



Completion Report

Project Number: 33443
Loan Number: 1924/Grant Number: 3945
December 2010

PRC: Efficient Utilization of Agricultural Wastes Project

CURRENCY EQUIVALENTS

Currency Unit – yuan (CNY)

		At Appraisal	At Project Completion
		15 September 2002	2 May 2010
CNY1.00	=	\$0.1200	\$0.1465
\$1.00	=	CNY8.2700	CNY6.8252

ABBREVIATIONS

ADB	–	Asian Development Bank
BIA	–	beneficiary impact assessment
CDM	–	Clean Development Mechanism
CO ₂	–	carbon dioxide
EEMP	–	energy and environmental monitoring plan
EIRR	–	economic internal rate of return
FIRR	–	financial internal rate of return
GEF	–	Global Environment Facility
HH	–	household
km	–	kilometer
m ³	–	cubic meter
MOA	–	Ministry of Agriculture
MOF	–	Ministry of Finance
O&M	–	operation and maintenance
PDD	–	project design document
PFB	–	provincial finance bureau
PIO	–	project implementation office
PMO	–	project management office
PLG	–	provincial project leading group
PPMS	–	project performance management system
PRC	–	People's Republic of China

NOTES

- (i) The fiscal year (FY) of the government and its agencies ends on 31 December. FY before a calendar year denotes the year in which the fiscal year ends, e.g., FY2009 ends on 31 December 2009.
- (ii) In this report, "\$" refers to US dollars.

Vice-President	C. Lawrence Greenwood, Jr., Operations 2
Director General	K. Gerhaeusser, East Asia Department (EARD)
Director	K. Kannan, Agriculture, Environment, and Natural Resources Division, EARD
Team leader	Y. L. Feng, Principal Natural Resources Management Specialist, EARD
Team members	C. Carreon, Associate Project Analyst, EARD M. Copeland, Agriculture Economist/Staff Consultant, EARD

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BASIC DATA

A. Loan Identification

1.	Country	People's Republic of China
2.	Loan/Grant Number	1924/3945
3.	Project Title	Efficient Utilization of Agricultural Wastes Project
4.	Borrower	People's Republic of China
5.	Executing Agency	Ministry of Agriculture
6.	Amount of Loan	\$33,119,000
7.	Amount of Grant	\$6,360,000
8.	Project Completion Report Number	1195

B. Loan/Grant Data

1.	Appraisal	
	– Date Started	24 May 2001
	– Date Completed	16 June 2001
2.	Loan Negotiations	
	– Date Started	2 September 2002
	– Date Completed	5 September 2002
3.	Date of Board Approval	22 October 2002
4.	Date of Loan Agreement	18 March 2003
5.	Date of Loan Effectiveness	
	– In Loan Agreement	16 June 2003
	– Actual	16 June 2003
	– Number of Extensions	None
6.	Closing Date	
	– In Loan Agreement	30 June 2008
	– Actual	23 August 2010
	– Number of Extensions	Two
7.	Terms of Loan	
	– Interest Rate	LIBOR rate
	– Maturity (number of years)	25 years
	– Grace Period (number of years)	5 years
8.	Terms of Relending	
	– Interest Rate	LIBOR rate
	– Maturity (number of years)	25 years
	– Grace Period (number of years)	5 years
	– Second-Step Borrower	Provincial governments of Henan, Hubei, Jiangxi, and Shanxi
9.	GEF Cofinancing	
	– GEF Approval	7 December 2001
	– Date of Financing Agreement	12 January 2004
	– Date of Effectiveness	16 February 2004
	– Closing Date in Financing Agreement	30 June 2008
	– Actual Closing Date	23 August 2010
	– Number of Extensions	Two

10. Disbursements

a. Dates—Loan

Initial Disbursement	Final Disbursement	Time Interval
16 June 2003	23 August 2010	87.5 months
Effective Date	Original Closing Date	Time Interval
16 June 2003	30 June 2008	61.4 months

b. Dates—GEF Grant

Initial Disbursement	Final Disbursement	Time Interval
25 October 2004	23 August 2010	71.2 months
Effective Date	Original Closing Date	Time Interval
16 February 2004	30 June 2008	53.2 months

c. Amount (\$'000)

Category or Subloan	Original Allocation	Last Revised Allocation	Amount Canceled	Net Amount Available	Amount Disbursed	Undisbursed Balance
A. ADB Loan						
01 — Funding Renewable Energy Generation and Eco-Environment Development	27,640	27,640	148	27,492	27,492	0
02 — Recovery of PPTA	206	203		203	203	0
03 — Front-End Fee	331	331		331	331	0
04 — Interest and Commitment Charges	4,942	4,945		4,945	4,754	191
Subtotal (A)	33,119	33,119	148	32,971	32,780	191
B. GEF Grant						
01A—International Consultants	956	896		896	896	0
01B—National Consultants	618	298		298	254	44
01C—Student Fellowships	190	40		40	40	0
02 — Biomass Development for the Poor	1,307	1,307		1,307	1,214	93
03A—Training Equipment	80	177		177	286	(109)
03B—Environment-al Equipment	198	131		131	20	111
03C—PPMS		40		40	40	0
04A—Training	1,069	1,581		1,581	1,576	5
04B—Workshops	300	452		452	460	(8)
04C—Tours	593	491		491	496	(5)
05 — Special Studies	92	947		947	966	(19)
06 — Contingencies	957	0		0	0	0
Subtotal (B)	6,360	6,360	0	6,360	6,248	112
Total	39,479	39,479	148	39,331	39,028	303

() = negative, ADB = Asian Development Bank, GEF = Global Environment Facility, PPMS = project performance management system, PPTA = project preparatory technical assistance.

11. Local Costs (Financed): None

C. Project Data

1. Project Cost (\$'000)

Cost	Appraisal Estimate	Actual
Foreign Exchange Cost	36,270	39,028
Local Currency Cost	41,002	44,521
Total	77,272	83,549

2. Financing Plan (\$'000)

Cost	Appraisal Estimate	Actual
Implementation Costs		
Borrower Financed	37,793	44,198
ADB Financed	27,640	27,492
Other External Financing—GEF	6,360	6,248
Subtotal	71,793	77,938
IDC Costs, TA Preparatory Cost, and FEF		
Borrower Financed	0	323
ADB Financed	5,479	5,288
Other External Financing	0	0
Total	77,272	83,549

Note: Numbers may not sum precisely because of rounding.

ADB = Asian Development Bank, FEF = front-end fee, GEF = Global Environment Facility, IDC = interest during construction, TA = technical assistance.

3. Cost Breakdown by Project Component (\$'000)

Component	Appraisal Estimate	Actual
A. Funding Renewable Energy Generation and Eco-Environment Development	48,436	62,880
B. Improved Mechanisms for Transferring Biomass Technology	1,042	3,301
C. Rehabilitated Farm-to-Market Facilities	1,019	5,756
D. Improved Environmental Policy Implementation and Awareness	1,711	1,076
E. Pilot Poverty-Focused Approaches for Biomass Development	2,780	2,188
F. Improved Project Implementation and Capacity Development	6,499	2,737
Total Baseline Costs	61,487	77,938
Physical Contingencies	6,140	0
Price Contingencies	4,166	0
Subtotal	71,793	77,938
TA Preparatory Cost	206	203
Front-End Fee	331	331
IDC	4,942	5,077
Total Project Costs	77,272	83,549

Note: Numbers may not sum precisely because of rounding.

IDC = interest during construction, TA = technical assistance.

4. Project Schedule

Item	Appraisal Estimate		Actual	
	Start	End	Start	End
A. Funding Renewable Energy Generation and Eco-Environment Development				
(i) Introduce improved loan processing skills	Jun 2003	Jun 2004	Jun 2003	Dec 2006
(ii) Operate investment funds and administer loans	Jan 2004	Jun 2008	Jan 2004	Dec 2009
B. Improved Mechanisms for Transferring Biomass Technology				
(i) Strengthen skills of biogas and gasification system contractors	Jun 2003	Jun 2006	Jun 2003	Jun 2008
(ii) Extension officers and farmers on-site skill transfer training	Jun 2003	Apr 2007	Jun 2003	Dec 2009
(iii) Study tours and workshops	Oct 2003	Jun 2008	Oct 2003	Dec 2009
C. Rehabilitated Farm-to- Market Facilities				
(i) Rehabilitate access roads	Oct 2003	Jun 2008	Oct 2003	Dec 2009
(ii) Rehabilitate bridges and drainage crossings	Oct 2003	Jun 2008	Oct 2003	Dec 2007
D. Improved Environmental Policy Implementation and Awareness				
(i) Develop environmental awareness program	Jun 2003	Jun 2008	Jun 2003	Dec 2009
(ii) Prepare publicity and extension materials	Jun 2003	Jun 2005	Jun 2003	Dec 2006
(iii) Provide student fellowships on environmental research	Jul 2004	Jun 2008	Jan 2007	Dec 2009
(iv) Establish renewable energy, environmental monitoring, and training station	Jul 2004	Jun 2005	Jul 2004	Dec 2008
(v) Provide environmental monitoring equipment	Jul 2004	Jun 2005	Jul 2004	Dec 2006
E. Pilot Poverty-Focused Approaches for Biomass Development				
(i) Women's training and participatory workshop	Jun 2003	Jun 2005	Mar 2007	Dec 2009
(ii) Selection and provision of basic biogas facilities	Jun 2003	Jun 2008	Mar 2007	Dec 2009
(iii) Special training for poor farmers	Jun 2003	Jun 2008	Mar 2007	Dec 2009
(iv) Fellowship for poverty research	Jul 2004	Apr 2008	Mar 2007	Dec 2009
F. Improved Project Implementation and Capacity Development				
(i) Provide office support	Jun 2003	Jun 2004	Jun 2003	Dec 2009
(ii) Recruit consultants	Jun 2003	Jun 2005	Jul 2004	Dec 2009
(iii) Establish monitoring and evaluation system	Jun 2003	Jun 2004	Jul 2004	Mar 2006

5. Project Performance Report Ratings

Implementation Period	Ratings	
	Development Objectives	Implementation Progress
From 31 Dec 2002 to 31 May 2003	Satisfactory	Satisfactory
From 01 Jun 2003 to 31 Jul 2003	Satisfactory	Highly satisfactory
From 01 Aug 2003 to 31 Aug 2004	Satisfactory	Satisfactory
From 01 Sep 2004 to 31 Oct 2007	Satisfactory	Highly satisfactory
From 01 Nov 2007 to 31 Dec 2009	Satisfactory	Satisfactory

D. Data on Asian Development Bank Missions

Name of Mission	Date	No. of Persons	No. of Person-Days	Specialization of Members ^a
Project inception mission	2–14 Aug 2003	8	13	a, b, c, d, e, f, g, h
Review mission 1	18–27 Oct 2004	4	10	a, b, i, j
Review mission 2	6–16 Dec 2005	3	11	a, k, l
Midterm review mission	2–24 Mar 2006	5	23	a, c, k, l, m
Special project administration mission	1–3 Aug 2006	2	3	a, m
Review mission 3	14–20 Oct 2006	3	7	l, m, n
Review mission 4	14–21 Mar 2007	2	8	a, m
Review mission 5	23–27 Mar 2008	7	5	a, o, p, q, r, s, t
Review mission 6	4–6 Dec 2008	2	3	a, p
Review mission 7	13–18 Dec 2008	2	6	a, p
Project completion review	21–30 Apr 2010	3	11	a, p, u

CDM = Clean Development Mechanism; EAAE = Agriculture, Environment, and Natural Resources Division, East Asia Department; PRC = People's Republic of China, PRCM = PRC Resident Mission; RSES = Environment and Safeguards Division, Regional and Sustainable Development Department.

a = assistant/associate project analyst; b = poverty reduction coordinator/specialist; c = principal sector economist; d = senior financial control specialist; e = counsel; f = project specialist; g = project officer; h = assistant disbursement analyst, PRCM; i = CDM specialist, RSES; j = biomass/biogas technology for CDM specialist (RSES consultant); k = rural development and finance specialist; l = CDM specialist (RSES consultant); m = environment specialist; n = director, EAAE; o = senior water resources engineer; p = principal natural resources economist; q = natural resources economist; r = rural development specialist; s = clean energy specialist, RSES; t = climate change mitigation specialist, RSES; u = agriculture economist (staff consultant).

