives and eligibility criteria of the proposed GEF-World Bank Strategic Partnership Investment Fund for Land-based Pollution Reduction in the Large Marine Ecosystems of East Asia, that was being proposed at the same time. The project also contributed to the objective of the GEF Focal Area of climate change and OP2 Coastal, Marine, and Freshwater Ecosystems.

## **1.2 Original Global Environment Objectives (GEO) and Key Indicators** *(as approved)*

1.2.1 The overall Project development objective was to reduce the major negative environmental and health impacts of rapidly increasing concentrated livestock production on the open waters and thus on the people of East Asia. Its global environment objective was to reduce livestock-induced, land-based pollution and environmental degradation of the South China Sea. Achievement of the project's development objective was to be monitored by the following key performance indicators:

- (a) Demonstrated Livestock waste management practices in the participating farms/villages within the project area;
- (b) Reduced livestock production related surface water pollution in the project area, including nitrates, phosphates, biological oxygen demand (BOD), COD and E. coli bacteria;
- (c) Development of a Replication Strategy and other policy measures for addressing livestock waste management, and their local and national adoption and enforcement;
- (d) Development of plans, programs and capacities to achieve a spatial distribution of livestock production better aligned with environmental and health objectives;
- (e) Reduced human health risk as a result of improved risk management of pathogens, antibiotics and virus transmission from livestock to humans; and
- (f) Increased public awareness and regional exchange of information on pollution threats and health problems from livestock waste.

## **1.3 Revised GEO** *(as approved by original approving authority)* **and Key Indicators, and reasons/justification**

1.3.1 Neither PDO nor GEO was revised.

## **1.4 Main Beneficiaries**

1.4.1 Project main beneficiaries included the following:

- (a) Farmers, employees and their families of participating farms benefitted firstly from increased on-farm investment leading to improved nutrient management and quality of domestic waterways. This resulted in reduced overall human and animal health risks posed by ill-managed livestock wastes, and reduced complaints from local communities. These stakeholders further benefitted from reduced workloads, increased availability and knowledge of innovative



technologies for livestock waste management through training and introduction of the technologies, as well as alternative, local energy generation supplied through biogas or electricity generated from livestock waste management facilities.

- (b) Local communities and neighboring villages benefitted from improvement of their natural environment including lower insect populations (flies), reduced livestock production pollution of air and waterways, reduced human health risks, and increased public awareness. Certain communities were also able to benefit from biogas supply from participating farms.
- (c) Officials from national and local governments in participating countries improved their capacities and skills in developing and enforcing livestock waste management policies, in introducing and supporting innovative and proven livestock waste management technologies, and in regulating, supporting and monitoring a more environmentally friendly and sustainable intensive livestock production industry.

### **1.5 Original Components** *(as approved)*

1.5.1 The project adopted a comprehensive approach to integrate technological solutions, policy development and enforcement, capacity building and regional synergy to achieve its development objective. The project includes the following components: (a) Component 1: Livestock Waste Management Technology Demonstration (US\$14.2 million); (b) Component 2: Policy and Replication Strategy Development (US\$4.4 million); (c) Component 3: Project Management and Monitoring (US\$3.9 million), and (d) Component 4: Regional Support Services (US\$1.5 million). The first three components were implemented by the three participating countries while the fourth was implemented by the UN Food and Agriculture Organization (FAO) through its Regional Facilitation Office (RFO) in Bangkok, Thailand.

### **1.6 Revised Components**

1.6.1 Project components were not revised.

### **1.7 Other significant changes**

1.7.1 The project closing date was extended for Vietnam (6 months), Thailand (12 months) and FAO (6 months). The slower than expected project implementation progress was the main reason for the extensions granted for Thailand and Vietnam. In Thailand, this was due to a number of factors including: (a) distraction caused by the project implementing agency's participation in the preparation of two associated carbon finance projects on the margins of the GEF project's approval, which limited the Project Management Office's (PMO) capacity to initiate timely project implementation; (b) a delay in the approval of counterpart funding by the Thai Cabinet; and (c) the social unrest experienced in the country in April and May 2010. In Vietnam, project implementation progress was largely the result of: (a) a change in project areas (see 1.7.2); (b) a major restructuring within the implementing agency in 2008; (c) unexpectedly severe storms in 2009 and 2010; and (d) the weak capacity of the Project Management Office in first years of the project's implementation. As a consequence, the project closing date was also extended for FAO, to allow for organization of the final project completion workshop and last Regional Coordination Group (RCG) meeting in June 2011, once all three countries

had generated sufficient implementation results to share with each other. These extensions contributed to the achievement of the project development objective and the global environment objective in all three countries.

1.7.2 The project areas were defined at the time of project appraisal. They included, Boluo County in Guangdong province, China, Ha Tay and Dong Nai provinces in Vietnam, and Ratchaburi and Chonburi provinces in Thailand. Any other counties in China's Guangdong province and other provinces in Vietnam and Thailand selected by the participating countries were also welcome to participate in the project, contingent on prior concurrence with the Bank. During project implementation, and with the Bank's prior concurrence, Dongyuan and Lianping Counties in Guangdong province, and Phetchaburi, Rayong, and Kanchanaburi provinces in Thailand, encouraged by the initial results of the project's implementation, joined the project in 2008 and 2009 respectively. In June 2008, Ha Tay province was merged into Hanoi, bringing Hanoi into one of two project provinces in Vietnam.

## **2. Key Factors Affecting Implementation and Outcomes**

### **2.1 Project Preparation, Design and Quality at Entry**

2.1.1 Background analysis. Project preparation was based on a thorough analysis of the sector issues identified by pre-project studies, and on available technical solutions and their assessed suitability given participating countries' contexts. The project focused on one of the most significant and rapidly growing sources of land-based pollution threatening the South China Sea – environmentally unsustainable intensive and geographically-concentrated livestock production – and selected China, Thailand and Vietnam, the three most important countries in East Asia in terms of livestock production to participate. It recognized that livestock wastes, if not managed appropriately, are a recognized pollutant, a human health threat, and a source of anthropogenic greenhouse gas (GHG) emissions. Based on the background analysis conducted, key challenges in managing livestock wastes in the three countries were identified: (i) a lack of available technical solutions to address and deal with the problem of nutrient imbalance; (ii) a lack of policy instruments and absence of a replication strategy for LWM; and, (iii) a lack of capacity, awareness, and collaboration to promote sound LWM practices. Furthermore, the project preparation process collected experience and lessons learned from World Bank rural environmental and livestock operations, from results of diagnostic work and field investigations under the Area-Wide Integration (AWI) pilot projects conducted in China, Thailand and Vietnam under the FAO's Livestock, Environment and Development Initiative (LEAD)<sup>1</sup>, as well as from ongoing government programs in the three countries. In line with the Bank's previous project experience and sector work, the project emphasized the importance of on-the-ground demonstrations of innovative, cost-effective LWM technology options by private livestock producers, complemented by country specific replication strategies to promote the broader adoption of such technologies.

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<sup>1</sup> LEAD is a multi-donor funded program with secretariat provided by the FAO.

2.1.2 Project design. The project design was timely, focused, of high quality and took on board input contributed by all participating countries and the FAO, as implementing agency for the Regional Support Services component. World-class leaders in the field participated in project preparation and brought their experience to project design. It is worth noting that the current PDO and GEO, largely defined by GEF requirements and accepted by Bank management, are the higher level objectives against which project interventions were expected to contribute. The PDO/GEO indicators and intermediate outcome indicators, which reflect project level intervention results considered realistic and achievable, were properly defined. Key features of project design included:

- (a) The project design supported an integrated and comprehensive implementation approach that called for the involvement of FAO and various government agencies from 14 national ministries in three countries, and covered 8 provinces. The \$7 million GEF grant project proposed the introduction of an integrated and comprehensive package of technological solutions, policy development and enforcement, national capacity- and regional synergy building to achieve the development objective. Emphasis was placed on on-the-ground demonstration of effective and affordable technological solutions for sound livestock waste management. Policy, capacity and strategy development activities were carried out based on successful results of technology demonstration and thus, were well received by all stakeholders. The project's intelligent design has contributed significantly towards guaranteeing the long term sustainability of project interventions.
- (b) With regard to technology demonstration, the project promoted those innovative technologies that are technically, agronomically, geographically, economically and institutionally acceptable to a broad audience drawn from different political groups, at various levels of social and economic development. Livestock production patterns and trends in the three countries were carefully assessed. Effective and affordable proven technologies, not yet been adopted in the countries, were identified and demonstrated selectively in each of the three countries. This design approach increased the likelihood that demonstrated technologies could be easily replicated in the project countries.
- (c) The project's design also emphasized the importance of providing financial incentives and technical support to mobilize interest and participation on the part of livestock farms to pilot sound waste management technologies. Based on country situations, different combinations of financial incentives were devised for each of the three countries. The thorough analysis of the cost effectiveness of manure management systems for different types of farms that was undertaken helped establish affordability thresholds for various technological options. The actual construction and successful operation of the first few LWM facilities in all three countries became positive showcases that attracted the participation of additional farms.
- (d) The project's regional approach maximized its contribution to the GEF objectives by ensuring that the region's three most important countries in terms of livestock production and waste pollution, were acting together under a common interest to protect the ecosystems of the South China Sea. This approach also promoted

cross-country learning and knowledge sharing and thus increased project impacts in the region. Further, the value of the regional approach in facilitating knowledge sharing between countries was shared with other countries in the region and around the world, through various international and regional knowledge exchange activities, the FAO and the GEF networks.

2.1.3 Government commitment and stakeholder involvement. Governments at all levels in all three participating countries actively participated in and were fully committed to the project design and implementation processes. In each participating country a project preparation team was assigned to work closely with FAO on project conceptualization and design. This lay the groundwork for the positive engagement of government throughout the project's duration including through provision of financial resources to support implementation and sustainability beyond the project's completion, as well as the establishment and maintenance of effective institutional structures at all levels during project implementation. Other key stakeholders, including farms, urban businesses, nearby urban dwellers, local communities and NGOs, were actively involved and participated throughout the project design and implementation phases in all three countries. Stakeholder Participation Plans were prepared by the participating countries and closely followed during project implementation.

2.1.4 Risks. A comprehensive assessment identified potential risks and mitigation measures at time of appraisal. In addition to risks associated with government commitment and institutional capabilities that are common to all projects, the key risks identified, and mitigation measures proposed were: (a) operational failure resulting from provision of inadequate financial incentives to stimulate private sector investment in waste management systems – this potential risk, rated moderate, was mitigated by providing sufficient incentives through the project, the government and other sources; (b) failure of the waste management technologies demonstrated – this was considered a low risk because the project was designed to introduce proven and effective technologies and provide all participating farms with intensive technical trainings and support, but ultimately, no technical failures were reported; and (c) failure in coordination among participating countries due to ineffective regional coordination arrangements, lack of country ownership, failure to observe commitments, etc. This last risk was considered moderate and was mitigated through close project supervision, Regional Coordination Group (RCG) meetings whose minutes clearly recorded agreements and commitments, and effective regional coordination through training, workshops, study tours, and the FAO RFO sponsored project website and newsletter.

2.1.5 QAG “Quality at Entry”. The project was interviewed by QEA8 in May 2007, and in June 2007 received a Satisfactory rating on all dimensions with the exception of Fiduciary Aspects, which was rated as Moderately Satisfactory due to certain inadequacies related to financial management. The project's Master Capacity Building Development Plans were rated highly satisfactory.

## **2.2 Implementation**

2.2.1 Overall, project implementation was successful. A number of proven LWM technologies were successfully demonstrated at project farms. This, in turn, attracted the interest of a large number of non-project farms' in learning from the project and

requesting project support. The actual standing pig population covered by project farms exceeded 57% of the appraised target. Project results were presented in a SmartLessons note, which later received a First Award in a Bank-wide SmartLessons Special Competition<sup>2</sup> in February 2012.

2.2.2 With only one exception, all project activities were successfully implemented under the project and completed by the closing dates stipulated in the respective Grant Agreements with each recipient. The one exception was the Support for the Treatment and Recycling of Animal Waste (STRAW) activity under the RSS component, which was not completed by the closing date due to failure on the part of the consultants to deliver the expected output on time. The development of STRAW remains ongoing under FAO financing. A draft version was available at the time of the writing of this ICR.

2.2.3 In January 2009, two cases of procurement collusion in Vietnam were identified and reported to the Bank's Institutional Integrity Unit (INT). In response, the Vietnam PMO, with the Bank's close supervision, undertook the necessary corrective actions to sanction the firms involved and to ensure that the two contracts concerned were properly rebid. In response, the Vietnam PMO adopted a procurement action plan in October 2009. Together, these actions ensured the integrity of project implementation in Vietnam.