I. PROJECT DESCRIPTION

1. The project supported the effort of the Government of the People's Republic of China (PRC) to make efficient use of agricultural wastes to (i) improve the rural environment, (ii) promote sustainable agricultural production, and (iii) enhance the livelihoods of rural households in disadvantaged rural areas in Henan, Hubei, Jiangxi, and Shanxi provinces.¹

2. The project cost was originally estimated at \$77.3 million, 43% of which was to be covered by loan of \$33.1 million from the Asian Development Bank (ADB) that became effective on 16 June 2003. The Global Environment Facility (GEF) provided a grant of \$6.360 million. On 21 January 2008, ADB approved the first extension of the loan closing date by 12 months to 30 June 2009. On 14 April 2009, ADB extended the loan closing date by 6 more months to 31 December 2009.

3. The project comprised six components. Component A funded renewable energy generation and eco-environment development. Component B aimed to improve mechanisms for transferring biomass technology. Component C involved rehabilitation of farmers' farm-to-market facilities. Component D was to improve awareness of biogas technology and environmental policy implementation. Component E piloted poverty-focused approaches for biomass development. Component F intended to improve project implementation and capacity.

4. Component A was to support four types of biogas technologies.² The type I system, a 4-in-1 model eco-farm, combined a greenhouse and pig raising (or other livestock) in an integrated system comprising a pigpen, greenhouse, vegetable crops, and a biogas digester.³ Type II systems, a 3-in-1 model eco-farm, combined pig raising (or other livestock) and a biogas digester with an orchard, or crops, or a fish pond. Type III systems piloted medium-scale biogas plants in commercial livestock farms. The type IV system, straw gasification plants, was cancelled during the midterm review due to the concerns about the technology maturity. The budget of type IV systems was then reallocated to construction of additional type II systems in Henan, Hubei, and Shanxi provinces.

5. The GEF financed components B, D, E, and F, and, in line with ADB's loan, aimed to reduce greenhouse gas emissions in the PRC. This was to be achieved by (i) overcoming financial and technical barriers; (ii) enhancing national environmental policies; and (iii) promoting the use of biomass technologies, including piloting poverty-focused approaches to promoting the use of small- and medium-scale, biomass-based renewable energy technologies in rural agricultural areas. The government financed component C.

¹ ADB. 2002. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the People's Republic of China for the Efficient Utilization of Agricultural Wastes Project*. Manila.

² The project design at appraisal proposed type I, II, III, and IV systems. The straw gasification plants subcomponent of the type IV systems was cancelled during the midterm review and the budget for it reallocated to construction of additional type II systems in Henan, Hubei, and Shanxi provinces.

³ The appraisal report differentiated between types Ia and Ib. The former involved the construction of a new greenhouse and biogas digester while the latter involved the construction of a new biogas digester for an existing greenhouse. The mission was informed that nearly all type I biogas digester systems constructed under the project involved the construction of a new greenhouse—i.e., type Ia.

II. EVALUATION OF DESIGN AND IMPLEMENTATION

A. Relevance of Design and Formulation

6. The project was relevant at appraisal. It addressed several challenges facing the government, including the needs to (i) increase agricultural productivity; (ii) reduce poverty in rural areas, particularly in the interior provinces; (iii) reduce the rural–urban income gap; and (iv) reverse environmental degradation. Rapid per capita income growth had driven up demand for meat products, particularly from the increasingly affluent urban population. Pollution worsened as a result as growing livestock production introduced greater amounts of untreated effluent into rivers, lakes, or other water bodies. Due to its extensive use of coal, the PRC was also creating more air pollution, with adverse effects on the environment and populations at the household, local, national, and global levels. The government was seeking through its agriculture development strategy to adopt integrated approaches to farming that were friendly to the environment. It also sought to (i) reduce the growth of coal consumption and of the environmental pollution coal consumption causes, and (ii) develop renewable energy options. ADB's country partnership strategy, 2008–2010 for the PRC⁴ had an overarching poverty reduction objective and its agriculture sector strategy emphasized increasing productivity and incomes in rural areas while conserving the environment.

7. Since appraisal, the government's support for biogas production to raise the incomes of the rural poor and improve the environment has intensified, further supporting project relevance. The PRC has created a national biogas development program, passed the Renewable Energy Law of 2006, and tightened environmental standards for livestock farms.

8. The project's goals and purposes remained highly relevant throughout project implementation. At midterm review, however, the project scope was altered to meet changed circumstances. These changes, discussed in paras. 9–20, did not deflect the project from its original overall goals.

B. Project Outputs

1. Component A: Funding Renewable Energy Generation and Eco-Environment Development

9. At appraisal, this component's target outputs included (i) rehabilitation or new construction of 4,700 greenhouses for the type I system; (ii) development of 10,900 hectares of new citrus fruit tree plantings; (iii) the construction of 15,600 new household biogas digesters, each producing about 600 m³ per year of biogas, for the type II and III systems; (iv) the construction of 14 medium-scale type IV system biogas plants, each producing 87,600 m³ per year of biogas and supplying 120 households; (v) the construction of 28 gasification plants, each producing 1.1 million m³ per year of producer gas and supplying 600 households; (vi) providing about 34,080 households with cheaper and cleaner energy; (vii) training about 31,200 farm beneficiaries in biogas technology; and (viii) enabling 4,700 farmers to produce green vegetables.

10. The midterm review led to a scope change and a lower type I target. For several reasons, this farm model, which included construction or rehabilitation of a greenhouse with the digester and pig pen, was less popular than the type II, which did not have a greenhouse. The

⁴ ADB. 2008. *Country Partnership Strategy (2008–2010): People's Republic of China*. Manila.

costs of greenhouse construction had risen steeply since appraisal due to higher prices for steel and bricks. Improvements in the PRC's transport infrastructure had considerably reduced the cost of moving vegetables from south to north, also narrowing the premium paid for greenhouse vegetables produced in the north. Households found type I biogas systems less convenient because the greenhouses were generally located some distance from their homes, which made it difficult to use the system for cooking and to put household waste in the digesters. The type I target was reduced from 4,700 to 2,545, as a result, and the type II target rose from 12,500 to 16,970.

11. A second change affected 14 type III systems that had been proposed at appraisal for the provinces of Henan (8), Hubei (2), and Shanxi (4). These systems involved medium-scale biogas plants located in large-scale, commercialized pig or other livestock farms. Hubei decided not to proceed with the type III model because the enterprises were no longer interested. During the midterm review, Shanxi and Henan proposed to increase their type III plants to six and nine, respectively.

12. In the third midterm review change, the 28 type IV plants were dropped from the project. The medium-scale straw biomass gasification plants were mostly to use crop residue for gas production but were assessed as nonviable for technical and economic reasons. The executing agency also proposed a minor change in the scope of the GEF grant during the midterm review, which added a special study on the preparation of a project design document (PDD) for a group of livestock farms to seek carbon financing from the Clean Development Mechanism (CDM).

13. Following these changes, the appraisal output targets were revised accordingly. Appendix 1 provides the updated project framework showing a full listing of the appraisal output targets, the revised output targets at midterm review, and the output achievements of the project. In general terms, the project has achieved or exceeded the output targets as revised at the midterm review. At 13.7 million m³, the amount of biogas produced each year exceeds the 13.1 million m³ goal set at midterm but is much less than the 41.0 million m³ expected at appraisal. This was because the type IV plants were dropped from the project. Vegetable production reached 21,862 tons, exceeding the revised targets at midterm review; and citrus fruits production was 156,114 tons, about 10% less than the target set at midterm review, reasons being that farmers changed their crop production from citrus fruits to vegetables following market changes. It could also be that the correct estimation of vegetable production was difficult due to market uncertainty.

2. Component B: Improved Mechanisms for Transferring Biomass Technology

14. Under component B, the government completed technical training for farmer beneficiaries, biogas contractors, and biogas technicians at extension centers. A total of 4,191 contractors and technicians and 6,131 extension workers were trained to provide services to farm households. About 38,054 farm households participated in training on the operation and maintenance (O&M) of biodigesters and in biogas safety. The component conducted 74 workshops and 80 domestic study tours. These numbers exceeded the targets for both trainees and workshops at appraisal and as revised at the midterm review.

15. The GEF budget allocations for training, workshops, and applied research were adjusted after the midterm review in 2006 to meet the actual needs for capacity development, improvement of policy implementation and awareness, and project implementation support. The activities identified for support were (i) benefits monitoring, (ii) environmental monitoring

and evaluation, (iii) piloting the preparation of a project preparation document for a bundling CDM project, (iv) an international workshop, and (v) special studies. The GEF funds allocated for training and capacity development to transfer biomass technology totaled \$4.7 million, \$900,000 more than the original allocation. The increase was a minor change, sourced from the contingencies, and did not affect project implementation arrangements. The special studies were completed according to the contracts and reports were submitted. Appendix 2 provides a summary of physical accomplishments.

3. Component C: Rehabilitated Farm-to-Market Facilities

16. The government provided additional counterpart funds for infrastructure improvements in the project areas that well exceeded the appraisal output target, with 526.7 kilometers (km) of farm-to-market roads constructed, compared with an appraisal target of only 60.0 km. In addition, 18 agroproduce markets were constructed and 113 mechanized wells were drilled under this component, which reinforced service infrastructure, strengthened the link between farmers and markets, and enabled convenient, speedy delivery of technical services. The increased government contribution to component C did not affect implementation of other components but it demonstrated the project's catalytic effect on the direction of government development planning and investment in rural areas.

4. Component D: Improved Environmental Policy Implementation and Awareness

17. The government issued the Renewable Energy Act of 2007, amended in 2009, which set out rural biogas development strategies for local governments, and established financing packages to support the development of renewable energy. These government regulation and policies further supported the project implementation and improved people's awareness of biomass renewable energy. The project implementation offices (PIOs) prepared flyers, handbooks, and posters to inform farmers of pollution problems posed by livestock waste, the benefits of biodigesters, and the need and procedures for O&M and biogas safety. Such communication strategy has improved the farmers' knowledge and awareness of biomass energy and its uses. In addition, 67 sets of equipment were purchased under this component to establish a system for monitoring emissions and the reduction of environmental pollution. The monitoring results were used in preparing the energy and environmental monitoring plan (EEMP). The procurement of environmental monitoring equipment exceeded the appraisal and midterm review targets because additional funding became available after the purchase of four sets of gasification station monitoring equipment for tar and ash analysis was cancelled and the gasification station subcomponent dropped.

5. Component E: Pilot Poverty-Focused Approaches to Biomass Development

18. Component E was designed to establish a financially viable and sustainable scheme to (i) provide basic biogas facilities to 9,000 poorer rural villagers, and (ii) give farmers livelihood training to lift them out of poverty. A total of 8,528 poor households that received GEF grants to set up biodigesters was lower than the target due largely to changes in the exchange rate. The project provided training to 9,747 low-skilled poor households, of which 9,182 households benefited by raising their incomes above the poverty line. The livelihood skills training included biogas technology, cropping and livestock production technologies, organic farming production, and utilization of biogas sludge and slurry. The government reported that about 40% of the trainees were women.

6. Component F: Improved Project Implementation and Capacity Development

19. International and national intellectual resources brought in to strengthen technical support and assistance for the project improved the implementation capability of the executing agencies, including the provincial finance and environmental protection bureaus. Following ADB's Guidelines on the Use of Consultants (2007, as amended from time to time), the project management office (PMO) hired 3 international and 22 national consultants in the areas of environment, renewable energy, biomass system development, financial management, and performance evaluation. They provided 134.07 person-months of expertise. Thirteen of the national consultants worked with the PMO and the remaining nine supported provincial PIOs. The project also conducted five special studies on use of crop straw and/or stalk for gasification, energy and environment monitoring, beneficiary impact assessment, comprehensive use of biogas sludge and slurry, as well as management information system development. The improved technical knowledge and project management capacity of the staff in the PMO, PIOs, and finance and environmental protection bureaus was demonstrated by the smooth implementation of the project.

20. The changes made to the project scope were positive, in light of the technical, economic, and social factors at play, and did not adversely impact the project's costs, time schedule, effectiveness, or efficiency. Appendix 2 provides a summary of the projects physical accomplishments for each of the provinces as proposed at appraisal, as revised at midterm review, and as achieved at project completion.

C. Project Costs

21. At appraisal, the project cost was projected to be the equivalent of \$77.27 million, comprising \$36.27 million in foreign exchange costs (47% of the total) and local currency costs equivalent to \$41.0 million. At loan closing, project expenditures amounted to \$83.55 million overall, divided between \$39.03 million in foreign exchange (47%) and the equivalent of \$44.52 in local currency. The cost increase in dollar terms was partly the result of the appreciation of the local currency during project implementation but mostly due to the additional activities undertaken under components B and C. The actual costs of component B to improve the mechanism for transferring biomass technology exceeded the appraisal target by 217%. Those of component C to rehabilitate farm-to-market facilities were 465% over target. In the case of component B, this reflected ADB's agreement during the midterm review to the transfer of funds from contingency to training, workshops, and applied research; and from unused provincial budgets for environmental facilities to office and training equipment. Construction of farm-to-market roads under component C rose by 778% from the target at appraisal and construction of agricultural produce markets and the drilling of mechanized wells also increased. The detailed project cost estimates are provided in Appendix 3.

22. The actual interest during construction of \$5.08 million was higher than the \$4.66 million estimated at appraisal, including a local currency portion of \$0.32 million, mainly due to the higher commitment fees and interest that resulted from the extension of the loan closing date by 1.5 years.

23. On utilization of the expenditure accounts, the total cost of materials for road works and the cost of labor for road works exceeded the appraisal target by 399% and 599% respectively. This again is because the government built more farm-to-market access roads and other rural infrastructure than envisaged at appraisal. The actual combined costs for training, workshops, special studies, and tours exceeded the appraisal target by 116%.

D. Disbursements

24. Total loan disbursement as of 23 August 2010 was \$32.78 million, or 99% of the loan fund of \$33.12 million. Loan disbursements comprised (i) \$27.49 million of subloans under component A, (ii) \$4.75 million of interest during construction, (iii) front-end fee of \$331,190, and (iv) recovery of the project preparatory technical assistance fund of \$203,153. Disbursement for subloans under component A consists of \$6.67 million for Henan province, \$5.68 million for Hubei, \$8.29 million for Jiangxi, and \$6.86 million for Shanxi. Achievement against the loan allocation of \$27.64 million is 99.5%.

25. Utilization of the GEF grant fund amounts to \$6.248 million, or 98.2% of the \$6.360 million grant. The updated project cost summary by expenditure accounts is provided in Appendix 4.

26. Process bottlenecks greatly slowed down the flow of project funds between levels of government during the first 3 years of implementation. County administrators would wait for some time to accumulate large numbers of farmer subloans with completed copies of loan agreements and construction progress reports before submitting them to the municipality. The municipality would then process the applications and submit them to the provincial government, where they would pass through several offices in the provincial finance bureau (PFB) for checking before being finally submitted to ADB for reimbursement.

27. To shorten the delays that resulted, the government and ADB agreed during the March 2006 midterm review that PFB officials and ADB streamline procedures for disbursing loan funds. After discussions, ADB's Controller's Department approved a proposal on 19 May 2006 to discontinue the requirement that the certificate of expenditures and the summary of certificates of expenditures for expenses related to the construction of biodigesters be submitted with withdrawal applications because these activities were not force account works. This resolved the loan fund flow problem.

28. The disbursements of GEF funds during the project's initial stage were also low and slow. This was due to (i) the PMO's and PIOs' lack of knowledge of ADB's administrative procedures for the implementation of GEF components because this was the first ADB project in the PRC with an associated GEF grant; (ii) the fact that the PIOs faced difficulties advancing their own funds to implement GEF activities while waiting for the GEF funds to become available; (iii) the delay until after the midterm review in implementing components B and E (paras. 14, 15, and 18); (iv) the protracted processing time for reimbursement of expenses that resulted from establishing the imprest account with the Ministry of Finance (MOF) rather than with the provinces.

E. Project Schedule

29. The project was completed after 6.5 years of implementation from June 2003 to December 2009. The loan account was financially closed on 23 August 2010 and the grant account on 30 August 2010. Project activities financed by the ADB loan began on time. Implementation of GEF components was delayed by 16 months from loan effectiveness to October 2004, when the GEF funds became available. The pilot program on biomass development for the poor under component E started only in March 2007. Component E was to be implemented during the project's first year but was postponed for review and modification to comply with current requirements (para. 18). The postponement contributed to the slower overall progress of GEF-funded activities.

30. Activities for component B to improve mechanisms for transferring biomass technology, the EEMP, the special study on utilization of digester effluent, and the CDM pilot project in Henan were only finalized and implemented after the midterm review. These activities required at least 24–36 months to implement. Consequently, the loan closing date was extended by 1.5 years, or until 31 December 2009. Appendix 5 compares the project implementation schedule at appraisal with the actual implementation.

F. Implementation Arrangements

31. The project implementation was satisfactory with the implementation arrangements (Appendix 6) set at project appraisal and throughout the project implementation period. Technical supporting groups were established in the provinces and counties to support the PIO work, particularly in environmental monitoring and training.

G. Conditions and Covenants

32. Most of the loan and project covenants have been complied with on time. Two covenants were complied with after delays: (i) the establishment of the project performance management system (PPMS), and (ii) implementation of the EEMP. The project agreement stipulated that the PPMS should be established within 12 months (Appendix 7, project agreement, para. 16) and the EEMP prepared within 6 months of loan effectiveness (Appendix 7, project agreement, para. 19). The PPMS was established only in April 2005, while the preparation of the EEMP began in September 2006. This was partly because GEF funding to implement these covenants became available only in late October 2004, or 16 months after loan effectiveness. The one covenant yet to be complied with requires the submission of environmental assessment reports by PIOs one year after project completion. The status of compliance with all major loan and project covenants is in Appendix 7.

H. Consultant Recruitment and Procurement

33. The PMO, PIOs, and project implementation units recruited 25 international and national consultants. International consultants were selected and engaged, through a firm using the quality- and cost-based selection method, as planned at appraisal and following ADB's Guidelines on the Use of Consultants (2007, as amended from time to time). Eight national research institutions and national consultants were recruited through arrangements satisfactory to ADB. Recruitment and procurement encountered no major problems. Increases in training and in the government's activities in component C did not affect the consulting and procurement arrangements.

I. Performance of Consultants, Contractors, and Suppliers

34. The performance of the consulting firm, research institutions, and individual consultants was *satisfactory*. No major issues were encountered regarding the consultants' performance. The results of an evaluation by the executing agency of the individual consultants' performance showed that 8 were rated *excellent*, 16 rated *satisfactory*, 1 rated *generally satisfactory*, and none rated *unsatisfactory*.

J. Performance of the Borrower and the Executing Agency

35. The performance of the borrower, represented by the MOF, and the executing agency was rated *satisfactory*. The increased government counterpart funding for infrastructure was

unexpected at appraisal but boosted the project's impact and the improvements to the living environment of rural households in the four project provinces. The executing and implementing agencies were dedicated to the delivery of the project outputs, provided sufficient counterpart funds and human resource support in project administration, were well involved in the project implementation, and provided timely suggestions on adjustments to project scope to make the project more relevant to rural energy development. The staff of the PMO and PIOs was stable and highly dedicated to maintaining the high standards of work quality put in place to enhance project sustainability. Project regulations, guidelines, and training materials were prepared and distributed. Project financial management by the PMOs, the four PIOs, and their PFBs demonstrated the competence of their staff and their ability to meet ADB requirements.

36. Some PIOs have started replicating the project management model, including feasibility evaluation, bidding procedures, contract award and execution, and project monitoring and evaluation, in their national rural energy programs.

K. Performance of the Asian Development Bank

37. Overall, ADB's performance was *satisfactory* during project implementation. ADB was responsive to the government's requests and proper justifications for adjustments in project scope and reallocations of funds, which ensured that the project design remained relevant and implementation was efficient. The cancellation of gasification plants due to technical issues demonstrated ADB's flexibility in adapting the design to avoid project failure. ADB also explored the possibility of establishing GEF imprest account in each province to fast-track the GEF grant disbursements. However, due to GEF financing agreement constraints, the provincial-level GEF imprest account establishment did not materialize, thus resulted in slower than targeted disbursements, and overall, it delayed implementation of GEF components. However, lessons learned have been applied to avoid similar issues in the recently approved Integrated Renewable Biomass Energy Development Sector Project.⁵ ADB's resident mission in the PRC also provided timely support to the government to address disbursement issues.

38. ADB's review missions were deemed unnecessarily intensive by the government. Frequent changes in project officers might have increased administrative costs and work for both ADB and the government. The government also suggested that the executing and implementing agencies should have had the authority to change project scope. In future, ADB may consider allowing minor changes in scope without prior ADB approval to enhance project efficiency in the PRC.

III. EVALUATION OF PERFORMANCE

A. Relevance

39. Interviews with officials of the Ministry of Agriculture and the implementing agencies show that the project design was and remains *highly relevant* to rural development in the PRC. An estimated 148 million rural households raise pigs or cattle and are suited to biogas development. The government's Renewable Energy Act of 2007, its amendment in 2009, and provincial strategies for rural biogas development, which include government financing support, all address the strong need for developing rural household biodigesters. The Circular Economy Promotion Law of 1 January 2009 encourages the use of agricultural waste in eco-farming to

⁵ ADB. 2010. *Report and Recommendation of the President to the Board of Directors on Proposed Loan and Administration of Grants to the People's Republic of China for the Integrated Renewable Biomass Energy Development Sector Project*. Manila.

replace chemical fertilizers and produce green energy. The project was aligned with the government's policy. The project financed not only the construction of household biodigesters and the integration of biogas generation with farmers' livelihoods but also piloted medium-scale biogas plants which, according to the Ministry of Agriculture and the implementing agencies, will be the trend in future rural biogas development in the PRC. More efficient medium- to large-scale livestock enterprises appear to be replacing the production of pigs on a small scale by individual households. While this could reduce fuel for biodigesters built under the project, the PCR mission was informed that straw is a likely replacement feedstock for pig and other livestock effluent and is in abundant supply within the project area.

40. Further underlining the project's relevance to government rural development strategies is the preparation of a national strategy on rural biomass energy development, supported by ADB⁶ and partially based on the project experience, as well as follow-up projects financed by World Bank. World Bank followed the project's design in preparing the China Renewable Energy Scale-up Program in 2005 and the Eco-Farming Project in 2008.⁷

41. Cancellation of the financing of the gasification plants was justified. The gasification technology was not mature enough and technical problems remained to be solved. The addition of a CDM study to the project was also relevant. The objective of the CDM study was to showcase a cost-effective approach to generating a future carbon revenue stream and to building the CDM capacity in both the provinces and farms by supporting them through the CDM project development cycle. The study furthered the project's original aim to reduce greenhouse gases and promoted the adoption of renewable energy by reducing implementation costs while introducing waste management practices for reducing farm pollution.

B. Effectiveness in Achieving Outcome

42. The project achieved a range of economic, social, and environmental goals, purposes, and outcomes. These outputs relative to appraisal targets and the revisions to these targets at the time of the midterm review are discussed in paras. 9–20 and set out in detail in Appendix 2. The project has met or exceeded its individual output targets and the small overrun in the total project costs mainly reflects the higher outputs. The outputs appear sustainable and the project has been a catalyst for an increase in government funding for biogas technology in rural areas.

43. The project did not provide biogas to as many households as envisaged at appraisal due to the dropping of type IV straw gasification plants. Only two of the 13 medium-scale type III plants financed under the project (one each in Shanxi and Henan provinces) provided the gas reticulation to rural households that were envisaged at appraisal.⁸ The 11 other plants produce gas for use in the operations of the project enterprises, including, for example, a slaughterhouse and a dairy factory. This change reflects the commercial risks involved in recovering investment and operating costs from many individual households through the sale of biogas and the capital costs of the reticulation network that would have been required. Neither these two scope nor the midterm review decision to redirect funding from type I to type II farm models detracted from the

⁶ ADB. 2010. *Rural Biomass Energy 2020*. Manila.

⁷ World Bank. 2005. *China Renewable Energy Scale-up Program*. Washington, D.C.; and World Bank. 2008. *Eco-Farming Project*. Washington, D.C.

⁸ Although Hubei province withdrew its participation in the project's type III systems component at midterm review, officials told the project completion review mission that one potential applicant for a type III scheme that had withdrawn from the ADB project due to financial difficulties had later proceeded with a type III scheme with government assistance. The biodigester was significantly bigger than that proposed under the project and served 1,000 rural households.

project's effectiveness. Instead, they demonstrated adaptability to a changing commercial environment and new information during implementation. Overall, the project is rated *highly satisfactory* in terms of its effectiveness.

C. Efficiency in Achieving Outcome and Outputs

44. The financial internal rates of return (FIRRs) for the biogas systems and the economic internal rate of return (EIRR) for the overall project have been recalculated using information provided in the government's project completion report and supporting spreadsheets, supplemented with information gathered in the field. For representative types 1 and 2 farm models in each of the four provinces, the FIRRs are estimated at between 10% and 40%. The type I models account for the lower rates of return, which is consistent with the decision at midterm review to shift the focus away from these systems. The higher rates of return are achieved by the vegetable and fish type II models and reflect significant savings in fertilizer and feed costs and increased yields from using the slurry produced by the digesters. These rates of return are very sensitive to changes in the price of pork. However, farmers in the project area are able to switch to other types of livestock when pork prices are low. In addition, straw is being increasingly used in digesters when pig effluent is not available. The FIRRs for the type III medium-scale models range between 9.0% and 23.2%, well above the prevailing interest rate on loans of 7.2%. Table A8.1 shows disaggregated FIRR results by model type and province.