2.2.4 Project implementation progress was slower than expected in the early years of project implementation in all three countries. While most components were implemented as scheduled, physical construction of demonstration facilities did not start until early 2008 in China, mid-2008 in Vietnam and late 2009 in Thailand. These delays were caused mainly by the initial lack of experience on the part of all project implementing agencies, by the preparation of two associated clean development mechanism (CDM)<sup>3</sup> projects in Thailand following approval of the GEF project, by natural disasters in Thailand and Vietnam, social unrest in Thailand and, the time-consuming governmental processes for internal review and approval of project endorsements and budget allocations. To address these issues, the project provided intensive training to build the capacity of the executing agencies, organized workshops to exchange experience among participating countries and provided overall support through regular routine communications and increased numbers of supervision missions. This spared the project being classified a "Project at Risk", and allowed implementation to be completed as planned in China by December 31, 2010, in Vietnam by June 30, 2011, and by Thailand and the FAO by December 31, 2011, following extensions of 6 and 12 months respectively. In summary, project implementation lasted 4.5 years in China, 5 years in Vietnam and with the FAO, and 5.5 years in Thailand.

2.2.5 Mid-term Review (MTR). A mid-term review was carried out in each country in concert with the FAO RFO during the third supervision mission held from January 12 to

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<sup>2</sup> SmartLessons is a World Bank Group program to share lessons learned on projects and programs regarding both technical and operational issues. SmartLessons are short papers that provide first-hand, straightforward, and useful analysis, written by professionals for professionals. The winners' papers are published and widely disseminated.

<sup>3</sup> The Thailand Livestock Waste Management Program was approved in June 2008 and the Thailand Small-scale Livestock Waste Management Program was approved in June 2009.

22, 2009. The MTR concluded that no MTR adjustment was required by the project. This conclusion was endorsed by all three countries.

### **2.3 Monitoring and Evaluation (M&E) Design, Implementation and Utilization**

2.3.1 M&E design. Design of the M&E component was based on project design, experience drawn from other similar projects, GEF requirements for IW projects, and individual country situations. With the agreed Results Framework and key performance indicators, the three countries prepared their respective M&E plans and included them in their country-specific project implementation plans (PIPs). Process indicators, stress reduction indicators and environmental status indicators relevant to IW projects were included in the M&E plans. These M&E plans were realistic and owned by all participating countries.

2.3.2 M&E implementation. Based on their respective M&E plans, the three countries developed thorough M&E systems and implemented M&E activities in an orderly, organized, and effective manner. Designated M&E staff members in each PMO were assigned at both the national and local levels, specialized training was provided, and the required funds were budgeted for implementation of the M&E plans. National PMOs were responsible for overseeing all M&E activities, while monitoring assignments for sampling, analysis, and reporting of livestock waste reduction were contracted out to independent professional firms or institutions. A summary of monitoring results was routinely reflected in semi-annual project progress reports. At project completion, a total of 52 environmental monitoring reports were submitted. A final aggregated M&E report was submitted by each country as part of its ICR package. Data collection and surveys for other M&E results were carried out by the PMOs, supported by the countries' environmental and public health agencies, to track implementation of project activities and related expenditures. Regular semi-annual progress reports, environmental monitoring reports and specific studies provided reliable information and data on project implementation.

2.3.3 M&E utilization. M&E results were carefully reviewed to evaluate project implementation status and identify issues that may require attention. Specifically, monitoring results were used to evaluate the performance of the demonstrated technology packages in comparison to the baseline. Ultimately, the M&E results were used as the major instrument by which to assess achievement of project impacts. The M&E results were also used for research and academic purposes by the Guangdong Academy of Agricultural Sciences and the South China Agricultural University, as well as for decision making purposes with respect to the development of livestock waste management policies at the county, municipal and provincial government levels in Guangdong Province. To collect post-project monitoring data, the project facilitated the mobilization of grant support from the Global Methane Initiative (GMI) to continue environmental monitoring at a selected number of participating farms for one additional year in Thailand and Vietnam, and two years in China, following the same protocol and parameters specified in the project PAD. The project also supported the wide dissemination of its M&E practices, to support the adoption of project practices in additional livestock farms in the three countries.

### **2.4 Safeguard and Fiduciary Compliance**

#### 2.4.1 Safeguard compliance.

- (a) Environmental Safeguard. Assessed as a Category “B” project, the project prepared an environmental assessment and an environmental management plan (EMP) in each of the three countries, in accordance with each country’s and the Bank’s safeguard policies and requirements. All implementing agencies established independent environmental management teams responsible for supervising and monitoring the EMP’s implementation. Internal and external environmental monitoring results confirmed that efficient implementation of the EMPs mitigated and controlled the adverse environmental impacts resulting from project construction to acceptable levels. No complaints with respect to environmental issues were reported during the course of the project’s implementation. In conclusion, project implementation was fully in compliance with the Bank’s environmental safeguard policies.
- (b) Social Safeguard Instruments and Implementation. OP 4.12 and OP 4.10 were triggered due to possible impacts on Indigenous Peoples and from Involuntary Resettlement. A set of Framework/Guidelines were prepared during project preparation covering Indigenous Peoples and Involuntary Resettlement. These Framework/Guidelines were applied by the three countries during project implementation. It was concluded that implementation was in compliance with the Bank’s social safeguard policies.

#### 2.4.2 Fiduciary Compliance

- (a) Procurement. Overall, procurement was carried out in a satisfactory manner. All goods, works and consulting services were procured as planned. Both the Bank’s Procurement and Consultant Guidelines were closely followed by all PMOs and the FAO RFO. As noted above, delayed initiation of project implementation led to slow procurement progress in the early years of project implementation. General procurement issues were addressed and resolved through timely communications, and provision of clarifications, between the PMOs and the Bank team. No substantial issues with respect to the procurement process were identified, save the two cases of procurement collusion noted above, that were resolved in 2010. The project’s implementation allowed the three PMOs to significantly improve their procurement capacity.
- (b) Financial Management. A sound internal control system was put in place by most recipients as of project effectiveness, to ensure that project funds would be used for their intended purposes. The financial management covenants and requirements contained in the Grant Agreements were, on the whole, complied with by most recipients. The financial management (FM) was rated satisfactory for China and the FAO, and moderately satisfactory for Vietnam and Thailand. For Vietnam, persistent weaknesses were identified in the capacity of the FM staff regarding financial reporting, internal control system management and monitoring of counterpart funding for project supported LWM facilities. In addition, several of the project’s annual financial audit reports had to be returned due to inconsistencies and errors, and during some supervision missions, ineligible expenditures were identified. For Thailand, the principal concern was that the

majority of FM and audit reports were submitted with delays. Ultimately however, it is to be noted that the three governments provided greater amounts of counterpart funds than had been committed.

## **2.5 Post-completion Operation/Next Phase**

2.5.1 It is expected that the project financed livestock waste management facilities will continue their operations and provide benefits to the project farms by generating biogas and/or biogas-generated electricity that reduces farm energy and pig production costs, and through the marketing of digested manure. In Thailand, the potential revenue from the sale of certified carbon emission reductions (CER) provides an additional incentive for the Thai farms to continue operating their livestock waste management facilities, as these revenues would be adequate to cover operating and maintenance (O&M) and re-investment costs. Furthermore, strong commitment on the part of the three participating countries to provide continued technical support services to project financed facilities will further enhance the sustainability of project interventions.

2.5.2 At project completion, all participating countries expressed strong commitment toward implementation of their country-specific Replication Strategies, which will allow for replication and scale up of the technologies demonstrated, and eventually allow for the integration of successful demonstration results into each country's overall livestock waste management strategy. In fact, an additional 679 farms in China, Thailand and Vietnam, with an estimated total of 1.9 million SPP, have adopted the project's practices within the context of the project's replication efforts. Such strategies are still being implemented in the three countries. Specific actions, by recipient, include:

- (a) **China** (Guangdong province) has included all participating farms in its technical support and extension system and will provide continued technical support to the farms. In addition, Boluo County and Heyuan City each issued a decree, in 2009 and 2010 respectively, promoting the adoption of sound LWM practices demonstrated by the project among their pig farms. Such policy actions are critical to incentivize continued operations of project financed facilities. Finally, based on the positive results achieved under this GEF-funded project, China launched the preparation of the Guangdong Agricultural Pollution Reduction Project, a \$100 million IBRD loan matched by \$100 million in co-financing, which figures in the Bank's FY14 lending program. The lending project will address agricultural pollution issues, and over 50% of the project financing will support further LWM investments in about 300 large commercial pig farms in Guangdong.
- (b) **Thailand** continues to implement the two associated CDM projects which cover 16 out of the 20 farms that were financed by the project. In addition, the Thai line ministries have agreed to continue promoting sound LWM in the country. They will maintain continued collaboration within the sector on LWM issues, provide guidance, information, and financial resources to project and non-project farms, and finance long-term technical support services, as well as strengthen cooperation with international and regional organizations and other countries to disseminate Thai experiences. Moreover, the Department of Livestock Development (DLD) in the Ministry of Agriculture and Cooperatives launched a



demonstration using liquid manure in rice paddy fields, expanding the project's replication potential, and the Pollution Control Department (PCD) of the Ministry of Natural Resources and Environment planned to develop new regulations, including effluent standards for small livestock farms and odor standards for pig farms, based on project results. Government grants are being mobilized to support post-completion operations including long-term environmental impact monitoring, performance evaluations of demonstrated technologies, and workshops to share project farms' experiences.

- (c) **Vietnam** has focused its efforts on replication and scale up through implementation of various initiatives. A documentary film developed by the PMO was broadcast in many communities to improve awareness amongst key stakeholders on demonstrated technologies and their environmental and economic benefits. Results of the GEF project have also been shared with the Bank's ongoing Livestock Competitiveness Project, which includes a component that addresses similar livestock waste management issues. Furthermore, a Hanoi cooperative has applied and obtained a government subsidy, complemented by a low interest loan, to replicate demonstrated anaerobic digestion (AD) technologies in five large pig farms and purchase 10 engines for biogas power generation.
- (d) **The UN FAO** facilitated the development of "A Global Agenda of Action for Sustainable Livestock Sector Development", co-chaired by the World Bank and the International Livestock Research Institute. Drawing on the results and experiences of the project, the Global Agenda defines one of its three areas of focus as Reduced Discharges, which promotes full recovery of nutrient and energy from animal manure.

### **3. Assessment of Outcomes**

#### **3.1 Relevance of Objectives, Design and Implementation**

3.1.1 The project and its objectives, as designed and implemented, remain highly relevant as it addresses one of the most significant and rapidly growing sources of land-based pollution of the South China Sea: the environmentally unsustainable and geographically-concentrated intensive livestock production in China, Thailand and Vietnam. The project demonstrated viable and replicable technological packages and developed country-specific replication strategies to guide the process into the future. The successful results and experiences generated by the project are also of regional and global significance for other countries bordering the South China Sea, as well as for other countries that face similar issues.

#### **3.2 Achievement of Global Environmental Objectives**

3.2.1 The project results provide clear evidence that both the PDO and GEO were achieved. The project reached or exceeded virtually all the outcome targets set at appraisal (see Section F of the Data Sheet), resulting in reduction of the major negative environmental impacts associated with concentrated livestock production. Ten proven livestock waste management technological packages were demonstrated on a total of 56 participating farms and in one village. These technological packages covered a total of 653,000 SPP, which is 57 percent more than the appraisal target. Based on monitoring

results, the demonstrated AD technological packages removed an average of 89% of P, 87% of N, and 95% of BOD from all participating farms. These are 152%, 58% and 280% more effective than the benchmark option targets for P, N and BOD removal, respectively. The quality of treated livestock waste water now meets the national discharge standards of each participating country. The actual pollution reduction effect was even more significant because the treated effluents from almost all participating farms were not discharged into public water bodies but rather, used as liquid fertilizer and on-farm recycled water. It is estimated that a total of 219,200 tCO<sub>2</sub>e of greenhouse gas (GHS) emission reduction was achieved during project implementation, and that an additional annual reduction of about 149,500 tCO<sub>2</sub>e will be achieved starting in 2012. With tangible financial benefits gained from the project, much improved and workable livestock waste management skills being applied and increased awareness regarding environmental protection issues, participating farms are motivated to sustain operation of project-constructed livestock waste management systems and to move away from the unsound management of livestock wastes.

3.2.2 The project also achieved significant reduction of health risks associated with concentrated livestock production activities by introducing sound livestock waste management practices including: (i) treatment of the wastes from all livestock populations on the participating farms and prohibiting the sale of fresh wastes; (ii) separate composting solid wastes not treated by AD facilities; and (iii) proper disposal of all treated solid and liquid wastes to avoid secondary pollution. Anecdotal evidence from surveys and data collected by the participating countries showed that project activities reduced over 90% of total E. coli on participating farms.<sup>4</sup> Such positive results with respect to health risk reduction have encouraged local Thai authorities to issue health risk business licenses for pig farms adopting demonstrated AD-based livestock waste management technologies.<sup>5</sup> In Vietnam, residents of the participating farms and neighboring communities reported<sup>6</sup> that they suffered from fewer infectious diseases - all closely associated with pig production - as a result of project implementation. It is estimated that intestinal disease infections dropped from 53% to 12%, surface water caused allergies dropped from 35% to 6%, methane caused eye diseases were reduced from 24% to 12%, and respiratory diseases dropped from 18% to 6%, following completion of the project financed livestock waste management facilities on the participating farms. It was also reported that project implementation contributed to the reduction of headache occurrences from 29% before the project to 18% after the project among of residents living at the participating farms and their neighboring communities. However, the project had no impact on the use of antibiotics and other residues in animal feeds as originally expected.

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<sup>4</sup> This result is consistent with the findings of a study funded by the US Environmental Protection Agency, which observed that AD technologies could kill over 90% of indicator organisms and potential pathogens (Eastern Research Group, Inc., 2005, An evaluation of A Mesophilic, Modified Plug Flow Anaerobic Digester for Dairy Cattle Manure. EPA Contract No. GS 10F-0036K).

<sup>5</sup> According to the Thai Public Health Act (1992), pig-raising is legally identified as a business posing public health risks. At the local level, TAO (Tambon (sub-district) Administrative Office) issues a "health risk business license" to permit establishment of a pig farm.

<sup>6</sup> Note that this report was not statistically corroborated.

3.2.3 The project's global environmental objective was achieved through implementation of the well designed and executed project activities, and the replication and scale-up of the project's demonstrated technological packages. During project implementation, it is estimated that a total reduction of 2,100 T of phosphorus, 3,600 T of nitrogen, 23,900 T of BOD and 63,100 T of COD was achieved. Based on the removal rates highlighted in Section 3.2.1, it has been estimated that an annual total of 1,500 T of phosphorus, 2,600 T of nitrogen, 17,200 T of BOD and 45,400 T of COD will be avoided from discharges into the South China Sea following project completion.

3.2.4 The project's long term impacts are aligned with the implementation of country-specific replication strategies and the dissemination of project results via various national channels (photographs, DVDs, documentary etc.), project newsletters, a project-dedicated website and regional and international workshops and conferences, that will facilitate regional and global replication and scale-up of sound livestock waste management practices.<sup>7</sup> Specifically, country-specific replication strategies were adopted and enforced in a total of 679 farms (570 in China, 14 in Thailand and 95 in Vietnam) during project implementation. The country-specific spatial distribution plans were developed in all participating countries and implemented in selected local areas during project implementation. The implementation of the national replications strategies and the spatial distribution plans are still ongoing in the three countries after project completion. Moreover, the project-sponsored International Conference on Water Pollution Reduction and Climate Change Mitigation held in China in September 2009, played an important role in dissemination of project experiences.<sup>8</sup> In addition, project posters were presented at the World Water Day event hosted by the United Nations Economic and Social Commission for Asia and the Pacific, held in Bangkok, Thailand on March 22, 2010. As of June 2011, 15 provinces in China and 7 countries bordering the South China Sea have requested project countries' support on livestock waste management training and extension programs. Visitors from 7 regional and international organizations and about 20 countries have visited various project farms.

### **3.3 Efficiency**

3.3.1 Consistent with the approach adopted at project appraisal, a cost-effectiveness analysis was performed to evaluate the project's efficiency with respect to achievement

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<sup>7</sup> Including: (i) International Conference on Nutrient Pollution Control in the Danube- Black Sea Basin (October 2006 in Moldova); (ii) East Asia Sea Congress (December 2006 in China); (iii) Fourth and Fifth Biennial IW Conference (August 2007 in South Africa and October 2009 in Australia); (iv) Methane to Markets Partnership Expo (October 2007 in China); and (v) International Conference on Water Pollution Reduction and Climate Change Mitigation (September 2009 in China).

<sup>8</sup> The International Conference was jointly sponsored by the World Bank, FAO, GEF, M<sub>2</sub>M, ADB, China (MOA), Thailand (MOAC), Vietnam (MONRE), and Guangdong Provincial People's Government from August 31 to September 2, 2009 in Guangzhou, China. The conference was a major project event attended by 146 participants including 88 Chinese national participants from 30 provinces and Hong Kong SAR, China; 58 international participants from 7 regional and international organizations and 13 countries. During the Conference, a total of 26 speakers shared their experiences and exchanged views, and many more participants used the Conference as a platform to learn from experiences, share ideas and explore potential opportunities for cooperation.

of project objectives. This analysis included carbon emission reductions as an important co-benefit that emerged during project implementation.

**3.3.2 Economic analysis.** The project's economic analysis examined and assessed the efficiencies of the various technical solutions for sound livestock waste management promoted by the project. This analysis concluded that the ten AD technology packages demonstrated by the project were, as a whole, cost effective in reducing pollution discharges from the project farms. The weighted average unit investment cost for the ten AD technological packages was higher than the benchmark option estimates at appraisal, but this is justified by the following factors: (a) the unit cost of nutrient removal at ICR was 16.9% and 8.1% lower than the benchmark option estimates for P and N reduction respectively; (b) the project achieved higher nutrient removal efficiency than the benchmark option targets by achieving 152%, 58% and 280% more for P, N and BOD respectively; (c) the project-introduced technology packages required higher initial investment costs but yielded better than projected financial returns to participating farms; (d) the demonstrated technological packages included additional features covering additional efficiency and operational safety; and (e) the market price of the major project inputs were significantly increased during project implementation.

**3.3.3 Financial analysis.** A financial analysis was conducted to evaluate the attractiveness of the project's financial incentives for participating farms. Up front, the project subsidized in the order of 60% of farm investments and contributed positive impacts on the participating farms' revenues resulting from technological upgrades. This ensured sufficient interest on the part of pig farms to participate in the project. A cash flow analysis on typical farms participating in the project showed that the Financial Internal Rate of Return (FIRR) on full costing was 8.7%, 14.7% and 8.2% respectively for the Chinese, Thai and Vietnamese farms. The higher FIRR for the Thai farms was directly due to their expected certified emission reduction (CER) revenues, and their additional sales income from dried digested sludge. The analysis concluded that from a financial perspective, the project presented an attractive option to all participating farms in converting their livestock waste management facilities to more sustainable modes of operation. However, as was documented at project appraisal and later confirmed during interviews with non-project farms, it is clear that subsidies will continue to be required for future sound LWM investments. This is due to the public goods nature of sound LWM actions, and the low investment interests of farmers on waste management facilities given that pig production remains a high-risk business affected by frequent epidemic diseases and volatile market conditions, and where pollution enforcement in the sector is lax due to the strong governmental interests in ensuring a sufficient and affordable supply of pig products.

### **3.4 Justification of Overall Outcome Rating**

Rating: Satisfactory

**3.4.1** The project's Satisfactory rating for overall outcome is justified by its high relevance to current country, regional and global priorities, as well as the Bank's country partnership strategies. Almost all PDO and GEO indicators were achieved (see details in Annex 2 on achieved outputs). Sound technology packages were demonstrated with high efficiency in achieving performance targets (see details in Annex 3). Furthermore, the

project's long term impacts – replication of demonstrated practices in the three participating countries as well as in other countries bordering the South China Sea – has been witnessed by solid post-completion actions undertaken by all three countries (see details in paragraph 2.5.1) in line with their respective country-specific Replication Strategies. All participating countries reported, and Bank supervision missions confirmed, that all project stakeholders were satisfied with the project's overall outcome. It is also recognized that two outcome indicators were partially achieved: (a) health risks associated the use of antibiotics and other residues in animal feeds were not tackled as originally planned, and (b) one of DSTs was not completed by the project closing date. However, such deficiencies have negligible impacts on the overall impacts of the project – successful technology demonstration and scaling up in the three most important pig production countries in the world.

### **3.5 Overarching Themes, Other Outcomes and Impacts**

#### **(a) Poverty Impacts, Gender Aspects, and Social Development**

3.5.1 The project was not designed with any specific poverty impact in mind. However, some farm-led initiatives did contribute positive poverty reduction impacts. Specifically, Luoxing Farm in Guangdong province provided free biogas to two local schools serving about 1,200 students and their teachers. Part of the saved energy cost at the two schools has been used to finance poor drop-out students to return to their studies, and to improve teaching facilities. Sa-ard farm in Thailand offered free biogas to a nearby elementary school whose student population are mostly from poor families. The sales revenue from dried digested sludge on the majority of participating Thai farms was partially distributed to poor farm workers. And, the supply, free of charge, of treated wastewater by participating farms to nearby crop farms in the three countries, reduced production costs for the mostly poor smallholder crop farmers.

3.5.2 Project implementation also yielded positive gender impacts in China and Vietnam. In Guangdong, a total of 529 households have shifted to project-produced biogas as cooking fuel and are paying a nominal charge to cover the operating and management costs of the biogas supply system. Of these, 441 households replaced fuel wood with biogas supplied from project financed facilities. In addition to the fuel cost savings achieved, this shift has reduced the labor intensity of 1-1.5 days per week, per household, on average required for fuel wood collection and cooking, which has traditionally been borne by women. This has provided women with time to undertake alternative activities, and the use of biogas has improved the indoor air quality in these households. Following the project's demonstration, this model was extended to cover a total of 5,187 households, or 25,935 persons, in Boluo County by the end of 2010. Similar benefits have positively affected women in Vietnam. In Thailand, no such benefits have been directly observed as all participating farms (except Sa-ard farm that has supplied biogas to a local elementary school) have used biogas to generate electricity for their own needs.

3.5.3 The project's social impact was positive and significant. By improving local environmental quality (reduced odors, improved local water quality, reduced health risks), the project improved relationships between the participating farms and their neighboring communities that had been negatively affected by livestock production related pollution

issues prior to project interventions. In addition, the project supported waste management facilities created new job opportunities on the farms. A further positive social impact on the Thai farms was observed, as these farms not only improved the quality of the working and living conditions for their workers, many of whom come from Myanmar, but also assisted these employees in obtaining their Thai work permits. All workers were trained to adapt to the new production environment after project implementation.

**(b) Institutional Change/Strengthening**

3.5.4 Successful implementation of the project-supported Master Capacity Building Development Plans has greatly improved capacity of all stakeholders and strengthened collaboration among key government agencies involved in livestock waste management. In addition, FAO provided capacity building support through various FAO training sessions, workshops, and regular RCG meetings. Support from experienced international and national consultants was also mobilized to assist the PMOs on key technical issues. All participating countries viewed the institutional strengthening activities as the project's top priority and described the project's contribution as comprehensive including, support for project management, policy development and enforcement, technical assistance, and physical investment on livestock waste management). Support provided was inclusive, benefiting all involved in the project at the national, provincial and local levels, with noticeable long term impacts in terms of awareness raising, development of replication strategies, improved collaboration among relevant government agencies, financial institutions, academia, and farmers, and cross-country and regional collaboration.

**(c) Other Unintended Outcomes and Impacts** (*positive or negative, if any*)

3.5.5 In addition to the two aforementioned positive impacts on poverty and gender in Thailand, an additional unintended outcome was the project's integration with two CDM projects during project implementation. This integration enabled 16 of the project's 20 participating farms to generate up to a total of 148,000 T of CO<sub>2</sub> equivalent emission reductions, plus an expected revenue of about \$1.9 million over the next 5 years. This additional CDM benefit was a great incentive for other eligible farms to seek project support in Thailand. One last unintended outcome of the project was that the project farms were able to produce and provide, or sell, the digested liquid and sludge waste as safe, inexpensive and good quality fertilizers and soil conditioners. Sales of these products provided further revenues to the project farms in Thailand.

**3.6 Summary of Findings of Beneficiary Survey and/or Stakeholder Workshops**

N/A.

**4. Assessment of Risk to Development Outcome**

Rating: Low

4.1.1 For project farms, the financial and economic analysis conducted at ICR has confirmed that project investments are financially sustainable. It did however, identify possible financial risk to the sustainability of project outcomes, as the analysis also showed that financial incentives would be required to incentivize additional farms to replicate the demonstrated project practices. This implies a risk that the three countries

might not be able to mobilize the incentives needed for replicating and scaling up project demonstrated technological packages after project completion. However, as discussed earlier in Section 2.5.2, the three countries have taken a series of actions to implement country specific Replication Strategies to scale up demonstrated project activities. This risk is therefore considered to be low.