45. The EIRR for the project as a whole has been estimated at 19.9%, based on the benefits from the increased biogas and agricultural production from the type I, 2, and 3 plants (see Appendix 8). If the benefits from reductions in cooking time, medical expenses, and carbon dioxide (CO₂) emissions are included in the quantitative analysis, the estimated EIRR increases to 25.8%. These results are robust across a range of sensitivity tests. For example, if the attrition rate for digesters built under the project is doubled from 2% per year to 4% per year, the project's EIRR falls by 2.4% from 19.9% to 17.5%, without the inclusion of savings in cooking time and medical expenses, and CO₂ reduction benefits. With the inclusion of these benefits and a 4% per year attrition rate, the project's EIRR is 23.5%. Other sensitivity testing results related to changing prices for agricultural outputs (pork, greenhouse and outdoor vegetables, crops, and fish), and for biogas and slurry are detailed in Appendix 8. To the extent that several projects components generate wider economic benefits than incremental biogas and agricultural production—including training, rural infrastructure rehabilitation and construction, environmental awareness, environmental policy implementation, and capacity development—these estimated EIRRs are conservative. The project is assessed efficient in achieving the intended outcome and outputs. The decision to cancel the financing of the gasification plants, and reduce the target of type I model resulted in better use of the project's funds by additional type II units, which demonstrated better FIRRs.

D. Preliminary Assessment of Sustainability

46. The sustainability of the project is assessed as most likely given the pool of trained technicians developed under the project and ongoing interest and financial incentives in the PRC to expand the use of biogas technology. Plant owners interviewed during the project completion review mission reported that plant reliability was good. The only report of a disruption in gas supply was due to the construction of a new railway line—a one-off event and beyond the control of the affected plant owner. Because ongoing government programs encourage the uptake of small- and medium-scale biogas technology, a network of support systems will be retained in the provincial and county governments.

E. Impact

47. **Social impact and poverty reduction.** A beneficiary impact assessment (BIA) and socioeconomic analysis of the project were completed in May 2008.⁹ The report on these studies presented only preliminary findings of the social impacts because the project still had almost 2 years to run when the data was collected and major project elements, including most of the type III biogas systems, still were not operational. Nonetheless, based on the before-project situation and non-project farm household comparisons, the report found that the project had already had a major effect in alleviating poverty, increasing farm household incomes, and making progress towards gender equality.

48. At project completion, around 19,000 households had new biogas plants built under the project, along with increased pig or other livestock breeding facilities, increased areas of vegetables (with a newly constructed greenhouse under the type I model), and increased areas of orchards, crops, or fish ponds. They were also using natural fertilizer in place of more expensive chemical fertilizers. The project had increased farm production, on-farm employment opportunities, and incomes and had made household environments cleaner, shortened cooking and fuel collection times, improved sanitary facilities, and thereby upgraded health and general living standards. The estimated average increase in farm household income was CNY8,510 per year at full project benefits (see Table A9.1). In addition, two of the type III biogas systems were delivering gas through a network to 600 rural households, improving their cooking and living conditions.

49. Women comprised 40% of the members of project's households and were the main beneficiaries of some of its achievements. Compared with the baseline year of 2003, project farmers reduced coal consumption by 30%, firewood consumption by 61%, charcoal consumption by 88%, and liquefied petroleum gas consumption by 18% in 2007. As a consequence, project farm households—and women, in particular, since these tasks were normally theirs—spent an estimated 41% less time cooking and 64% less time boiling water than before. Women no longer needed to cut or collect firewood, and had more time for other chores than cooking. The BIA showed that 75% of farm households said that use of the digesters had reduced the numbers of flies and mosquitoes and improved sanitation, the environment, and the health of individuals in their households. Again, women were the main beneficiaries here because they enjoyed a better living environment when staying in their houses and had more time to take care of household chores or livelihoods.

50. The government's counterpart contribution of better farm-to-market roads and additional market facilities and mechanized wells has also improved living standards in the project area.

51. The project component to pilot poverty-reduction approaches to biomass development targeted 9,000 impoverished farm households at appraisal for livelihood training and GEF grants to subsidize construction of type I and II biogas digesters. Only 8,528 poor households actually received grants due to a fluctuating exchange rate that reduced the local currency funds available. Nevertheless, 9,182 poor households were able to increase their incomes and improve their quality of life because of the strong demand from non-project poor households to take part in the livelihood training and to learn better farming practices. The project was able to provide additional training slots to these households at no additional cost.

⁹ Center for Integrated Agricultural Development. 2008. *Final Report on Beneficiary Impact Assessment and Socioeconomic Analysis of the Efficient Utilization of Agricultural Wastes Project, May 2008*. Agricultural University, College of Humanities and Development. Beijing.

52. A BIA study of project beneficiaries' incomes indicated that the project had contributed to a decline in poverty even before it was completed. The BIA put the percentage of the beneficiaries who could be described as being among the absolute poor (those with per capita net income below CNY700 per year) at 15.00%, 11.25%, and 6.00% in the baseline year of 2003, in 2006, and in 2007, respectively. The percentages of the poor (those with per capita net income of between CNY700 and CNY1,000 per year) were 9.25%, 6.75%, and 2.50% in the same 3 years, indicating another decline in poverty among beneficiaries. The percentages among the beneficiaries of those defined as the vulnerable poor (per capita net income of between CNY1,000 and CNY2,000 per year) were 15.00% (2003), 11.25% (2006), and 6.00% (2007). This data must be interpreted cautiously because general price inflation will have lifted some project beneficiaries out of their original categories and some incomes may have risen due to factors unrelated to the project, including other government programs and remittances from family members working in cities. However, the steady and substantial trend across the four categories does indicate early project success in reducing poverty.

53. The BIA survey also recorded that project beneficiary per capita incomes had increased over the baseline year by CNY729 in 2006 and by CNY2,534 in 2007. By comparison, non-project farmers' per capita incomes increased by considerably smaller amounts during the same period—by CNY228 in 2006 and by CNY1,672 in 2007—implying additional relative per capita income gains of CNY501 by 2006 and CNY862 by 2007 for beneficiary farmers.

54. **Institutional capacity development.** The project helped strengthen four provincial environmental monitoring and training stations by providing monitoring equipment and technical training. The project also trained biodigester contractors, technicians, and extension workers, and prepared training materials on awareness raising, O&M for household biodigesters, and livelihood improvement. These can continue to be used by the government's own rural energy projects. Importantly for the project's sustainability, the training and extension stations have continued to be staffed by trained technicians after project completion. PMO and PIO officials have also gained experience and knowledge of project administration and information dissemination, which will sustain the project's impact into the future.

55. **Environmental impact.** The project's EEMP surveyed before-project, with-project, and without-project environmental conditions extensively across a wide range of environmental monitoring variables. Among the main findings were significant reductions in the use of traditional rural energy sources (coal and firewood) and chemical fertilizer, and declining emissions of CO₂, sulphur dioxide, and nitrogen dioxide. Soil and indoor air quality rose measurably as a result of the project. Although pesticide residues on crops decreased, overall use of pesticides grew slightly due to an increase in cropped areas under the project (Appendix 10).

IV. OVERALL ASSESSMENT AND RECOMMENDATIONS

A. Overall Assessment

56. The project is assessed as *successful*. It was rated (i) *highly relevant* to the development strategies of ADB and the government, (ii) *effective* in achieving outcomes, (iii) *efficient* in achieving outcomes and outputs, and (iv) *most likely sustainable*. The minor change in scope that cancelled the type IV model reduced a project risk raised by the potential failure of the technology. Similarly, the switching of resources from type I to type II biogas systems was appropriate in the changed economic environment. The reduction in the number of rural households provided with reticulated biogas supply from type III plants resulted from the fact

that private sector operators would have faced commercial risks by investing in the originally envisaged gas distribution networks without financial support from the project.

57. The belated approval of GEF funds by the GEF caused the delay in project completion by 18 months. Nonetheless, the project was implemented efficiently with satisfactory performance throughout. The project achieved its objectives, which were to improve the environment and the welfare and living conditions of rural households through efficient utilization of agricultural wastes.

B. Lessons

58. **Simplify grant disbursement arrangements.** The flow of GEF funds was slow and tedious and delayed implementation. This was due partly to the lack of an imprest account in the provinces. These disbursements arrangements need to be simple. The government has drawn lessons from the project and has now agreed to the establishment of imprest accounts in provincial departments of finance to receive grant funds directly from ADB. Such an arrangement is expected to accelerate the disbursement of the GEF grants in future GEF-cofinanced projects and ensure the effectiveness of the fund uses.

59. **Government ownership key.** The project objectives were in line with the government's national policy on environmental improvement, renewable energy development, and poverty reduction in rural areas. The project activities were also well integrated with the existing institutional system, which involved rural energy offices and extension service stations in the counties and villages. The government demonstrated a strong ownership of and commitment to the project by increasing its counterpart contribution to the construction of infrastructure in the project area and the issuance of relevant laws and policies during project implementation, which made the project successful and sustainable.

60. **Training crucial to sustainability.** A well-designed, well-executed capacity development program assures that a project will be sustainable and can be replicated. The sound planning of this project's training programs was one of the keys to its success. The training combined courses on biogas systems and agricultural production, giving farmers an opportunity to use new technology, knowledge, and ideas to improve their incomes and living standards. It was also broad and flexible, allowing the family members who are often the final users of the biogas to take part. This ensured that the type I and II systems would remain operational. The project also trained technicians in service centers and stations in the counties and villages, helped establish service networks in the project areas, and ensured the availability of maintenance services in rural areas.

61. Providing training in the year after construction of the biogas digesters was also effective since this was when project farmers needed to learn about O&M for their new equipment and how to make use of the slurry and sludge from the digesters in agricultural production. The project also established an institutional mechanism linking contractors with extension service stations and the farmers, which is critical in promoting further development of rural household biodigesters. The training program has created ripple effects in the participating provinces. The implementing agencies have started replicating the project's biodigester-cum-livelihood design and training in other areas, using the training materials and extension services established by the project.

62. **Climate and location important.** Local weather conditions can affect the success of technology, as they did in the case of the type I system. The sustainability of type I systems,

which include a greenhouse, could be marginal in Shanxi Province where the annual average temperature is low and they can only function properly for about half the year. The province's harsh weather also means that the greenhouses deteriorate faster and need more intensive maintenance. Understanding the geography of farmers' lives is also important in designing projects such as this. The systems were constructed on the farms and were usually far from farmers' houses. This limits the benefits of using the biogas to cooking one or two meals a day when farmers are at work in their fields.

63. **Due diligence critical before using new technology.** The technical and economic viability of a new technology, such as the straw gasification technology in the project, must be examined carefully before its inclusion in a project. This is particularly important to poverty-focused projects as poor stakeholders would have less capacity in managing risks of project failure. The cancellation of type IV gasification plants at midterm review mission over the concerns about their technology immaturity and economic viability avoided project failure and was a sound decision. However, it also showed a lack of proper due diligence regarding these factors at the appraisal. The supplementary appendix A of the report and recommendation of the President (RRP) indicated that the technology was only beginning to be tried. The fixed bed gasifier had been installed only by one company and had not been widely adopted. The other equipment type, a fluidized bed gasifier, had not received certification from Chinese authorities at the time of the project appraisal. The project design was unclear about the type IV systems' implementation arrangements and investors. This was especially risky because the majority of the project beneficiaries were to be farmers with limited skills, and the beneficiaries and implementing officers would both need capacity development in basic biodigester construction and O&M. The type IV system technology would have been too complicated for farmers to operate and maintain. It might well have failed if the 28 units had been set up as planned.

64. **Enterprise ownership lacking.** The lack of ownership and commitment on the part of the project enterprises to the preparation of the PDD might cause the CDM pilot bundling project to fail. In the case of the pilot CDM project in Henan Province, the provincial government may need to change its role from direct involvement in the CDM project development to technical support. The government should also seek direct involvement by the enterprises to enhance their ownership and understanding of the CDM process. The enterprises considered carbon financing as an easily accessible fund and were not aware of the commitment and efforts that would be required from them to avail of the carbon credit. The absence of direct involvement in preparing the CDM pilot project and lack of full understanding of the process may lead to the failure of the pilot bundling project.

C. Recommendations

1. Project Related

65. **Future monitoring.** The types I and II systems are highly sensitive to the prices of pigs and pork, weather conditions, and rural economic growth. The executing and implementing agencies should therefore continue to monitor the use of the project systems and their impact on farmers' livelihoods.

66. **Covenants.** In accordance with the project agreement, the four PIOs will present their respective environmental assessment reports 1 year after project completion (para. 32). The environmental assessment reports should include a compilation of the environmental monitoring results carried out during project implementation, a summary of the environmental assessment carried out by type III systems and their approvals, and the environmental management

measures undertaken following the summary initial environmental examination report in the report and recommendation to the President.

67. **Revolving funds.** The loan has a 25-year term but the repayment periods for subloans are less than 10 years. Some subborrowers have started repayment and the government is considering recycling the funds to maximize the project benefits. The departments of agriculture and finance in Jiangxi province are preparing rules and guidelines to set up a revolving fund. Once approved by the MOF, this will allow loan repayments to be used to establish additional type II systems and multiply the project's impact. ADB has asked the government to share its final rules and guidelines on the revolving fund so that ADB could consider using such mechanism in other projects in the PRC.

68. **Timing of the project performance evaluation report.** It is recommended that ADB prepare the project performance evaluation report 3 years after project completion to assess the project's impacts and sustainability and identify lessons for ADB's future lending to similar projects. The report should evaluate (i) repayment conditions of household subborrowers, (ii) O&M of type I and II systems, (iii) the usefulness of the training materials in the government's rural biomass renewable energy projects, (iv) the financial and economic viability of gas supply to villagers by biogas plants, and (v) the feasibility of using revolving funds to multiply the project's impacts.

2. General

69. The loan agreement required the borrower to establish a national policy coordination committee as a project policy-making body. Although the borrower complied with the requirement, the PCR mission found that the committee was not really operational. The government has its own mechanism for policy making in general and is unlikely to develop policy through a committee established under an ADB investment project. Future ADB projects should consider whether such a covenant or requirement in the loan agreement is needed and actually serve its purposes.

70. The PMO and PIOs prepared training materials in many media forms on subjects including O&M of household biodigesters and the safe use of biogas. It is recommended that the government continue to use these training materials in the project provinces for training biogas technicians and farmers and that it share them with other provinces and international financial institutions, such as World Bank, for training in biogas construction and O&M.

71. It is recommended that the PIOs, in consultation with relevant rural environmental monitoring stations, develop a rural environmental monitoring program to make the best use of the monitoring equipment purchased using the GEF grants.

72. ADB's future projects involving rural household biodigesters should consider (i) integrating rural livelihood development into a biodigester project design and promoting the use of bioslurry and sludge to replace chemical fertilizers and pesticides, thereby raising farm productivity and incomes, adding value to a project's design and better ensuring project sustainability; (ii) establishing rural service extension networks to give farmers a timely supply of spare parts and support in solving operational problems; (iii) studying the availability of alternative feedstock for biogas digesters during planning to avoid the risk of shortages of raw materials; (iv) emphasizing proper due diligence regarding the technical viability of innovative technology; and (v) avoiding the promotion of biodigesters in cold regions where O&M of household biodigesters is difficult.

PROJECT FRAMEWORK

Design Summary	Performance Indicators/Targets			Monitoring Mechanisms	Assumptions and Risks
	Appraisal	Revised Targets at Midterm	Actual		
Goals					
<p>Improve the environment</p> <p>Promote sustainable agricultural production to enhance economic growth, and improve welfare and living conditions of rural households (HHs) in disadvantaged areas in Henan, Hubei, Jiangxi, and Shanxi provinces</p>	<p>Improved quality of air, soil, and water</p> <p>Increased clean, renewable energy supply, and improved quality of agricultural outputs</p> <p>Expanded rural production and decreased number of HHs living below the poverty line</p>	Not changed	Completed	<p>Provincial statistics</p> <p>Project performance management system (PPMS) reports</p> <p>Project completion report (PCR)</p> <p>Environmental monitoring reports</p> <p>Results monitoring evaluation</p>	<p>Government policies are favorable to promote generation of renewable energy.</p> <p>Government investments in rural infrastructure are sustainable.</p> <p>Government remains committed to poverty reduction.</p>
Purposes					
<p>Demonstrate economic viability of sustainable biomass technology for efficient utilization of agricultural waste for generation of clean, renewable energy; and promote private sector participation</p> <p>Enhance agricultural productivity and rural income through recycling of biomass resources, and reduce poverty</p>	<p>Sustainable incremental annual production of</p> <p>41 million cubic meters (m³) of biogas per producer gas renewable energy</p> <p>289,780 pigs</p> <p>882 tons of green vegetables (comprising greenhouse vegetables like cucumber, squash, tomato, etc.)</p> <p>209,280 tons of citrus fruit</p> <p>645,952 tons of digested effluent/sludge (organic fertilizer)</p>	<p>Sustainable incremental annual production of</p> <p>13.1 million m³ of biogas renewable energy</p> <p>355,150 pigs</p> <p>2,291 tons of green vegetables</p> <p>173,278 tons of citrus fruits</p> <p>738,712 tons of digested effluent and sludge</p>	<p>Sustainable incremental annual production of</p> <p>13.7 million m³ of biogas renewable energy</p> <p>344,286 pigs</p> <p>21,862 tons of green vegetables (including greenhouse vegetables such as cucumber, tomato, sweet potato)</p> <p>156,114 tons of citrus fruits</p> <p>851,233 tons of digested effluent and sludge (organic fertilizer)</p>	<p>Provincial statistics on agriculture and renewable energy</p> <p>Project progress and PPMS reports</p> <p>PCR</p> <p>Post-evaluation report</p> <p>Environmental monitoring reports</p>	<p>Market prices for renewable energy (biogas) and agricultural products are favorable and stable.</p> <p>Farmers respond favorably to efficient utilization of renewable energy and management of biogas technologies.</p> <p>Sufficient counterpart funds are provided. Appropriate policies on renewable energy expansion are implemented.</p> <p>Provincial government officials are capable of handling credit and debt repayment</p>

Design Summary	Performance Indicators/Targets			Monitoring Mechanisms	Assumptions and Risks
	Appraisal	Revised Targets at Midterm	Actual		
	<p>Sustainable annual incremental environmental benefits estimated for</p> <p>78,338 tons of carbon dioxide (CO₂) reduction</p> <p>Annual treatment of over a million tons of agricultural wastes (pig manure, crop residues, vegetable wastes, etc.) resulting in improved air and groundwater quality</p> <p>Increased incomes and quality of life for about 34,080 HHs, including about 9,000 poor HH families</p>	<p>Sustainable annual incremental environmental benefits estimated at</p> <p>84,429 tons of CO₂ reduction</p> <p>Annual treatment of over 738,712 tons of agricultural waste (pig manure), resulting in improved air and groundwater quality</p> <p>Increased incomes and quality of life for about 21,435 HHs, including about 9,000 poor HH families</p>	<p>Sustainable annual incremental environmental benefits estimated at</p> <p>86,682 tons of CO₂ reduction</p> <p>Annual treatment of over 948,612 tons of agricultural waste (pig manure, straw, vegetable wastes), resulting in improved air and groundwater quality</p> <p>Increased incomes and quality of life for about 21,796 HHs, including about 9,182 poor HH families</p>		services.
Outputs					
Output 1: Funding Renewable Energy Generation and Eco-Environment Development					
Rehabilitation/construction of greenhouses for year-round organic vegetable production	Rehabilitate/construct 4,700 greenhouses for organic vegetable production under the 4-in-1 model	Rehabilitate/construct 2,545 greenhouses for organic vegetable production under the 4-in-1 model	Constructed 2,515 greenhouses for organic vegetables production under 4-in-1 model	Project progress reports and review missions PPMS annual survey	Orchard farmers issued with land use rights long enough to provide them incentives for investing in land development and orchard establishment
Establishment of plantations for citrus production	Develop 10,900 hectares of citrus under the 3-in-1 model	Develop 16,970 hectares of citrus or vegetables under the 3-in-1 model	Developed 16,597 hectares of citrus or vegetables under the 3-in-1 model	Nongovernment organization (NGO) reports	Provincial finance bureaus capable of administering credit disbursement and loan repayment
Construction of HH biogas digesters, medium-scale biogas plants, and biomass gasification plants	Construct 15,600 HH biogas digesters, each producing 600 m ³ /year of biogas	Construct 19,515 HH biogas digesters, each producing about 600 m ³ /year of biogas	Constructed 19,083 HH biogas digesters, each producing 600 m ³ /year of biogas	Environmental monitoring reports PCR	

Design Summary	Performance Indicators/Targets			Monitoring Mechanisms	Assumptions and Risks
	Appraisal	Revised Targets at Midterm	Actual		
	<p>Construct 14 large-scale biogas plants, each producing 87,600 m³/year of biogas and supplying 120 HHS</p> <p>Construct 28 biomass gasification plants, each producing 1.1 million m³/year of producer gas and supplying 600 HHS</p> <p>34,080 HHS benefiting from cheaper biogas and cleaner environment</p> <p>About 31,200 farm beneficiaries trained on biogas technology</p> <p>4,700 farmers qualified to produce green vegetables</p>	<p>Construct 16 large-scale biogas plants, each producing 87,600 m³/year of biogas</p> <p>Proposed to cancel this type IV and adjust the budget into the first 3 types</p> <p>18,175 HHS benefiting from cheaper biogas and cleaner environment</p> <p>2,545 farm HHS qualified to produce organic vegetables</p>	<p>Constructed 15 large-scale biogas plants, each producing 87,600 m³/year of biogas</p> <p>Plan for 28 biogas gasification stations dropped</p> <p>19,875 HHS benefited from cheaper biogas and cleaner environment</p> <p>19, 875 HH beneficiaries received training on biogas technology</p> <p>2,515 farm HHS qualified to produce organic vegetables</p>	<p>Post-evaluation report</p>	<p>Adequate technical services made available to advise and monitor construction and operation of biogas production units</p> <p>Sustainable operation and maintenance (O&M) for biogas digesters</p> <p>Adequate quantity of straw for soil mulching</p>
Output 2: Improved Mechanisms for Transferring Biomass Technology					
<p>Conduct of courses for transfer of engineering and technical skills to biogas digester contractors</p> <p>Provision of training and extension services to beneficiaries and project officials</p> <p>Conduct of workshops and study tours to acquire biomass technology</p>	<p>120 biomass digester contractors and technicians trained to provide services to farmers</p> <p>About 33,000 farmers trained</p> <p>About 650 extension workers trained</p> <p>20 annual workshops conducted</p> <p>100 study tours to neighboring counties or provinces</p>	<p>1,750 biomass digester contractors and technicians trained to provide services to farmers</p> <p>About 18,870 farmers trained</p> <p>About 2,000 extension workers trained</p> <p>49 annual workshops conducted</p> <p>80 study tours to neighboring counties or provinces</p>	<p>4,191 biomass digester contractors and technicians trained to provide services to farm HHS</p> <p>About 38,054 farm HHS trained</p> <p>About 6,131 extension workers trained</p> <p>74 annual workshops conducted</p> <p>80 study tours to neighboring counties or provinces conducted</p>	<p>Project progress reports</p> <p>Midterm review report</p> <p>PPMS</p> <p>PCR</p>	<p>Effective development of training programs by the PMO</p> <p>Farmers and county officials' training programs effectively carried out</p> <p>Project implementation offices' officials effectively organized courses, workshops, and study tours.</p>

Design Summary	Performance Indicators/Targets			Monitoring Mechanisms	Assumptions and Risks
	Appraisal	Revised Targets at Midterm	Actual		
Output 3: Rehabilitated Farm-to-Market Facilities					
Development of rural infrastructure, including farm-to-market access roads and bridges, and other rural marketing facilities in the villages	Construct/rehabilitate 60 kilometers (km) of farm-to-market rural roads and bridges/drainage in four provinces 100 organized community groups participate in the construction and maintenance of the rural infrastructure facilities	Construct/rehabilitate 525.0 km of farm-to-market rural roads and bridges/drainage in four provinces Not changed	Built/rehabilitated 526.7 km of farm-to-market rural roads Organized more than 100 community groups to participate in the construction and maintenance of the rural infrastructure	Project progress reports and review missions NGO and PPMS reports PCR Post-evaluation report	Farmers organized for O&M activities of rural infrastructure facilities Adequate counterpart funds provided by provincial governments for construction and maintenance of major roads leading to farms
Output 4: Improved Environmental Policy Implementation and Awareness					
Removal of barriers for adoption of renewable energy Development of facilities and establishment of system for monitoring environment to assure high environmental standards for air, water, soil, and farm produce Promotion of public awareness and political support for healthy environment Establishment of system to monitor emission of environmental contaminants	Develop system and policies to remove barriers for renewable energy development Develop communication strategy in each PIO to encourage public awareness of environmental issues Establish system to monitor emission of environmental contaminants by providing 38 sets of environmental monitoring equipment	Not changed Not changed	Developed system and policies to remove barriers for renewable energy development Developed communication strategy in each provincial PIO to encourage public awareness of environmental issues Procured 67 sets of environmental monitoring equipment and established a system for monitoring emission reduction of environmental radioactive pollution	Project progress reports PPMS reports NGO and review missions reports PCR Post-evaluation report	Environmental protection policies implemented in all project provinces Support from rural communities for environmental protection and improvement Government provided sufficient counterpart funds to agriculture environment protection bureaus to effectively carry out environment awareness and environmental monitoring activities