4.1.2 There is also a potential risk that some of the project farms may stop supplying biogas to the neighboring communities, villagers and schools, resulting in conflicts at community level. This risk is expected to be low as local authorities, farmers and communities in the project areas have developed strong social awareness. More importantly, there were relevant agreements signed among all parties involved.

4.1.3 The environmental benefits achieved under the project are significant and will be sustainable during the lifetime of the project financed LWM facilities. There might be a potential environmental risk if wastes are not properly managed at the time of major maintenance of the facilities, however this environmental risk is low as it would be temporary in nature and sufficient mitigation measures have been built into the operations manuals of each facility.

## **5. Assessment of Bank and Borrower Performance**

### **5.1 Bank**

#### **(a) Bank Performance in Ensuring Quality at Entry**

Rating: Satisfactory

5.1.1 As the GEF implementing agency of this project, the Bank ensured that the project design was technically sound and could achieve the proposed measurable project objectives in a cost effective manner. The Bank also ensured that fiduciary arrangements were adequate and that provision of safeguards mitigation measures was guaranteed. The Bank achieved all these by working closely with all three countries and the FAO to identify sound technical proposals to address the key sector issues based on actual country situations. This ensured the joint development of a final product that was owned by all parties.

5.1.2 Technically, the project's design was informed by a group of highly experienced international and national experts. It also incorporated FAO experience from previous pilot projects in the three countries, the results from consultations with key stakeholders, and the experience and lessons learned from many other initiatives and programs funded by the Bank, as well as other international and regional organizations. By aligning closely with the governments' priorities and strategies, this project design was guaranteed the strong support of all stakeholders during implementation.

5.1.3 The project was interviewed by the QAG panel and rated Satisfactory for quality at entry in almost all aspects. The project's Master Capacity Building Development Plans were rated highly satisfactory (see Section 2.1.5).

#### **(b) Quality of Supervision**

Rating: Satisfactory

5.1.4 The Bank carried out consistent project supervision with highly qualified staff members from both the Bank's headquarters and country offices. In addition to routine communications and frequent review of project documents, the seven supervision missions conducted by the Bank over the course of project implementation served to ensure that implementation progress remained on track, Bank policies were followed, legal covenants were observed, required technical support was being provided, issues or concerns were identified and addressed and ultimately, that project objectives were being achieved. All supervision mission arrangements, mission findings and recommendations were fully discussed and agreed between the Bank and the three participating countries. The mid-term review was carried out as scheduled.

5.1.5 Issues, including the two cases of collusion in procurement, were flagged and resolved in a timely manner. The Bank team's six project procurement and financial management country offices-based specialists provided adequate oversight and efficient and effective support to address fiduciary compliance. This was particularly important with respect to procurement issues, since all procurement documents were drafted in the local languages. The Bank's country office-based environmental safeguards and social development specialists supervised compliance of the Bank safeguard policies in all three countries and thus maintained cross-country consistency on safeguards supervision. Such arrangements and efforts were highly appreciated by all three participating countries. The Bank team's quality of supervision was recognized positively by the September 2009 QAG assessment, but no rating was provided. In April 2012, the Bank awarded a 2012 East Asia and the Pacific (EAP) Vice Presidency Unit (VPU) Team Award to the project for its successful implementation and significant developmental impacts.

**(c) Justification of Rating for Overall Bank Performance**

Rating: Satisfactory

5.1.6 Despite the constraints and challenges that such an innovative, multi-country demonstration project presented during project preparation and implementation, the Bank maintained a highly responsive team throughout the project design, implementation and completion phases, which resulted in solid provision of support on every aspect of project implementation to the country teams and FAO. The Bank team played a decisive role in the success implementation of the project, as well as facilitated follow-up actions in all three countries at project completion.

**5.2 Borrower**

**(a) Government Performance**

Rating: Satisfactory

5.2.1 The governments of all three participating countries provided strong political and financial commitments to the project. They were responsive and supportive to the project activities, and actively coordinated project preparation and implementation in their respective countries. The contributions and support made by each government, which are considered adequate, flowed through each government's designated project implementing agency. Both the national and local governments of the three countries participated in project interventions actively. At project completion, it was calculated that the three governments had each provided higher levels of counterpart funding than had been committed at appraisal.



## **(b) Implementing Agency or Agencies Performance**

Rating: Satisfactory

5.2.2 Four implementing agencies were involved in project preparation and implementation: three country PMOs and the RFO of FAO. All implementing agencies contributed significantly to project preparation and implementation, delivering counterpart funding committed by the three countries and FAO, establishing functional institutional arrangements for project implementation, and mobilizing needed technical support to facilitate project implementation. In addition, the Bangkok-based FAO RFO provided regional support services to the three country implementing agencies for capacity building, coordination and facilitation and knowledge dissemination.

5.2.3 As noted earlier, the lack of experience with Bank projects and organizational adjustments within the three country implementing agencies did contribute to a slow project implementation start. However, implementation was quickly accelerated following PMO reorganization and improved understanding of Bank operations generated through “learning by doing”, training, study tours and hands-on support provided during Bank supervision missions. Ensuring the functionality of the three PMOs allowed project implementation to be successfully completed, despite the challenges experienced, in particular by Vietnam and Thailand, during implementation. Overall, all the implementing agencies were responsive to implementation issues identified by supervision missions, and closely followed the Bank’s recommendations in order to resolve issues in a timely manner. All implementing agencies also carried out the M&E activities in accordance with the agreed M&E plans. Although the FM performance of two PMOs (see 2.4.2 for details), is rated as only moderately satisfactory, given the overall complexity of the project and the well-structured and well-managed overall management performance which allowed problems to be quickly identified and resolved, this aspect is not considered to sufficiently tilt the balance away from an overall Satisfactory rating.

## **(c) Justification of Rating for Overall Borrower Performance**

Rating: Satisfactory

5.2.4 Despite an initial steep learning curve for the three country implementation agencies, each of which was new to Bank operations, the three governments and their implementing agencies demonstrated strong commitment with regard to the project’s objectives and its implementation, as well as on replication and scaling up of the project’s demonstrated practices in their respective countries. Successful project completion and ongoing implementation of replication actions underscore the borrowers’ satisfactory performance.

## **6. Lessons Learned**

6.1 Stakeholders’ strong commitments. To ensure project ownership, sustainability and success, strong commitments are needed - from government partners (for compliance, enforcement, and provision of incentives) and from key stakeholders (for full involvement in project preparation and implementation). The project succeeded in gaining strong commitments from all stakeholders through: (a) integration of project interventions with the governments’ mainstreamed programs; (b) implementation based

on existing institutional mechanisms; and (c) identification and involvement of key local stakeholders such as, village committees and the women's federation in China, pig cooperatives in Vietnam, and local administrations, communities, and nongovernmental organizations in Thailand, on project design and implementation.

6.2 Technology selection based on actual country situations. Livestock waste management technologies should be simple to operate and compatible with the various waste-handling practices and methods of livestock farms, be cost-effective and offer financial returns and, be able to be locally developed and serviced. A number of LWM technologies exist, ranging from simple to complex, with various cost implications that range from moderate to high. As demonstrated by the project, selection of such technology should be based on country specific conditions to ensure acceptance, feasibility, efficiency and sustainability of project investments.

6.3 Comprehensive approach for long-term sustainability. This project's comprehensive approach integrated a suite of actions ranging from demonstration of technical solutions, development of policy development and improvement in enforcement, capacity building and awareness-raising, to regional coordination and dissemination. Successful demonstration of technical solutions provided concrete waste management practices that are financially viable, environmentally sound, socially beneficial and locally accessible, showcasing what could be studied and further replicated in the countries. Such demonstration also formed the basis for development and implementation of country specific policy actions such as the Replication Strategies and improvement in environmental enforcement. The needs and results of such demonstration then helped refine capacity building activities to match the actual needs, as did increased awareness among all stakeholders, which improved acceptance of project interventions and replication actions. Knowledge sharing among the project countries and at the regional and global levels was also key.

6.4 Procurement lessons, including (i) selecting qualified procurement consultants and maintaining designated PMO procurement staff unchanged throughout the project implementation period are critical for procurement success; (ii) a sub-grant approach instead of using the conventional procurement method could be considered with detailed procedures specified to ensure fair competition, economy, efficiency, quality, and transparency; and (iii) contracting period could be more realistically estimated and contract implementation should be well managed for timely completion.

6.5 Financial management lessons, specific for Vietnam, including: (i) adequate FM staff should be designated for project financial management; (ii) adequate training should be provided to FM staff to ensure effective management of project accounting works; (iii) management of FM documents on counterpart funding provision for project financed waste treatment facilities should be improved; and (iv) the Project Operational Manual should be updated regularly to improve internal control weaknesses.

## **7. Comments on Issues Raised by Borrower/Implementing Agencies/Partners**

### **(a) Borrower/implementing agencies**

7.1.1 The following is a summary of the Bank team's comments on the general issues raised by the participating countries.

- The World Bank shall continue to focus on the global environmental issues - livestock waste management in particular; promote new technologies and experience sharing; follow up on long term monitoring of this project and implementation of Replication Strategies in the participating countries; and launch a second phase demonstration project.

Bank team comment: The Bank is committed to the areas proposed and values highly the close cooperation with all participating countries and the FAO as demonstrated during the project preparation and implementation. The Bank is willing to work with Thailand and Vietnam and is working with China to scale up demonstrated practices under this GEF project in Guangdong. While interested in exploring opportunities for future cooperation, the Bank thanks Thailand and Vietnam for take continued actions to ensure project sustainability and promote replication as committed.

- The World Bank's procurement regulations have too many processes and are not flexible. Time taken for World Bank's review was excessive in earlier years of project implementation. The disbursement procedures were complicated which often caused delay in project implementation.

Bank team comment: These are the lessons learned. Procurement delays were often related to misunderstanding and lack of experience with Bank procurement policies. As witnessed in final years of project implementation, timely and cordial communications between the Bank and the clients, procurement training and learning from experienced PMOs of other Bank financed projects have helped address such delays.

**(b) Cofinanciers**

7.1.2 No cofinancier was involved in this project.

**(c) Other partners and stakeholders**

7.1.3 No comments were received from other partners or stakeholders.

## Annex 1. Project Costs and Financing

### (a) Project Cost by Component (in USD Million equivalent)

Components	Appraisal Estimate (US\$ million)	Actual /Latest Estimate (US\$ million)	Percentage of Appraisal
1.Livestock Waste Management Technology Demonstration	14.15	17.89	126.43
2.Policy and Replication Strategy Development	4.43	2.78	62.75
3.Project Management and Monitoring	3.93	2.96	75.32
4.Regional Support Services	1.50	1.51	100.67
<b>Total Baseline Cost</b>	<b>24.01</b>	<b>25.14</b>	<b>104.71</b>
Physical Contingencies	-		
Price Contingencies	-		
<b>Total Project Costs</b>	<b>24.01</b>	<b>25.14</b>	<b>104.71</b>
Project Preparation Facility (PPF)	0.70	0.70	100
Front-end fee (IBRD only)			
<b>Total Financing Required</b>	<b>24.71</b>	<b>25.84</b>	<b>104.57</b>

### (b) Financing

Source of Funds	Type of Financing	Appraisal Estimate (US\$ million)	Actual/Latest Estimate (US\$ million)	Percentage of Appraisal
Government		9.85	10.11	102.64
Private Sector		6.66	6.67	100.15
FAO		0.50	0.53	106.00
GEF		7.00	6.92	98.86
GMI		-	0.91	N/A
Total		24.01	25.14	104.71

## **Annex 2. Outputs by Component**

1 As designed during project preparation, it was expected that on-the-ground demonstrations of innovative, cost-effective LWM technologies by private livestock producers and development of country specific replication strategies would be the project's principal outputs. Many other outputs were also achieved under the project, but most were not targeted because the actual physical demonstration sites for improved LWM (number of sites and covered SPPs) could not be pre-decided during project preparation. The demonstration sites were selected on a yearly basis by each participating country according to agreed selection criteria, specific technologies to be introduced and availability of project funds.

### **Component 1: Livestock Waste Management Technology Demonstration**

2 This component addressed the need to demonstrate technically, geographically, economically and institutionally workable solutions to reduce regionally-critical livestock waste pollution caused by industrial or concentrated livestock production, with a focus on reducing excess nutrients (nitrates and phosphates in particular) and human health risks. This was achieved through construction of LWM facilities supported by training programs. These were achieved with the following key outputs.

- (a) A total of 58 LWM systems supported by 10 proven LWM technological packages were constructed. An estimated total of 653,000 SPP were covered by these systems in the three participating countries, which is 57 percent higher than the appraisal target.
- (b) An additional 679 farms with an estimated total of 1.9 million SPP followed the project practices in the participating countries as part of the project's replication efforts.
- (c) An average of 89 percent of P, 85 percent of N, and 95 percent of BOD were removed from the participating farms and the quality of treated livestock wastes on participating farms now meet the national discharge standards of the respective countries. This implies that an annual total of 1,500 ton of phosphorus, 2,600 ton of nitrogen, 17,200 ton of BOD and 45,400 ton of COD were prevented from reaching the South China Sea. During the project implementation period, a total reduction of 2,100 ton of phosphorus, 3,600 ton of nitrogen, 23,900 ton of BOD and 63,100 ton of COD was reported.
- (d) Over 90 percent of total E. coli was reduced in participating farms in China and Thailand. In Vietnam, important reductions in infectious diseases (all closely associated with pig production) were reported as a result of project implementation including, intestinal diseases down from 53 percent to 12 percent, surface water-caused allergy reduced to 6 percent from 35 percent, methane-caused eye diseases down from 24 percent to 12 percent, and respiratory diseases reduced to 6 percent from 18 percent.

- (e) A total of 219,200 tCO<sub>2</sub>e of greenhouse gas emission reductions was reported during the project implementation period and an annual reduction of about 149,500 tCO<sub>2</sub>e, as of 2012, has been estimated.
- (f) A total of 10.1 million m<sup>3</sup> of biogas was generated during the project implementation period and an annual generation of 5 million m<sup>3</sup> of biogas, as of 2012, has been estimated.
- (g) A total of 46.4 million Kwh of biogas-fueled electricity was generated during the project implementation period and an annual generation of 27.6 million Kwh of biogas-fueled electricity, as of 2012, has been estimated.
- (h) A total of 16,000 ton of dried digested pig manure was sold during the project implementation period and annual sales of 13,500 ton of dried digested pig manure, beginning in 2012, have been estimated.
- (i) Three manuals for the operation and maintenance of livestock waste treatment system were developed.
- (j) During the project implementation period, the following were organized: (i) 114 workshops, attended by 809 persons; (ii) training of 3,100 person-days and 3,600 person-days respectively for staff and farmers; (iii) 36 domestic study tour groups involving 422 persons; and (iv) 11 international study tour groups involving 111 persons.

## **Component 2: Policy and Replication Strategy Development**

3 This component supported the establishment of a policy and regulatory framework for environmentally sustainable development of livestock production in each country that would induce further policy reforms and encourage farmers to adopt improved manure management practices. This was achieved through the development and testing of a Replication Strategy and other policy measures in each country. These were achieved with the following key outputs.

- (a) A total of three Country-specific Replication Strategies were finalized by respective country. The Replication Strategy report was submitted by each country in accordance with their project's respective closing date. In order to incorporate the Bank's comments, as well as the latest results of project implementation, experiences and lessons, policy developments and study tour results, the three countries took some additional time to finalize their Replication Strategies. These were all received by the Bank in April and May 2012.
- (b) Three Spatial Distribution Plans were developed and implemented, generating improved capacities in all three participating countries.
- (c) Fifty-eight (58) nutrient management plans for livestock waste were developed and then integrated in farm specific mini-PIPs for all participating farms.
- (d) Other policies developed during the project implementation included: (i) Nutrient Flux Management for Demonstrated Farm (China); (ii) Code of Practice for Livestock Waste Management Project (China); (iii) Code of Practices and Regulation for Environmental Management in Pig Farms (Thailand); (iv) Technical Base for Regulation on Environmental Protection in Animal Husbandry Activities

(Vietnam); and (v) Emission Norms of Livestock Waste Water Pollutants (Vietnam).

### **Component 3: Project Management and Monitoring**

4 This component supported the establishment and operations of a national (provincial in China) PMO and other implementing units in each participating country and effective project monitoring and evaluation. These were achieved with the following key outputs.

- (a) National Steering Committees (NSCs) and a Project Leading Group (PLG) in Guangdong province were established and maintained throughout the project implementation period, and assigned with functions and responsibilities satisfactory to the Bank.
- (b) One PMO in each participating country was established and maintained throughout the project implementation period, and furnished with sufficient resources and an adequate number of competent staff.
- (c) Local implementing units were established and maintained throughout the project implementation period.
- (d) About 9,100 copies of implementation manuals, 134,100 copies of project brochures, and 1,100 copies of DVDs and VCDs were disseminated.
- (e) A total of 63 monitoring reports were prepared. In addition, periodic evaluations were carried out and monitoring results were reflected in semi-annual progress reports prepared by the participating countries.

### **Component 4: Regional Support Services**

5 This component focused on capacity building support and coordination and facilitation support. The key outputs achieved included the following:

- (a) Three decision support tools (DST) were developed together with the participating countries: Cost of Compliance Simulation Model (CoSiMo), Spatial Planning, and Environmental Monitoring Guidelines. The CoSiMo was developed and disseminated in the three participating countries. The Spatial Planning served Thailand only because the other two countries did not request the service. The Environmental Monitoring Guidelines were developed to provide guidance to participating countries on water, odor sampling and their analysis. The fourth DST, the STRAW, which was not completed by the project closing date, is being finalized with FAO financing. A draft version of the STRAW is available.
- (b) Four training modules were developed and various trainings were organized including five training courses for CoSiMo, four development sessions for STRAW, continued support to the Thailand PMO during the last year of project implementation via a Thai consultant for Spatial Planning, and presentation of the Environmental Monitoring Guidelines in each country.
- (c) A total of six RCG meetings were held. Meeting minutes were prepared in each case to share information and exchange experience during the project implementation period.

- (d) A regional pool of experts has been formed.
- (e) The project website was developed and maintained by the RFO and used to transfer main project results on to the FAO website to ensure long-term availability. Five issues of project newsletters were distributed to all participating countries. A project brochure was prepared, printed and distributed to countries. A Project Experience Note following the IWLEARN format was also prepared.



### **Annex 3. Economic and Financial Analysis**

1. Consistent with the approach adopted at project appraisal, a cost-effectiveness analysis was performed to evaluate the project's efficiency in achieving project objectives. This analysis however included carbon emission reduction as an important benefit that emerged during project implementation.

#### **A. Economic Analysis**

2. The project's main economic benefits were derived from: (a) direct energy savings by using project produced biogas and biogas-generated electricity; (b) the sale of dried treated sludge and pig manure; (c) increased on-farm and off-farm agricultural production (crop, orchard and fish); (d) reduced carbon emissions; (e) reduced pollution in the public waters leading to the South China Sea; (f) improved environment for participating farms and for neighboring communities; (g) reduced human health risks and, (h) the expected improved efficiency of government agencies in public administration and improved capacity of government staff in managing livestock waste in the three participating countries through similar domestic investment programs. As many of the above economic benefits cannot be easily quantifiable and some benefits are remotely relevant to the project objectives, this project's economic analysis focused on cost effectiveness of project intervention to assess the efficiencies of various technical solutions.

3. Various technological packages are available to remove excess nutrients and organic matter from livestock wastes, such as composting, aeration processes and anaerobic digestion (AD). Composting is the least-cost option suitable for farms that handle solid wastes only, with very low carbon-reduction potential and no biogas generation. Aeration processes are effective only when adequate retention time and a series of processes are ensured. The aeration processes are very costly if electricity is used to provide adequate oxygen to satisfy the biological demand of the livestock waste. Such processes require sizable land areas and are suitable for farms that handle dilute wastes, where emissions can be high. AD is an anaerobic (without oxygen) biological process that stabilizes waste material, reduces BOD, produces biogas, and trace amounts of hydrogen sulfide. Biogas is combustible and when recovered may be used in renewable energy applications such as electrical generation, heating, cooking fuel, and lighting, among others. Digested solids are used as fertilizer for crops, orchards and gardening while digested liquids are used as liquid fertilizer for crops, orchards and water plants, as well as for fish feed. In some cases, such liquids, post-sanitation and disinfection processes, are recycled as cleaning water for pig barns. In addition, AD reduces carbon emissions which bring real or potential carbon emissions reduction revenue to participating farms. As a result, all participating countries sought to adopt the AD biogas-recovery technological packages.

4. Various commercially proven ADs are available for farms of various sizes, with an associated range of operational complexity and costs. To achieve the project objectives, the project introduced and demonstrated a total of ten proven technological packages (combined AD treatment and various other processes) to effectively remove

nutrients and prevent discharge of untreated livestock waste into the waterways. These AD technologies are proven to be highly efficient in reducing fluxes of critical nutrients (N, P) and organic matter (BOD) originating from livestock waste into the environment. The following table provides a comparison of nutrient removal efficiencies and costs of project-demonstrated technological packages against the Using Combined Treatment and Recycling Technology option (the benchmark option) developed at project appraisal.

5. The nutrients and organic matter removal rates of the benchmark option listed in the above table were considered, at appraisal, realistic, optimal and best able to contribute to achievement of project objectives. These rates and the associated costs were therefore, used as the benchmarks against which the project's demonstrated technological packages would be compared. All project demonstrated technical solutions used the combined AD treatment with additional processes including: (a) composting; (b) land application or sale of composted or digested solids; (c) aerobic exposure in series storage ponds for digested liquids; (d) growing water plants (green algae, water spinach etc.) and raising fish in storage ponds; and (e) on-farm recycling of treated liquids to achieve the maximum results.

6. The comparison indicated that the unit investment cost per pig cycle of the aggregated average of all ten technological packages was \$2.06 in constant 2005 prices. This number is higher than the estimate of the benchmark option - \$1.42. The higher unit investment cost is due mainly to the following reasons: (a) demonstrated AD technologies required high investment costs but yielded robust financial returns to participating farms; (b) actual AD investment included additional components for improved treatment efficiency and operational safety; and (c) CDM-related requirements added investment costs of the facilities in Thailand (e.g. large digesters were required for long hydraulic retention time and wastewater/biogas flow meters were installed to properly monitor biogas generation). Exclusion of such additional facilities in Thailand would have resulted in no, or reduced carbon emissions reduction credits and thus, was not accepted. This higher unit cost is considered reasonable and justified for the technological packages because (a) the cost/ton of the nutrient removal at ICR was actually 16.9% and 8.1% lower than the benchmark option estimates for P and N, respectively; and (b) the project achieved higher nutrient removal efficiency i.e. removal of 152%, 58% and 280% more than the benchmark option targets on P, N and BOD respectively.

**Table 3.1: Nutrient Removal Efficiency and Costs**

Situations	Using Combined Treatment and Recycling Technology Option				
	Removal rate	cost/pig cycle (US\$)		Nutrient removal	
	%	per unit	for nutrient removal on one percentage point base	kg/pig cycle	cost/ton (US\$)
<b>Nutrient Safely Removed by Level 2 System (appraisal estimate)<sup>a/</sup></b>					
P <sub>2</sub> O <sub>5</sub>	80	1.42	N/A	3.20	222
P <sup>b/</sup>	35		0.040	1.41	504
N	55		0.026	0.55	1,291
BOD	25		0.057		
<b>Nutrient Safely Removed by the Technological Packages Demonstrated under the Project (ICR estimate)</b>					
<b>Project</b>	<b>Weighted average of all 10 technological packages</b>				
P	89	2.06	0.023	3.55	419
N	87		0.024	0.87	1,187
BOD	95		0.022		
<b>China</b>	<b>1. Large scale up-flow fixed dome package</b>				
P	94	2.13	0.023	3.76	426
N	99		0.022	0.99	1,077
BOD	98		0.022		
	<b>2. Red-mud Plastic Baffled Reactor package<sup>2.43</sup></b>				
P	70	3.88	0.055	2.80	1,891
N	38		0.102	0.38	5,103
BOD	97		0.040		
	<b>3. Underground Series Domes package</b>				
P	96	2.33	0.024	3.84	496
N	94		0.025	0.94	1,237
BOD	99		0.023		
	<b>4. Pre-fabricated Steel Reactor Unit Package</b>				
P	99	2.33	0.023	3.96	481
N	100		0.023	1.00	1,163
BOD	99		0.023		
<b>Thailand</b>	<b>5. Channel Digester Plus Package</b>				
P	85	2.06	0.024	3.40	438
N	80		0.026	0.80	1,285
BOD	93		0.022		
	<b>6. Channel Digester Package</b>				
P	85	1.48	0.017	3.40	227
N	73		0.020	0.73	1,013
BOD	91		0.016		
	<b>7. Modified Covered Lagoon Package</b>				
P	87	3.01	0.035	3.48	917
N	79		0.038	0.79	1,905
BOD	89		0.034		
<b>Vietnam</b>	<b>8. Covered Lagoon Package</b>				
P	82	1.57	0.019	3.28	265
N	78		0.020	0.78	1,013
BOD	95		0.017		
	<b>9. Large scale up-flow fixed dome Package</b>				
P	94	2.01	0.021	3.76	378
N	99		0.020	0.99	1,015
BOD	98		0.021		
	<b>10. Household-based Small Scale Fixed Dome Package</b>				
P	79	1.53	0.020	3.14	264
N	67		0.023	0.67	1,145
BOD	75		0.020		

a/ No COD value was estimated and there was no distinction among three participating countries.

b/ Converted from P<sub>2</sub>O<sub>5</sub> values.