Design Summary	Performance Indicators/Targets			Monitoring Mechanisms	Assumptions and Risks
	Appraisal	Revised Targets at Midterm	Actual		
Provision of technical assistance and training for environmental protection and monitoring	<p>Provide four sets of gasification monitoring equipment for tar and ash analysis</p> <p>Train staff of agriculture environment protection stations in 37 counties (three persons from each station) by national consultants</p> <p>Establish four environmental monitoring and training stations</p>	<p>Not changed</p> <p>National consultants to train staff of agriculture environment protection stations in 37 counties (13 persons from each station)</p>	<p>Plan for procurement of four sets of gasification station monitoring equipment for tar and ash analysis was canceled due to dropping of gasification station item</p> <p>National consultants trained 488 staff from agriculture environment protection stations in 37 counties</p> <p>Established four environmental monitoring and training stations</p>		
Output 5: Pilot Poverty-Focused Approaches to Biomass Development					
<p>Establishment of financially viable and sustainable scheme to provide credit to poorer segments of rural villagers (living below poverty line) for biogas generation, greenhouse vegetable production, and other products</p> <p>Provision of specific training targeting poor farmers</p>	<p>9,000 poor households lifted from poverty</p> <p>Provide basic biogas facilities to 9,000 poor HHs</p> <p>Provide specific training to poor farmers</p>	<p>Not changed</p>	<p>9,182 poor households lifted from poverty.</p> <p>Provided basic biogas facilities to 8,528 poor HHs</p> <p>Provided training to 9,747 poor farmers on biogas technology, cropping and livestock production technologies, organic farming, and utilization of biogas sludge and slurry</p>	<p>Project progress reports and review missions reports</p> <p>NGO and PPMS reports</p> <p>PCR</p>	<p>Effective village committees formed with strong support from county finance bureaus</p> <p>Clear criteria to identify poor farm families</p>

Design Summary	Performance Indicators/Targets						Monitoring Mechanisms	Assumptions and Risks
	Targets (\$ million)			Actual (\$ million)				
	Foreign Exchange	Local Currency	Total	Foreign Exchange	Local Currency	Total		
Activities/Inputs								
Funding renewable energy generation and eco-environment development	23.7	24.8	48.4	27.5	35.4	62.9	Project progress reports	Sufficient local counterpart parts available on timely basis
Improved mechanisms for transferring biomass technology	0.3	0.8	1.1	2.2	1.1	3.3	PPMS reports	
Rehabilitated farm-to-market facilities	0.2	0.8	1.0	0.0	5.8	5.8	PCR	
Improved environmental policy implementation and awareness	0.5	1.2	1.7	0.5	0.5	1.0	Post-evaluation report	
Pilot poverty-focused approaches to biomass development	0.1	2.7	2.8	1.2	1.0	2.2		
Improved project implementation and capacity development	1.6	4.9	6.5	2.3	0.4	2.7		
Base Costs	26.4	35.1	61.5	33.7	44.2	77.9		
TA preparatory cost	0.2	0.0	0.2	0.2	0.0	0.2		
Physical contingencies	2.6	3.5	6.1	0.0	0.0	0.0		
Price contingencies	1.8	2.4	4.2	0.0	0.0	0.0		
Commitment fee, FF, IDC	5.3	0.0	5.3	5.1	0.3	5.4		
Total Project Costs	36.3	41.0	77.3	39.0	44.5	83.5		

FF = front-end fee, GEF = Global Environment Facility, IDC = interest during construction, PCR = project completion report, PPMS = project performance management system, TA = technical assistance.

Source: Asian Development Bank estimates.

SUMMARY OF PHYSICAL ACCOMPLISHMENTS

	Henan				Hubei				Jiangxi				Shanxi				Total			
	Appraisal Target	Revised Target	Actual	% Complete	Appraisal Target	Revised Target	Actual	% Complete	Appraisal Target	Revised Target	Actual	% Complete	Appraisal Target	Revised Target	Actual	% Complete	Appraisal Target	Revised Target	Actual	% Complete
Loan Funds (Component A)																				
Type 1 (unit)	1,200	818	818	100	0	0	0	0	0	0	0	0	3,500	1,685	1,697	101	4,700	2,503	2,515	100
Type 2 (unit)	1,500	2,370	12,560	530	4,400	5,000	4,232	85	5,000	6,100	1,769	29	0	3,500	1,715	49	10,900	16,970	20,276	119
Type 3 (unit)	8	9	9	100	2	0	0	0	0	0	0	0	4	6	4	67	14	15	13	87
Type 4 (unit)	15	0	0	0	11	0	0	0	0	0	0	0	2	0	0	0	28	0	0	0
GEF Funds (Components B, C, D, E)																				
Technicians	30	500	1,100	220	30	400	960	240	30	550	1,350	245	30	300	781	260	120	1,750	4,191	239
Farmers Trained	8,250	3,230	6,008	186	8,250	5,000	10,550	211	8,250	9,140	13,377	146	8,250	1,500	8,119	541	33,000	18,870	38,054	202
Extension Workers																				
Trained	163	500	1,084	217	163	500	1,360	272	163	500	1,860	372	161	500	1,827	365	650	2,000	6,131	307
Workshops	5	8	20	250	5	8	15	188	5	25	32	128	5	8	7	88	20	49	74	151
Study Tours	25	10	22	220	25	20	26	130	25	40	24	60	25	10	8	80	100	80	80	100
Road (kilometer)	15	100	64	64	15	200	200	100	15	200	200	100	15	25	63	252	60	525	527	100
Environmental Monitoring																				
Equipment (unit)	10	10	1	10	9	10	5	50	10	25	25	100	9	10	36	360	38	55	67	122
EPB Staff Training	28	300	108	36	28	60	108	180	28	14	166	1,186	27	100	106	106	111	474	488	103
Poor households	2,221	2,221	2,225	100	1,848	1,848	2,010	109	2,698	2,698	2,698	100	2,233	2,233	2,249	101	9,000	9,000	9,182	102

EPB = environmental protection bureau, GEF = Global Environment Facility.

Source: Asian Development Bank estimates.

DETAILED PROJECT COST ESTIMATES

Item	Appraisal									Actual								
	(CNY'000)			(\$'000)			% Foreign Exchange	% Total Base Costs	(CNY'000)			(\$'000)			% Foreign Exchange	% Total Base Costs		
	Foreign	Local	Total	Foreign	Local	Total			Foreign	Local	Total	Foreign	Local	Total				
A. Baseline Costs																		
1. Funding renewable energy generation and eco-environment development	196,395.4	205,628.1	402,023.5	23,662.1	24,774.5	48,436.6	49	79	185,992.3	239,415.7	425,408.1	27,491.7	35,388.3	62,880.0	44	81		
2. Improved mechanisms for transferring biomass technology	2,244.3	6,401.9	8,646.2	270.4	771.3	1,041.7	26	2	14,958.8	7,372.9	22,331.6	2,211.1	1,089.8	3,300.9	67	4		
3. Rehabilitated farm-to-market facilities	1,982.7	6,472.2	8,454.9	238.9	779.8	1,018.7	23	2	0.0	38,941.9	38,941.9	0.0	5,756.0	5,756.0	0	7		
4. Improved environmental policy implementation and awareness	4,110.2	10,089.5	14,199.7	495.2	1,215.6	1,710.8	29	3	3,660.9	3,622.7	7,283.6	541.1	535.5	1,076.6	50	1		
5. Pilot poverty-focused approaches to biomass development	531.2	22,542.1	23,073.3	64.0	2,715.9	2,779.9	2	5	8,215.3	6,585.8	14,801.2	1,214.3	973.5	2,187.8	56	3		
6. Improved project implementation and capacity development	13,628.5	40,317.8	53,946.3	1,642.0	4,857.6	6,499.5	25	11	15,436.8	3,078.3	18,515.1	2,281.7	455.0	2,736.7	83	4		
Subtotal (A)	218,892.3	291,451.6	510,343.9	26,372.6	35,114.6	61,487.2	43	100	228,264.2	299,017.3	527,281.5	33,739.9	44,198.0	77,938.0	43	100		
B. Contingencies																		
1. Physical contingencies	21,875.3	29,089.4	50,964.7	2,635.6	3,504.7	6,140.3	43	10	0.0	0.0	0.0	0.0	0.0	0.0	0	0		
2. Price contingencies	14,802.8	19,773.6	34,576.4	1,783.5	2,382.4	4,165.8	43	7	0.0	0.0	0.0	0.0	0.0	0.0	0	0		
Subtotal (B)	36,678.1	48,863.0	85,541.1	4,419.0	5,887.1	10,306.1	43		0.0	0.0	0.0	0.0	0.0	0.0	0			
Subtotal (A+B)	255,570.4	340,314.6	595,885.0	30,791.6	41,001.8	71,793.4	43		228,264.2	299,017.3	527,281.5	33,739.9	44,198.0	77,938.0	43			
C. Technical Assistance Preparatory Cost	1,709.8	0.0	1,709.8	206.0	0.0	206.0	100		1,374.7	0.0	1,374.7	203.2	0.0	203.2	100			
D. Front-End Fee	2,748.8	0.0	2,748.8	331.2	0.0	331.2	100		2,240.6	0.0	2,240.6	331.2	0.0	331.2	100			
E. Commitment Fee	2,336.2	0.0	2,336.2	281.5	0.0	281.5	100		0.0	0.0	0.0	0.0	0.0	0.0	0			
F. Interest During Construction	38,675.3	0.0	38,675.3	4,659.7	0.0	4,659.7	100		32,164.1	2,184.1	34,348.1	4,754.2	322.8	5,077.0	94			
Total Project Costs	301,040.5	340,314.6	641,355.1	36,270.0	41,001.8	77,271.7	47		264,043.6	301,201.4	565,245.0	39,028.5	44,520.9	83,549.4	47			
Percentage of Financing				47%	53%	100%						47%	53%	100%				

Source: Asian Development Bank estimates.