7. Such AD technological packages are more effective in removing nutrients and organic matter than the benchmark option. Nevertheless, variations in unit investment costs existed among ten technological packages due to (a) local availability of equipment, (b) fluctuating market prices of major inputs, (c) local capacity to design, build, and operate such facilities, and (d) preference and affordability of participating farmers. Variations also existed in unit costs associated with nutrient removal among the ten technological packages for P, and N. Noticeably, the Red-mud Plastic Baffled Reactor and the Modified Covered Lagoon technological packages yielded a cost/ton for nutrient removal higher than the benchmark option for both P and N indicating a lower efficiency of nutrient removal than the benchmark option. This was caused primarily by: (a) higher unit investment cost; (b) higher cost/pig cycle for nutrient removal on one percentage point base; and, (c) lower than average nutrient removal rates among ten technological packages.

8. The benchmark option was based on combined treatment (non-biogas techniques – composting, lagoons) and recycling (land application). Such a combination, at a lower unit investment cost, yielded a relatively lower efficiency in removing nutrients and organic matter. The ten AD technological packages however, required higher investment cost for the AD process but removed higher rates of nutrients and organic matter (through combination of AD and post-treatment processes). These AD technological packages therefore, contributed more significantly to the achievement of project objectives. As more nutrients and organic matter were removed, the higher unit cost presented as a form of geometrical progression. And, while recycling was fully promoted wherever appropriate under the project, various other alternative post-treatment options were also used including, drying bed for digested slurry, more and larger exposure and sludge storage ponds, water planting and fish raising, etc., but all came at a higher unit cost.

9. Farmers' interest in participating in the benchmark option was low even with a full financial subsidy to cover all investment costs. This was due to the fact that the benchmark option yielded a minimal financial return for the participating farmers - primarily from savings by using less chemical fertilizers and more pig manure on their land, and that no recovery of investments was projected under this option. In contrast, all participating farmers accepted an average subsidy of about 60% of their total investment cost and selected technological packages based on their specific farm conditions. These 10 AD technological packages have generated significant financial returns (see next section on Financial Analysis) to the project farms. This will make partial and even full recovery of the farm investment costs feasible.

10. The waste water discharge from benchmark option could partially meet the respective national standard of each participating country. However, all ten AD technological packages yielded satisfactory results which also met national discharge standards. The participating countries were convinced of and recognized that these technological packages could serve as models for national long-term replication and dissemination, as well as the basis for policy development and enforcement. They also highly valued all other economic benefits, both quantifiable and non-quantifiable, derived from project implementation of the ten AD technological packages.

11. Based on the above, it is reasonable to conclude that the ten AD technological packages introduced and demonstrated by the project were overall, highly efficient and

cost effective. Note that the variations in nutrient removal efficiency among the ten AD technological packages suggest that the selection and construction AD technological packages need to be carefully done to minimize unit investment costs and unit nutrient removal costs while maintaining efficiency for the delivery of optimal results in future programs.

## B. Financial Analysis

12. The project initially projected financing comprised of 25% of GEF grant, 25% grant from the government, matched by a 50 % investment from each participating farm. With additional support provided by the GMI in the form of power generators, gas flares and training, the actual share of the total cost of technology demonstration activities was 21%, 34%, 40% and 5% respectively for the GEF grant, government, participating farms and the GMI. The actual contributions made by the participating farms varied among the countries ranging from 26% in Vietnam, 36% in China and 54% in Thailand. Overall, the project provided in the order of a 60% financial subsidy to farms and contributed to improving participating farms’ revenues. This helped mobilize the strong interest from all participating farms’ in the project.

13. The following table provides a summary of estimated annual financial benefits at the project completion for the entire project, as well as by country.

**Table 3.2: Summary of Annual Financial Benefits at Project Closing**

Financial Benefit	China		Thailand		Vietnam		Total	
	Quantity	US\$000	Quantity	US\$000	Quantity	US\$000	Quantity	US\$000
Biogas produced (000M <sup>3</sup> )	4,856	2,312			154	27	5,010	2,339
Electricity generated (000Kwh)	10,442	994	16,047	1,360	1,076	79	27,565	2,433
Dried sludge/pig manure sold (000ton)			9	301	5	44	14	345
CER revenue (000tCO <sub>2</sub> e)	44	786	102	1,835	4	68	150	2,689
Contracted (000tCO <sub>2</sub> e)			94	1,685			94	1,685
Potential (000tCO <sub>2</sub> e) 1/	44	786	8	150	4	68	56	1,004
<b>Total Benefit</b>		4,092		3,496		218		7,806

1/ Expected revenue is the CER amount generated but not yet contracted.

- (a) Despite the mostly public goods nature of the project, a financial analysis was conducted to evaluate the project’s financial attractiveness to participating farms and draw conclusions for future promotion. To assess the project’s financial performance, a financial cash flow analysis, with the following assumptions, was carried out for one typical participating farm in each country. Inputs and output prices. The analysis was based on market prices for all tradable goods and labor, using 2012 constant prices.
- (b) Calculation period. A 20-year period was used for cash flow analysis purposes based on commonly accepted depreciation period for the major AD facilities constructed.

- (c) Opportunity cost of capital (OCC). An 8 percent OCC was used to estimate the NPV, and as a benchmark in computing the financial internal rate of return (FIRR).
- (d) Financial benefits. The main financial benefits included biogas; biogas-generated electricity; sale of dried digested sludge and pig manure; saved labor costs; increased fish production (in Vietnam only) and revenue from transaction of certified carbon emission reduction for the first two years (in Thailand only).
- (e) Financial costs. The financial costs included both investment costs and operating costs.
- (f) Only incremental values were used in the analysis.

The results of the financial analysis were shown in Table 3.3.

**Table 3.3: Financial Analysis for Typical Participating Farms (in US\$)**

	Hengchang Farm - China		Wanchai Farm - Thailand		Loc Farm - Vietnam	
	Year 1	Years 2-20	Year 1	Years 2-20	Year 1	Years 2-20
<b>In-flow</b>	17,714	560,952	22,015	2,194,761	10,804	260,799
<b>Incremental income</b>	16,686	528,381	20,147	1,843,615	8,544	217,866
Certified mission reduction			10,800	86,400		
Biogas					1,177	29,925
Electricity	16,686	528,381	9,347	1,757,215	2,655	67,364
Pig manure					4,712	120,577
<b>Other income</b>	1,029	32,571	1,868	351,146	2,260	42,933
Labor cost saved	1,029	32,571			1,538	29,231
Dried digested sludge			1,868	351,146		
Increased fish production					721	13,702
<b>Out-flow</b>	74,381	443,333	453,618	996,261	131,291	19,000
<b>Investment costs</b>	57,143		407,815		130,541	
AD facility	23,810		286,286		128,618	
Electricity generator	33,333		95,312		1,923	
Other cost			26,217			
<b>Operating Costs</b>	17,238	443,333	45,803	996,261	750	19,000
Land rental	159	3,016				
Labor cost	4,762	90,476	4,271	162,305		
Packing for pig manure	9,143	289,524	610	23,186	649	16,442
Utilities			1,750	66,517	14	365
Maintenance cost	3,175	60,317	34,561	656,659	87	2,192
Lab and calibration expenses			4,610	87,593		
<b>Net cash flow</b>	-56,667	117,619	-431,603	1,198,500	-120,487	241,799
<b>NPV</b>	2,578		186,185		1,602	
<b>FIRR for full investment</b>	8.7%		14.7%		8.2%	
<b>FIRR for farmer's own investment</b>	19.7%		19.2%		31.0%	

14. The financial analysis indicated that the FIRR of the typical farms on full costing was 8.7%, 14.7% and 8.2% respectively for China, Thailand and Vietnam, with an NPV of US\$2,578, US\$186,185 and US\$1,602 respectively for the three participating countries. The much higher FIRR for Thailand was driven by CER revenues (3.5%) and the sale of dried digested sludge (5.9%) under a well developed market for treated

manure. The marginal FIRR for China and Vietnam was acceptable to the participating countries and the participating farmers, and indeed was beyond the initial expectations on the part of key stakeholders' with regard to an environment-focused project. These financial analysis results justify the project financing arrangement. For all three countries' typical farms, the cash revenues were adequate to cover all operating costs of the AD technological packages and partially or even fully recover their investment costs. The following should be noted:

- (a) With farmers' own contributions in the range of 36%, 54% and 26% of the total investments respectively for China, Thailand and Vietnam, participating farmers were able to construct one of the project-introduced technological packages with the necessary technical support which resulted in them being able to meet government LWM requirements. In addition, the project helped achieve an FIRR of about 20% (China), 19% (Thailand) and 31% (Vietnam) on the participating farmers' own investments based on analysis of undertaken at typical farms. These were the obvious incentives that attracted the strong interest of farmers in participating and secured their commitment to contribute.
- (b) This calculation did not include a number of other non-cash revenue and off-farm benefits such as supply of free biogas and free digested slurry to neighbors, improved crop quality and increased crop yield by other farmers using digested sludge or slurry, or savings from on-farm recycling of treated waste water, suggesting that the actual financial returns are likely to be even higher than those calculated.

15. Overall, the project's financial analysis concluded that the project is financially attractive to all participating farms to sustain operations of their LWM facilities, and that the significant subsidies provided helped mobilized farm participation to demonstrate selected AD technological packages. Clearly, the initial capital cost may be a barrier to such investments, even though the financial pro forma shown by the project is favorable. In addition, local consultations held during project implementation with farmers to determine their willingness to pay have indicated that once the technology is seen and accepted as efficient, medium and large farms are willing to shoulder the majority of the cost. However, almost all farmers interviewed were not willing to pay for more than 60% of investment costs because pig production remains a high-risk business suffering from frequent pig epidemic diseases and unpredictable market price changes of pig products. Furthermore, it was indicated that farmers would be more willing to act and take on these extra costs if: (a) regulations and their enforcement were strengthened; (b) increased market demand for treated manure products was in evidence; and, (c) public pressure demanding improved farm environmental performance increased.

16. As shown in the Thailand case, an additional benefit is the carbon emission reduction credits that may be generated from project financed facilities. Such a steady stream of additional CDM revenue will further improve financial incentives of the farms to manage their wastes properly even though the CDM process so far has been slow and complicated for the two associated Thai CDM projects.

## Annex 4. Bank Lending and Implementation Support/Supervision Processes

### (a) Task Team members

Names	Title	Unit	Responsibility/ Specialty
<b>Lending</b>			
Yi Dong	Sr Financial Management Specia	EAPFM	
Achim Fock	Senior Economist	AFTAR	
Jennifer Ifft	Junior Professional Associate	EASRE - HIS	
Xiaoping Li	Senior Procurement Specialist	AFTPC	
Patricia Miranda	Senior Counsel	LEGIP	
Margaret Png	Lead Counsel	LEGEM	
Chongwu Sun	Senior Environmental Specialis	EASCS	
Weiguo Zhou	Consultant	EASER	
Cornelis de Haan	Consultant	ARD	
<b>Supervision/ICR</b>			
Quang Ngoc Bui	Operations Officer	EASVS	
Waraporn Hirunwatsiri	Environmental Specialist	EASTS	
Minhnguyet Le Khorami	Program Assistant	EASER	
Oithip Mongkolsawat	Senior Procurement Specialist	EAPPR	
Dzung The Nguyen	Senior Rural Development Spec	EASVS	
Hoai Van Nguyen	Procurement Specialist	EAPPR	
Cung Van Pham	Sr Financial Management Specia	EAPFM	
Quynh Xuan Thi Phan	Financial Officer	GEF	
Nipa Siribuddhamas	Financial Management Specialis	EAPFM	
Chongwu Sun	Senior Environmental Specialis	EASCS	
Kien Trung Tran	Senior Procurement Specialist	EAPPR	
Ha Thuy Tran	Financial Management Specialis	EAPFM	
Ly Thi Dieu Vu	Consultant	EASVS	

### (b) Staff Time and Cost

Stage of Project Cycle	Staff Time and Cost (Bank Budget Only)	
	No. of staff weeks	USD Thousands (including travel and consultant costs)
<b>Lending</b>		
FY03		28.59
FY04		126.71
FY05		206.78
FY06		93.87
FY07		2.13
FY08		0.00



	<b>Total:</b>	458.08
<b>Supervision/ICR</b>		
FY03		0.00
FY04		0.00
FY05		0.00
FY06		25.01
FY07		58.51
FY08		66.75
	<b>Total:</b>	150.27

## **Annex 5. Beneficiary Survey Results**

No beneficiary survey was performed.

## **Annex 6. Stakeholder Workshop Report and Results**

No stakeholder workshop was organized.

## **Annex 7. Summary of Borrower's ICR and/or Comments on Draft ICR**

### **Summary of China ICR**

1. Governments at all levels (national, provincial, county) demonstrated their continued commitments. Collaboration among government agencies has been working effectively and government line agencies played their respective and active roles in the project. Involved government line agencies included the Ministry of Finance, the Ministry of Agriculture, the Ministry of Environmental Protection at the national level; the Department of Finance, the Department of Agriculture, the Department of Environmental Protection and the Department of Health in Guangdong Province; the Bureaus of Agriculture in Boluo and Heyuan counties. The Guangong PMO was established and located in the Guangdong General Station of Agricultural Environment Protection and Rural Energy Resources under the Guangdong Department of Agriculture. All participating farms showed their strong interests in the project.

- (a) The project has played an exemplary role in demonstration and dissemination of sound livestock waste management practices in Guangdong. The project supported 23 participating farms with a total standing pig population (SPP) of 262,000 in four types of AD technological packages for livestock waste management – large scale up-flow fixed domes, red-mud plastic cover baffled reactor, underground series domes, and factory-fabricated and field-assembled steel reactor units. All were recognized as the best practices in efficiency, effectiveness and sustainability in livestock waste management technologies in Guangdong. During construction and operation of these technological packages, about 1,600 visitors from Guangdong and other provinces of China as well as international visitors from 13 countries visited the demonstration farms. As immediate results of the project, (i) the project area was extended to Heyuan County of the province; and (ii) as of December 31, 2010, about 75% of the total number of pig farms in Boluo County had followed the project practices, an increase of about 78% against the pre-project situation in 2006.
- (b) Project has promoted the development of a harmonious society in rural areas through various social undertakings such as (i) four participating farms offer alternative supply of bio-gas energy as cooking fuel to a total of 529 households which increased to 5,187 households by end of 2010 in Boluo county; (ii) Luoxing farm provide free biogas to the Yihe Primary and Middle Schools of about 1,200 students and teachers to support poor drop-out students to come back to school and improve teaching facilities with the saved energy costs; (iii) Mashigang farm and Yihu farm provided treated sludge free of charge to a vegetable farm and a greenhouse farm respectively, and the practice was followed by many other participating farms.

### Beneficiaries of Alternative Supply of Biogas

Name of farm	Benefiting Households (No.)		Total Benefiting Persons (No.)
	Total	Of which, previously using fuel-wood	
Taimei	125	115	625
Xuhui	130	130	676
Shunchang	186	170	893
Xinhua	88	26	448
Total	529	441	2,642
Total in Boluo county by end 2010	5,187	3,883	25,935

- (c) Funded by the GMI, two biogas specialists from Guangdong province visited project sites in Vietnam in December 2009 and May 2010 respectively to provide technical support to the Vietnam PMO. This support was highly recognized by the Vietnam PMO as well as the supported farmers.
- (d) Suggestion. China proposes that the World Bank continues to focus on the world-wide development and environmental issues, especially in livestock waste management in China, to continue providing technology, experience, management mechanism and funds to help developing countries; to help relevant countries and regions in the way of projects or other cooperation, communication, professional and management training for their progress and development; continue promoting the technology and experience exchange, enhancing communication and concerning about the effects of replication in the countries or different parts. We recommend that the World Bank continue to assist the developing countries to promote the above task.

### Summary of Thailand ICR

2. Eleven government line agencies from four ministries – the Ministry of Finance, the Ministry of Agriculture and Cooperatives, the Ministry of Natural Resources and Environment (MONRE), the Ministry of Public Health – and governments at relevant provincial and Tambon levels were involved in project preparation and implementation. The national PMO was established and located in the Department of Livestock Development of the Thailand Ministry of Agriculture and Cooperatives.

- (a) The project supported 20 participating farms with a total SPP of 286,000 in three types of AD technological packages for livestock waste management – channel digester plus, channel digester and modified covered lagoon. These packages are proven technologies with robust design and no negative impact on environment. Close cooperation with PCD, DEDE, ERDI and consultant team ensured technical support and services to participating farms.
- (b) The PMO has organized 10 workshops with a total of 500 participants, various training, public awareness-raising campaigns, and distributed environmental

campaign poster for pig farms through PLOs, pamphlet of DLD biogas system for small pig farms and delivered various training for about 6,600 trainees.

- (c) There were encouraging practices found during project implementation (i) despite significant delay in physical construction of demonstration facilities, Thailand successfully integrated two CDM Livestock Waste Management Programs into the project; (ii) Sa-ard farm has been sharing its biogas with the nearby Ban Huay Yang Elementary School of about 150 students for lunch preparation since 2009, and (iii) with the soft loan kindly provided by other participating farms, one farm was able to overcome its financial liquidity problem and continue its participation in project.
- (d) Challenges. The project has been implemented with some main challenges which shaded unfavorable impact on project implementation: (i) frequent change of DLD management (5 deputy director generals and 4 directors of Bureau of Livestock Standard and Certification in 6 years); (ii) slow government internal process for funding by the Cabinet and within DLD; (iii) frequent typhoons, floods and social unrest in 2008 and 2009; and (iv) DLD's lack of experiences in implementing a co-financed project that required a process for the Cabinet resolution.
- (e) Feedback from participating farmers. Their feedbacks focused on (i) positive experience which included that they were happy with their new technology and receive full support from consultant teams; they improved relationship with their neighbors in general with improved environment and with cropland farmers in particular who utilized treated wastewater as fertilizer; they achieved improved financial returns by saving on-farm power expense from using biogas generated electricity and sale of the dried digested sludge; the GEF grant, government subsidy and other financial support built their confidence and greatly reduced their financial pressure for investment; (ii) suggestions for improvement which included that project be implemented faster without delay and investment cost be lower;
- (f) Feedback from government agencies. Their feedbacks in general were mostly positive. The national PMO had close collaboration with the MONRE, the Ministry of Public Health and local government offices. They provided very useful information, shared their experience and rendered their services for project implementation. Provincial, district and TAO officials in project area have been very positive and supportive to the project. They assisted the PMO in communication with farmers and making meeting arrangements. The suggestion is that more workshops and trainings should be organized for government agencies to get them more familiar with COPs developed under the project and more efficient and effective in applying such COPs.
- (g) Feedback from the consultant teams. Several consultant teams were hired to provide services on project site survey, technical design, construction of livestock waste management facilities, and O&M. They shared their feedbacks in the following areas: (i) the PMO and consultant teams shared good experiences; (ii) with clear working scope, consultant teams could plan and work within an agreed

- time frame; (iii) the PMO had an efficient management for project implementation; (iv) the electricity generator, instrumentation or biogas flare should be separated from the construction bidding package; and (v) a minimum of one year service contract for system operation and maintenance should be signed to ensure sustainability.
- (h) Procurement Aspects. (i) Training was well provided to PMO; (ii) good explanations were given for any queries; (iii) the World Bank Procurement has too many processes and takes long time; and (iv) procurement was not so flexible.
  - (i) Concerning three types of AD technological packages for livestock waste management – channel digester plus, channel digester and modified covered lagoon – actually the project should have demonstrated more various types of AD treatment systems because Thailand has various different areas that must be considered together with the cost of system. Finally farmers will select appropriate types for them. It will be better if we have many types of solutions for them. However Thai PMO had very limited opportunities to choose any AD systems other than Channel Digester and Channel Digester Plus because they are proven technologies according to the CDM program condition and every farm participating in the project needed to bundle together under the same technology to meet the GHG mitigation target.
  - (j) Concerning Recycling, PMO focused more on treatment system than recycling. So Integration of crop and livestock sector was not done efficiently and systematically. The model of Area Wide Integrated farming project (crop and livestock) was not demonstrated and evaluating the result of the project.
  - (k) COP is well developed with complicated options, it needed to be tested by TAO in different area. So COP must be distributed for TAO testing.
  - (l) Suggestion: (i) M&E for Channel Digester Plus and Modified Covered Lagoon should continue after project completion; (ii) M&E for CDM projects should continue after project completion; (iii) various models of Area Wide Integrated farming project (zero waste) should be developed and promoted to crop and livestock farmers for sustainable environment; (iv) COP test in the area of TAO before COP announcement; (v) extension of spatial planning to TAO application; and (vi) international study tour among participating countries should be promoted for exchanging experience on waste management.

### **Summary of Vietnam ICR**

3. The State Bank of Vietnam and five ministries – the Ministry of Natural Resources and Environment, the Ministry of Agriculture and Rural Development (MARD), the Ministry of Health, the Ministry of Finance, the Ministry of Planning and Investment – and governments at relevant provincial and district levels were involved in project preparation and implementation. The national PMO was established and located in the Ministry of Natural Resources and Environment.

- (a) The project supported 14 demonstration systems with a total SPP of 105,000 in three types of AD technological packages for livestock waste management –

- covered lagoon, large scale up-flow fixed domes (Chinese technology) and household based small sized fixed underground dome. These proven technologies fit the country's situation very well. This was achieved with unremitting efforts of everyone involved and with the excellent technical support and backups of two leading Chinese biogas specialists who paid two visits to Vietnam during 2009 and 2010. The Manual on Operation and Maintenance of Livestock Waste Treatment System was developed and disseminated to many provinces in Vietnam.
- (b) The PMO had been working under the direction of the National Steering Committee and also worked very closely with line government agencies at national, provincial, district levels, participating farms and consultant teams during project preparation and implementation. The PMO has also worked in close collaboration with FAO team in developing three major decision support tools. The PMO organized workshops to share information and exchange experience in demonstration of livestock waste management technology systems with different technologies in relevant biogas project conducted by MARD such as the Biogas Program for the Animal Husbandry Sector in Vietnam funded by the Netherlands Development Organization. During the implementation, the PMO, NSC members and representatives of farm owners attended the International Conference on Water Pollution Reduction and Climate Change Mitigation, RCG Meetings and the final workshop on project to share information and exchange experience in project results, outcomes with colleagues from China and Thailand.
  - (c) During project implementation, 92 training courses and workshops were held at national, provincial, district to commune levels for a total of about 9,000 participants; 19 national study tours and 2 international study tours were organized to (i) introduce and disseminate the project outcomes and livestock waste management technology; and (ii) contribute to effective project management and implementation.
  - (d) There are encouraging practices found during project implementation: (i) Dong Nai province is the first province in Vietnam to develop a master plan for livestock development and livestock waste management for the next 5 to 10 years; (ii) The Co Dong Livestock Cooperative and Thanh Hung Farm in Hanoi and Mrs. An farm in Dong Nai played an active and leading role in the project and their dedication and commitment greatly contributed to the successful project implementation; (iii) many neighboring villages and pig farmers visited the livestock waste management facilities of the participating farms and expressed their favorable impressions and strong interests in participation in the project.
  - (e) A communal village scale system was constructed in 2008 in Tu Duong village of Ha Tay province. Though no evidence of technical design failure was identified and the system had resulted in positive environmental and human health benefits, the communal system however was experiencing significant operational difficulties attributable basically to a fifty year storm event in November 2008 which caused extensive flooding in the area and had washed out all anaerobic reactors; and reduced SPP (from agreed 1,000 to only 300) due to epidemic pig diseases and declining pig prices in market. Despite various efforts made,



- restarting operation of the non-functioning communal system has not been successful.
- (f) At project preparation, pig farms were typically small, involving confined household-based production that was concentrated in particular villages. This structure led to project design for livestock waste management technology demonstration activities on a communal (village) rather than individual farm basis. However, this situation changed dramatically during the project implementation. Though small scale pig farms were still typical, medium and large sized pig farms were growing rapidly representing the obvious trend of pig production in Vietnam. To reflect this trend, medium and large farms were included in the project and became the dominant beneficiaries of the project. This had a far-reaching significance to guide the entire pig industry in its future development in terms of livestock waste management.
  - (g) Challenges. The project has been implemented with several major challenges which slowed down overall project implementation: (i) epidemic disease outbreaks and severe floods; (ii) change of project implementing entity within MONRE and change of national project coordinator; (iii) overwhelmingly long time taken for going through government internal process for approval of budget adjustment due to project adjustment; and (iv) dealing with the World Bank's INT investigation on three contracts in 2009 (see paragraph 2.4 for more details).
  - (h) Comments. The Bank financing mechanism was very complicated and required long procedural process. It often caused a long delay in project implementation. In the first three years, the WB approval sometimes took too much time, maybe there haven't achieved the consensus on activities of the plans between the WB and PMO; and planning capacity of PMO was limited. Nevertheless, the late approval of the procurement plans had affected the project implementation progress.
  - (i) Requests. Due to real demands, the follow-up project should be designed. At many workshops held in provinces, especially the final workshop held on June 24-25<sup>th</sup>, 2011 in Son Tay, Hanoi, many mid- and large scale size farm owners proposed PMO to find the opportunity for second phase of the Project so that some more farms could be participated and benefited by livestock waste management technology.