PROJECT COST SUMMARY BY EXPENDITURE ACCOUNTS

Item	Appraisal						Actual						% Inc/ (Dec)
	(CNY'000)			(\$'000)			(CNY'000)			(\$'000)			
	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	
A. Investment Costs													
1. Civil Works													
a. Roads—materials	1,982.7	3,682.1	5,664.8	238.9	443.6	682.5	0.0	23,055.6	23,055.6	0.0	3,407.9	3,407.9	399
b. Roads—labor	0.0	2,790.1	2,790.1	0.0	336.2	336.2	0.0	15,886.2	15,886.2	0.0	2,348.2	2,348.2	599
c. Training station	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
d. Office renovation	139.4	557.8	697.2	16.8	67.2	84.0	0.0	192.9	192.9	0.0	28.5	28.5	(66)
e. Biomass development for the poor	0.0	19,754.0	19,754.0	0.0	2,380.0	2,380.0	8,215.2	6,584.8	14,800.0	1,214.3	973.3	2,187.6	(8)
Subtotal	2,122.1	26,784.0	28,906.1	255.7	3,227.0	3,482.7	8,215.2	45,719.5	53,934.8	1,214.3	6,757.8	7,972.1	129
2. Vehicles	1,382.0	460.7	1,842.6	166.5	55.5	222.0	0.0	513.2	513.2	0.0	75.9	75.9	(66)
3. Equipment													
a. Office equipment	1,451.7	2,177.6	3,629.3	174.9	262.4	437.3	270.6	220.2	490.8	40.0	32.6	72.6	(83)
b. Training equipment	398.4	597.6	996.0	48.0	72.0	120.0	1,936.3	414.0	2,350.3	286.2	61.2	347.4	190
c. Environmental facilities	4,010.6	6,015.8	10,026.4	483.2	724.8	1,208.0	136.0	2,453.3	2,589.3	20.1	362.6	382.7	(68)
Subtotal	5,860.7	8,791.0	14,651.7	706.1	1,059.2	1,765.3	2,342.9	3,087.6	5,430.4	346.3	456.4	802.7	(55)
4. Special Funds—Biogas Development													
a. Credit funds (ADB loan)	195,845.8	0.0	195,845.8	23,595.9	0.0	23,595.9	185,992.3	0.0	185,992.3	27,491.7	0.0	27,491.7	17
b. Credit funds (local government)	0.0	97,922.9	97,922.9	0.0	11,797.9	11,797.9	0.0	123,376.8	123,376.8	0.0	18,236.4	18,236.4	55
c. Beneficiary contribution	0.0	97,922.9	97,922.9	0.0	11,797.9	11,797.9	0.0	109,864.9	109,864.9	0.0	16,239.2	16,239.2	38
Subtotal	195,845.8	195,845.8	391,691.6	23,595.9	23,595.9	47,191.8	185,992.3	233,241.7	419,234.0	27,491.7	34,475.7	61,967.4	31
5. Consultants, Training, Workshops, Special Studies, and Tours													
a. Consulting Services													
i. International consultants	11,205.0	0.00	11,205.0	1,350.0	0.0	1,350.0	6,064.3	0.0	6,064.3	896.4	0.0	896.4	(34)
ii. National consultants	0.0	9,673.7	9,673.7	0.0	1,165.5	1,165.5	1,715.0	0.0	1,715.0	253.5	0.0	253.5	(78)
iii. Student fellowships	0.0	1,338.0	1,338.0	0.0	161.2	161.2	270.6	0.0	270.6	40.0	0.0	40.0	(75)
Subtotal	11,205.0	11,011.6	22,216.6	1,350.0	1,326.7	2,676.7	8,050.0	0.0	8,050.0	1,189.9	0.0	1,189.9	(56)
b. Training	405.0	7,275.8	7,680.8	48.8	876.6	925.4	10,665.0	1,280.4	11,945.4	1,576.4	189.3	1,765.7	91
c. Workshop	0.0	2,136.9	2,136.9	0.0	257.5	257.5	3,108.0	830.0	3,938.0	459.4	122.7	582.1	126
d. Special studies	0.0	664.0	664.0	0.0	80.0	80.0	6,536.1	379.7	6,915.7	966.1	56.1	1,022.2	1,178
e. Tours	2,071.7	3,107.5	5,179.2	249.6	374.4	624.0	3,354.3	1,433.5	4,787.7	495.8	211.9	707.7	13
Subtotal	13,681.7	24,195.8	37,877.5	1,648.4	2,915.2	4,563.6	31,713.3	3,923.5	35,636.8	4,687.6	579.9	5,267.5	15
6. Reports	0.00	2,095.8	2,095.8	0.0	252.5	252.5	0.0	0.0	0.0	0.0	0.0	0.0	(100)
7. Project Management Operating Costs													
a. Project management staff salaries	0.0	15,238.8	15,238.8	0.0	1,836.0	1,836.0	0.0	5,178.9	5,178.9	0.0	765.5	765.5	(58)
b. Project management travel	0.0	4,834.1	4,834.1	0.0	582.4	582.4	0.0	2,682.9	2,682.9	0.0	396.6	396.6	(32)
c. Project management office expenses	0.0	4,968.4	4,968.4	0.0	598.6	598.6	0.0	2,352.5	2,352.5	0.0	347.7	347.7	(42)
Subtotal	0.0	25,041.3	25,041.3	0.0	3,017.0	3,017.0	0.0	10,214.3	10,214.3	0.0	1,509.8	1,509.8	(50)
Subtotal (A)	218,892.2	283,214.3	502,106.5	26,372.6	34,122.2	60,494.8	228,263.7	296,699.8	524,963.5	33,739.9	43,855.5	77,595.3	28
B. Recurrent Costs													
1. Salaries													
a. Provincial	0.0	840.6	840.6	0.0	101.3	101.3	0.0	369.9	369.9	0.0	54.7	54.7	(46)
b. Municipal	0.0	249.0	249.0	0.0	30.0	30.0	0.0	169.9	169.9	0.0	25.1	25.1	(16)
c. County	0.0	5,371.4	5,371.4	0.0	647.2	647.2	0.0	1,439.5	1,439.5	0.0	212.8	212.8	(67)
Subtotal	0.0	6,461.1	6,461.1	0.0	778.4	778.4	0.0	1,979.3	1,979.3	0.0	292.6	292.6	0
2. Operation and Maintenance	0.0	1,776.2	1,776.2	0.0	214.0	214.0	0.0	338.3	338.3	0.0	50.0	50.0	0
Subtotal (B)	0.0	8,237.3	8,237.3	0.0	992.4	992.4	0.0	2,317.6	2,317.6	0.0	342.6	342.6	0
Subtotal—Baseline Costs	218,892.2	291,451.6	510,343.8	26,372.6	35,114.6	61,487.2	228,263.7	299,017.4	527,281.1	33,739.9	44,198.0	77,937.9	28
C. Contingencies													
1. Physical contingencies	21,875.3	29,089.4	50,964.7	2,635.6	3,504.7	6,140.3	0.0	0.0	0.0	0.0	0.0	0.0	(100)
2. Price contingencies	14,802.8	19,773.6	34,576.4	1,783.5	2,382.4	4,165.8	0.0	0.0	0.0	0.0	0.0	0.0	(100)
Subtotal (C)	36,678.0	48,863.0	85,541.0	4,419.0	5,887.1	10,306.1	0.0	0.0	0.0	0.0	0.0	0.0	(100)
Subtotal (A+B+C)	255,570.3	340,314.5	595,884.8	30,791.6	0.0	71,793.4	228,263.7	299,017.4	527,281.1	33,739.9	44,198.0	77,937.9	9
D. TA Preparatory Cost	1,709.8	0.0	1,709.8	206.0	0.0	206.0	1,374.7	0.0	1,374.7	203.2	0.0	203.2	(1)
E. Front-End Fee	2,748.8	0.0	2,748.8	331.2	0.0	331.2	2,240.8	0.0	2,240.8	331.2	0.0	331.2	0
F. Commitment Fee	2,336.2	0.0	2,336.2	281.5	0.0	281.5	0.0	0.0	0.0	0.0	0.0	0.0	(100)
G. Interest During Construction	38,675.3	0.0	38,675.3	4,659.7	0.0	4,659.7	32,164.1	2,184.1	34,348.1	4,754.2	322.8	5,077.0	9
Total Project Costs	301,040.4	340,314.5	641,354.9	36,270.0	0.0	77,271.7	264,043.3	301,201.4	565,244.7	39,028.5	44,520.9	83,549.3	8

CNY = yuan, Dec = decrease, Inc = increase, TA = technical assistance.
Source: Asian Development Bank estimates.

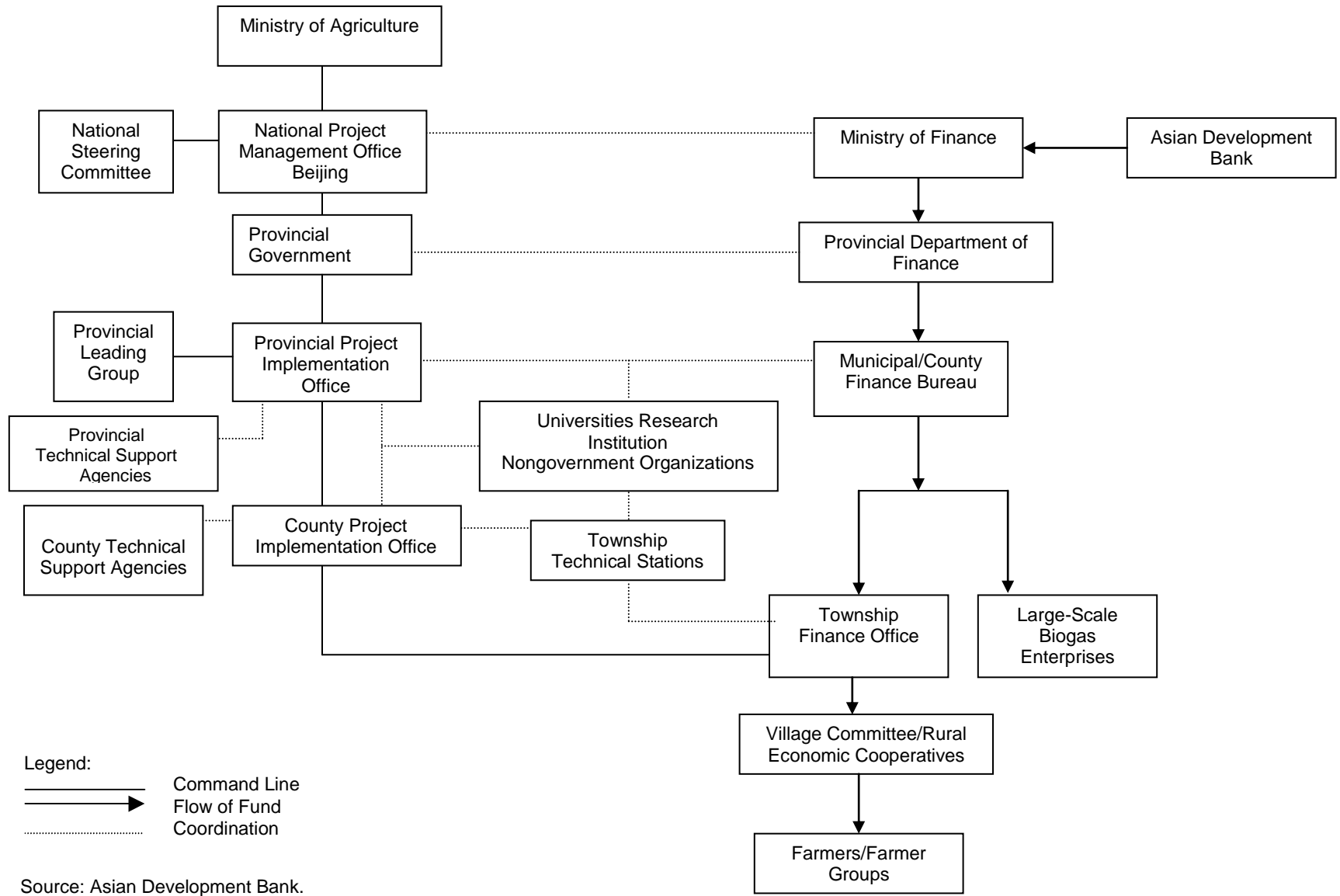
PROJECT IMPLEMENTATION SCHEDULE

Project Component Key Activity	Implementation Period																									
	2003		2004				2005				2006				2007				2008				2009			
	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4				
Funding Renewable Energy Generation and Eco-Environment Development																										
Introduce improved loan processing skills	█																									
Operate investment funds and administer loans			█				█				█				█				█							
Improved Mechanisms for Transferring Biomass Technology																										
Strengthen skills of biogas and gasification system contractors	█		█				█				█				█				█							
Extension officers and farmers on-site skill transfer training	█		█				█				█				█				█							
Study tours and workshops	█		█				█				█				█				█							
Rehabilitated Farm-to-Market Facilities																										
Rehabilitate access roads	█		█				█				█				█				█							
Rehabilitate bridges and drainage crossings	█		█				█				█				█				█							
Improved Environmental Policy Implementation and Awareness																										
Develop environmental awareness program	█		█				█				█				█				█							
Prepare publicity and extension materials	█		█				█				█				█				█							
Provide student fellowships on environmental research			█				█				█				█				█							
Establish renewable energy, environment monitoring, and training station			█				█				█				█				█							
Provide environmental monitoring equipment			█				█				█				█				█							
Pilot Poverty-Focused Approaches to Biomass Development																										
Women's training and participatory workshop	█		█				█				█				█				█							
Selection and provision of basic biogas facilities	█		█				█				█				█				█							
Special training for poor farmers	█		█				█				█				█				█							
Fellowship for poverty research	█		█				█				█				█				█							
Improved Project Implementation and Capacity Development																										
Provide office support	█		█				█				█				█				█							
Recruit consultants	█		█				█				█				█				█							
Establish monitoring and evaluation system	█		█				█				█				█				█							

█ Target at Appraisal
 █ Actual as of 31 December 2009

Source: Asian Development Bank.