### **Summary of FAO ICR**

4. FAO is one of the Grant recipients responsible for implementation of the Regional Support Services component through the RFO physically located in its regional office in Bangkok of Thailand and with members from both its headquarters in Rome and its regional office. This was based on FAO's previous experience in providing services for both technical support and project coordination and facilitation. All three participating countries were strongly committed to the Regional Support Services Component, as demonstrated by their active attendance and consistent contributions to all RCG meetings.

- (a) Capacity Building Support. Three DSTs were developed together with the participating countries i.e. CoSiMo, Spatial Planning, and Environmental Monitoring Guidelines. The CoSiMo was developed to provide guidelines and approaches to support the design of policy framework to reduce land and water pollution from livestock production while acknowledging other objectives such as poverty reduction, public health improvement, economic growth and animal disease control; which is a process rather than a standalone tool and was developed to satisfy individual country needs. The Spatial Planning was a GIS and multiple criteria evaluation based tool to achieve spatial distribution of livestock production better aligned with environmental and health objectives at national and local levels which served Thailand only because the other two countries did not request the service. The Environmental Monitoring Guidelines were developed to provide guidance to participating countries on water, odor sampling and their analysis. The fourth DST i.e. the STRAW, not yet completed by project closing, was an ambitious programme developed to identify and select manure management options for confined pig production in rapidly growing economies and is still under finalization by FAO financing and a draft version of the STRAW is available. Four training modules were developed and various training on using DSTs for farmers, extension agents, policy makers, project implementing agencies and professionals were organized i.e. five training courses for CoSiMo and four development sessions for STRAW were organized, and the Environmental Monitoring Guidelines were presented in each country. Continued support to Thailand PMO during the last year of project implementation via a Thai consultant for Spatial Planning was provided. A regional pool of experts has been formed. An impressive project website ([www.lwmeap.org](http://www.lwmeap.org)) was developed in 2007 to provide information available for sharing including semi-annual progress reports, approved annual work programs, good models, impressive photos, summary of important meetings, etc. However, the Grant Letter of Agreement stipulates a total of six DSTs to be developed and six training modules to be delivered. The decision to consolidate 2 of the tools identified during project preparation (i.e., Nutrient flux models, Technical validation of on-farm manure management technologies) into one (i.e. STRAW) was taken in agreement with the three participating countries.
- (b) Coordination and Facilitation Support. The regional coordination and facilitation support was carried out by the RFO. Specific activities included facilitating the six RCG meetings serving as secretariat; communicating with all relevant regional programs; evaluating partnership potential; making recommendations for follow-up to the RCG. Activities for regional dissemination included organization for ICR workshop; continued liaison with the national PMOs. RFO's service focused primarily on the three participating countries, but eventually also on other countries draining into the South China Sea for replication through (i) study tours, (ii) internet portal, and (iii) publications. As a result of the September 2009 International Conference on Livestock Waste Management and Climate Change Mitigation in Guangzhou, several countries expressed their interests in learning more about the two DSTs.

- (c) In addition, the RFO also tried hard to provide technical and monitoring supports to the participating countries as agreed during the second RCG meeting in April 2007. However, this service was discontinued in 2009 due to limited demand expressed by participating countries.

## **Annex 8. Comments of Cofinanciers and Other Partners/Stakeholders**

No comments were received.

## **Annex 9. List of Supporting Documents**

### **By World Bank**

1. Project Concept Note, September 29, 2003
2. Project Appraisal Document, February 22, 2006
3. Project Concept for Pipeline Entry and PDF B Request, June 2003
4. Request for GEF CEO Endorsement/Approval, 2006
5. Supervision Mission Aide Memoires

### **By China**

1. Implementation Completion Report, October 2011
2. Environmental Monitoring Summary Report, 2011
3. Replication strategy of Livestock Waste Management (Guangdong demonstration), by Institution of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences and Dunji ZHENG, 2011
4. Mini-PIPs for Participating Farms
5. Semi-annual Progress Report
6. Annual Work Program
7. Environmental Monitoring Reports in the first group of demonstration sites in Guangdong, 2007-2011
8. Monitoring and Evaluation of Sanitation Indicators in the Pig Farm (2<sup>nd</sup> group), 2008-2009
9. Nutrient Flux Management for Demonstrated Farm, by Xindi Liao, March 2008
10. Spatial Distribution Plan, by Xindi Liao, March 2008
11. Code of Practice for Livestock Waste Management Project, by Institution of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences, May 2010
12. Various Brochures, project DVDs, 2009

### **By Thailand**

1. Implementation Completion Report, March 2012
2. Environmental Monitoring Summary Report
3. Replication Strategy of Livestock Waste Management, 2007-2012
4. Mini-PIPs for Participating Farms
5. Semi-annual Progress Report
6. Annual Work Program
7. Practical Manual for Local Authority to Issue Health Risk Business License (Pig Farms), by PMO and Thai Environment and Energy Development Co., Ltd., 2011
  - (a) Environment Management in Pig Farms for DLD Officer, 2008
  - (b) Environment Management in Pig Farms for Local Authorities, 2008
  - (c) Environment Management in Pig Farms Farmers, 2008
  - (d) Livestock Waste for Agriculture Utilization, 2009, 2010 (reprinted)
8. Waste-water Treatment System for Livestock Waste-water, 2009
9. Study Reports:

- (a) Environmental Baseline Survey Before and After Construction of Wastewater Treatment System in 20 Demonstration Farms, by PMO and CMS Engineering and Management, 2006, 2007 and 2009
  - (b) Management of Remaining Nutrients in Treated Waste Water from Pig Farms by Spirulina Cultivation, by PMO and Algal Biotechnology Laboratory, King Mongkut's University of Technology Thonburi, 2006
  - (c) Code of Practices and Regulation for Environmental Management in Pig Farms, by PMO and Thai Environment and Energy Development Co., Ltd., 2006-2007
  - (d) Engineering Survey and Design for Construction of Wastewater Treatment System in 20 Demonstration Farms, by PMO and Thai Environmental Remediation Co., Ltd., 2006, 2007 and 2009
  - (e) Spatial Distribution Plan for Livestock Production and Nutrient Management Plans for Livestock Waste, by PMO and Thai Environment and Energy Development Co., Ltd., 2007
  - (f) Carbon Footprint from Pig and Chicken Production in Thailand, by PMO and Andaman Environmental Consultant Co., Ltd., 2009
  - (g) Effects of Pig Waste Farms Treatment and Utilization on Human Health Risk, by PMO and Fuengsiri Engineering Co., Ltd., 2011
  - (h) Utilization of Pig Farm Wastes for Crop Production, by PMO and Fuengsiri Engineering Co., Ltd., 2011
10. Presentation Materials for Training:
- (a) General Information for Wastewater from Pig Farms, by Dr. Sommai Chatsanguthai, 2006
  - (b) Wastewater Treatment System for Pig Farms, by Dr. Sommai Chatsanguthai, 2006
  - (c) Ponding System for Wastewater from Pig Farms Treatment, by Dr. Sommai Chatsanguthai, 2006
  - (d) Introduction of DLD Wastewater Treatment System (Biogas Type) for Pig Farms, by Dr. Sommai Chatsanguthai, 2006
  - (e) How to Select DLD Wastewater Treatment System, by Dr. Sommai Chatsanguthai, 2006
  - (f) Engineering Basic for Wastewater Treatment System Design, by Dr. Sommai Chatsanguthai, 2007
  - (g) Introduction to Flat Covered Lagoon, by Dr. Sommai Chatsanguthai, 2007
  - (h) Case Study - Flat Covered Lagoon of Joseph Farms, USA, by Dr. Sommai Chatsanguthai, 2007
  - (i) Introduction to Environmental Baseline Study Before and After Construction of Wastewater Treatment System in Demonstration Pig Farms, by CMS Engineering & Management, 2008
  - (j) Effect of Farm Waste to Environment, by Dr. Sommai Chatsanguthai, 2008
  - (k) Farm Waste Management and Sustainable Agriculture, by Dr. Sommai Chatsanguthai, 2008
  - (l) GIS Data Model & Structure and Database Management, by Geo-Informatics and Space Technology Development Agency, 2008

- (m) GIS System for Environment Management, by Geo-Informatics and Space Technology Development Agency, 2008
  - (n) GIS System for Spatial Planning, by Geo-Informatics and Space Technology Development Agency, 2008
  - (o) GIS System for Suitable Area for Farm Establishment, by Geo-Informatics and Space Technology Development Agency, 2008
  - (p) Management of Remaining Nutrients in Treated Wastewater from Pig Farms by *Spirulina platensis*, by Assoc. Prof. Boosya Bunnag King Mongkut's University of Technology Thonburi, 2008
  - (q) Environment Management for Slaughter Houses, by Dr. Sommai Chatsanguthai, 2008
  - (r) Animal Excrement for Aquaculture, by Dr. Orapin Jintatapon Kasetsart University, 2009
  - (s) Case Study; Mixed Livestock Farm and Aquaculture, by Dr. Sommai Chatsanguthai, 2009
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- (a) Water Treatment for Consumption and Utilization, by Dr. Sommai Chatsanguthai, 2009
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  - (h) Biogas Technology Selection for Good Efficiency to Reduce GHG in Thailand, by Dr. Saroch Boonyakijombat, King Mongkut University of Technology Thonburi, 2010
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12. Various Brochures, project DVDs

**By Vietnam**

1. Implementation Completion Report, October 2011,
2. Report on Baseline and Project Impact Monitoring of Livestock Waste Management in East Asia Project, January 2012
3. Strategy for Application and Replication of Livestock Waste Treatment Technology to the Year 2020 (in both Vietnamese and English), June 2011
4. Mini-PIPs for Participating Farms
5. Semi-annual Progress Report
6. Annual Work Program
7. Handbook on Biogas, December 2010
8. Emission Norms of Livestock Waste Water Pollutants (in Vietnamese), 2008
9. Technical Base for Regulation on Environmental Protection in Animal Husbandry Activities (in Vietnamese), 2009
10. Survey, overall assessment on pig breeding in Vietnam and suggest appropriate provinces and districts that meet project criteria for livestock waste management testing (in Vietnamese), 2010
11. Survey, assessment on breeding circumstance and environmental issues at selected areas to identify households, group of household or farms that met project criteria for livestock waste management testing. (Household, group of household or farm in the South) (in Vietnamese), 2010
12. Detailed assessment on breeding circumstance, environmental and other related issues of selected households, group of household or farms to identify technology demonstration and biogas plan designing. (Household, group of household or farm in the North) (in Vietnamese), 2010
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16. Information Exchange Scheme among Related Agencies (in Vietnamese), 2010
17. Social Assessment (in Vietnamese), 2010
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1. Implementation Completion and Results Report, April 2012
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12. Backus, Ge (2006) Cost of Compliance Simulation Model (CoSiMo): a policy formulation decision support tool (DST)
13. Backus, Ge (July 2009) Second CoSiMo Mission report
14. Burton, Colin (October 2006). Manure Management Systems required for specific Livestock farms visited in Thailand, Vietnam and Guangdong province of China
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19. Carsjens, Gerrit (October 2006) Spatial Planning and Decision Support of Livestock Production in East Asia
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21. Choi, Hong Lim (July 2007) Backstopping Report on Manure Management and Environmental Monitoring in Vietnam
22. Choi, Hong Lim (August 2007) Backstopping Report on Manure Management and Environmental Monitoring in Guangdong Province of China
23. Menzi, Harald Decision Support Tool (DST) for Nutrient Balances and Fluxes at the Farm and Area-wide Scale

# EAST ASIA LIVESTOCK WASTE MANAGEMENT IN EAST ASIA PROJECT

- PROJECT AREAS
- PROJECT COUNTRIES
- TARGETED INTERNATIONAL WATERS
- CITIES
- NATIONAL CAPITALS
- MAIN ROADS
- RAILROADS
- PROVINCE BOUNDARIES (SHOWN IN PROJECT COUNTRIES ONLY)
- INTERNATIONAL BOUNDARIES



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