ORGANIZATIONAL CHART AND PROJECT IMPLEMENTATION ARRANGEMENTS



STATUS OF COMPLIANCE WITH MAJOR LOAN AND PROJECT COVENANTS

Covenant	Reference	Status/Remarks
<p>The borrower shall establish a national project coordination committee (NPCC) in the Ministry of Agriculture (MOA), which shall serve as the policy-making body of the project. The NPCC shall comprise a senior official of the MOA as chairperson; and as members, senior directors from the Department of Development Planning; the Department of Research, Education, and Rural Development; the Foreign Economic Cooperation Center (FECC); the Ministry of Finance (MOF); the Poverty Alleviation Office; the State Development and Planning Commission; and the State Environmental Protection Administration.</p>	<p>Loan agreement, Schedule 5, para. 1</p>	<p>Complied with. The NPCC was established on 31 May 2003.</p>
<p>The borrower shall establish a national project management office (PMO) at FECC for overall project management, coordination, training and recruitment of consultants, and other implementation and monitoring activities. The PMO shall be the secretariat of the NPCC; and the PMO director shall serve as secretary for the NPCC.</p>	<p>Loan agreement, Schedule 5, para. 3</p>	<p>Complied with. The PMO was established on 1 August 1999.</p>
<p>Each of Henan, Hubei, Jiangxi, and Shanxi shall be a project executing agency in the provinces, each responsible for carrying out project implementation in its own province.</p>	<p>Loan agreement, Schedule 5, para. 4</p>	<p>Complied with.</p>
<p>A provincial project leading group (PLG) shall be established at each project province to oversee project implementation, review and approve project plans, source counterpart funding, carry out intersectoral coordination, and provide guidance and advice to resolve field-level project implementation issues. The PLG shall comprise a vice governor as the chairperson; and senior directors of the departments of agriculture, audit, and finance; the environmental protection bureau (EPB); the State Development and Planning Commission; women's associations; and other relevant bureaus in the provincial government as members.</p>	<p>Loan agreement, Schedule 5, para. 4</p> <p>Project agreement, Schedule, para. 1</p>	<p>Complied with. The PLGs were established on the following dates: Henan—29 Sep 2003; Hubei—14 Mar 2003; Jiangxi— 9 Aug 1999; Shanxi—18 Aug 2000.</p>
<p>Under the administrative control of each department of agriculture in Henan, Hubei, Jiangxi, or Shanxi, a project implementation office (PIO) shall be established to manage and oversee project implementation activities in the concerned project province. Each PIO shall be staffed with trained and qualified technical, financial, and management personnel and headed by a senior official of the provincial agriculture department as the PIO director. Each PIO shall serve as the secretariat for the concerned PLG.</p>	<p>Loan agreement, Schedule 5, paras. 5–6</p> <p>Project agreement, Schedule, paras. 2–3</p>	<p>Complied with. The PIOs were established on the following dates: Henan—29 Sep 2003; Hubei—14 Mar 2003; Jiangxi—7 Dec 2002; Shanxi—18 Aug 2000.</p>
<p>Each concerned county government shall set up a PLG and establish a project implementing unit (PIU) for field-level project activities. The PIUs shall be located at the Bureau of Agriculture in the concerned county governments and supported by the bureaus of finance and livestock, the renewable energy offices, the poverty alleviation offices, and other relevant technical agencies of</p>	<p>Loan agreement, Schedule 5, para. 7</p> <p>Project agreement,</p>	<p>Complied with. The PIUs were established, provided with support staff, and office space and equipment.</p>

Covenant	Reference	Status/Remarks
the concerned municipal and county governments. The PIUs shall work closely with the township government and village committees, nongovernment organizations such as women's association, research institutes, and universities.	Schedule, para. 4	
Each provincial finance department (PFD) of Henan, Hubei, Jiangxi, and Shanxi shall be responsible for management of the finances for the part of the project in its own province. The proceeds of the loan shall be released from the PFD to the municipal and/or prefecture and county finance bureaus, on the basis of the recommendations of the PIOs; and in turn, disbursed to the subborrowers. The disbursement, repayment and other finance activities shall be channeled through the relevant finance bureaus and/or offices for the medium-scale biogas and biomass gasification subprojects using types III and IV technology, and through township finance offices to the subborrowers for other biogas subprojects using types I and II technology.	Loan agreement, Schedule 5, para. 8 Project agreement, Schedule, para. 5	Complied with. The signed copy of the onlending agreements between the MOF and the provincial governments of the four provinces have been submitted to the Asian Development Bank (ADB) during the review mission in October 2004.
Each of Henan, Hubei, Jiangxi, and Shanxi shall furnish to ADB semiannual reports on the execution of the project, and on the operation and management of the project facilities. Such reports shall be submitted in such form and in such detail, and within such a period as ADB shall reasonably request; and shall indicate, among other things, progress made and problems encountered during the 6 months under review, steps taken or proposed to be taken to remedy these problems, and proposed program of activities and expected progress during the following 6 months.	Project agreement, Article II, Section 2.08(a)	Complied with.
Promptly after physical completion of the project, but in any event not later than 3 months thereafter or such later date as ADB may agree for this purpose, each of Henan, Hubei, Jiangxi, and Shanxi shall prepare and furnish to ADB a report, in such form and in such detail as ADB shall reasonably request, on the execution and initial operation of the project, including its cost; the performance of each of Henan, Hubei, Jiangxi, and Shanxi of its obligations under the project agreement; and the accomplishment of the purposes of the loan.	Project agreement, Article II, Section 2.08(c)	Complied with. The government's draft consolidated project completion report was received by ADB on 10 February 2010.
Each of Henan, Hubei, Jiangxi, and Shanxi shall (i) maintain separate accounts for the project and for its overall operations; (ii) have such accounts and related financial statements (balance sheet, statement of income and expenses, and related statements) audited annually, following appropriate auditing standards consistently applied, by independent auditors whose qualifications, experience, and terms of reference are acceptable to ADB; and (iii) furnish to ADB, promptly after their preparation but in any event not later than 9 months after the close of the fiscal year to which they relate, certified copies of such audited accounts and financial statements, and the report of the auditors relating thereto (including auditor's opinion on the use of the loan proceeds and compliance with the covenants of the loan agreement), all in the English language.	Project agreement, Article II, Section 2.09(a)	Complied with. The PIOs submitted their individual audit report for each fiscal year within the due date most of the time.

Covenant	Reference	Status/Remarks
<p>Within 12 months of the effective date, each of Henan, Hubei, Jiangxi, and Shanxi shall establish a suitably staffed project performance management system (PPMS) unit within the concerned PMO and PIOs. Each of Henan, Hubei, Jiangxi, and Shanxi shall monitor and evaluate project impacts and effects through PPMS to ensure that the project facilities are managed effectively and the benefits are maximized. Each of Henan, Hubei, Jiangxi, and Shanxi shall cause the concerned PIOs to conduct routine results monitoring evaluations and socioeconomic surveys, and transmit the results to the PMO, which will in turn consolidate and reports the result to ADB, the Global Environment Facility, and MOF together with the semiannual progress reports.</p>	<p>Project agreement, Schedule, para. 16</p>	<p>Complied with delays. The PPMS was established only in April 2005. The second phase of the beneficiary impact assessment, which involves field investigation and data collection, began in December 2007.</p>
<p>Each of Henan, Hubei, Jiangxi, and Shanxi shall ensure that all activities to be supported under the project shall meet the national environmental standards and the environmental impact assessment (EIA) procedures which are based on ADB's <i>Environment Guidelines for Selected Agriculture and Natural Resources Development Projects and for Selected Infrastructure Projects</i>; and no subprojects shall be approved for financing without an initial environmental examination (IEE) or an EIA report reviewed and approved by the concerned government's EPB.</p>	<p>Project agreement, Schedule, para. 17</p>	<p>Complied with.</p>
<p>Each of Henan, Hubei, Jiangxi, and Shanxi shall ensure that the facilities are constructed and operated following national and local government environmental procedures and guidelines, and ADB's environmental policy and guidelines.</p>	<p>Project agreement, Schedule, para. 18</p>	<p>Complied with.</p>
<p>Each of Henan, Hubei, Jiangxi, and Shanxi shall cause each concerned PIO to prepare an environmental management and monitoring program (environmental program) for each project province within 6 months of the effective date, which shall include the following: (i) an environmental management structure for the project components in the concerned project province, municipality, and county, including respective responsibilities among them; (ii) requirements for preparation of the IEE of each subproject; (iii) a program for training and education of staff to ensure that they are up-to-date on all aspects of the subprojects, particularly technology and the environmental implications; and (iv) the conduct of impact assessment during and after completion of the subproject ensuring that applicable environmental regulations are adhered to by the concerned subborrowers.</p>	<p>Project agreement, Schedule, para. 19</p>	<p>Complied with delays. The implementation of the energy and environmental monitoring and evaluation plan (EEME) commenced in September 2006 in the four provinces. The main task of the EEME plan was to investigate the environmental impact, environmental economic benefits, energy use structure, crop production, and animal production.</p>
<p>Each of Henan, Hubei, Jiangxi, and Shanxi shall cause its provincial rural energy and environmental protection station and/or office to be responsible for the implementation of the environmental program under the supervision of the provincial EPB. Monitoring results shall be reported in the semiannual progress reports on project implementation. Each of Henan, Hubei, Jiangxi, and Shanxi shall prepare, through its PIO in collaboration with</p>	<p>Project agreement, Schedule, para. 20</p>	<p>Being complied with. The four provinces will each prepare an environmental evaluation report to be submitted by 31 December 2010, a year after the project completion.</p>

Covenant	Reference	Status/Remarks
the provincial EPB, an environmental evaluation report 1 year after completion of the project.		
Each of Henan, Hubei, Jiangxi, and Shanxi shall ensure that adequate counterpart funds are made available in a timely manner for the concerned PIOs and PIUs to implement planned project activities, as well as maintenance and management of all project assets.	Project agreement, Schedule, para. 22	Provincial government counterpart funds as of 2009 were as follows: Henan—CNY73.9 million; Hubei—CNY81.2 million; Jiangxi—CNY85.9 million; Shanxi—CNY87.8 million.
Each of Henan, Hubei, Jiangxi, and Shanxi shall follow ADB's Policy on Gender Development during implementation of the project and take all necessary actions to encourage women living in the project areas to participate in planning and implementing the project.	Project agreement, Schedule, para. 23	Complied with. About 40% of project beneficiaries were women.

ECONOMIC AND FINANCIAL ANALYSIS

A. Financial Analysis

1. Data and Assumptions

1. This financial analysis for Efficient Utilization of Agricultural Wastes Project recalculates the financial internal rates of return (FIRRs) for the representative type I and type II farm models based on average incremental capital and operating costs and revenues for each of the four provinces (Shanxi, Henan, Jiangxi, and Hubei) and for each of the 13 medium-scale type III plants in Shanxi and Henan provinces. The data used in the models is based upon that provided by each of the provincial project implementation offices (PIOs) for the government's project completion report financial analysis calculations but has been cross-checked and supplemented with additional information gathered during the project completion report mission of the Asian Development Bank (ADB). All data is converted to a 2009 price basis, meaning that the FIRRs calculated are real rates of return. The FIRRs are also the rates of return on total costs (i.e., both equity and debt funding), with no account taken of the gearing effects of borrowing. The terms of loans (i.e., the loan period, grace period, and interest rate charged) varied considerably between borrowers but the current average interest rate charged appears to be about 7.2%, and an FIRR on total investment costs greater than this rate implies an even higher return on equity. The FIRRs are calculated assuming a 15-year life for the type I and II digester plants¹ and a 20-year life for the type III plants. At appraisal, a 15-year life was assumed for type I plants and a 20-year life for types II and III.

2. Assumptions vary between provinces on average investment costs, the quantities of inputs and outputs with and without the project, and prices of inputs and outputs. These variations reflect provincial differences in climate, agricultural practices, and market conditions.² However, it was considered appropriate to standardize the price of pork across the four provinces at CNY14 per kilogram (kg). The same was done with biogas, at CNY1.5 per cubic meter (m³), and rural labor, at CNY50 per day.³ In the case of pork, field interviews indicated that CNY14 per kg was the price in 2009 although it has been volatile and fell to around CNY10 per kg in the first quarter of 2010. It is difficult to forecast the average long-term price for pork over the next 15–20 years. This uncertainty is addressed via sensitivity testing. In the case of biogas, only two of the type III plants actually sell biogas as biogas is for the farmers' own use in the type II and III systems. The price of CNY1.5 per m³ corresponds to an energy equivalent cost of coal of around CNY500 per ton, which is the approximate current coal price in the project area. It is also consistent with a 2006 coal equivalent price of CNY435 per ton for the average cost of fuel used before biogas became available.⁴ In the case of labor, the PIO analyses used rates varying from CNY30 to CNY60 per day and, based on

¹ Source: Officials of the Ministry of Agriculture

² The FIRRs will also to some extent reflect the fact that the analysis was undertaken independently by different staff in each of the PIOs, although the same financial model framework was used.

³ The daily labor cost corresponds to an annual salary of CNY15,000 per year. Note that the slurry for the type I and II plants is for the farms' own use and its benefits are reflected in savings in fertilizer costs or for feed in the case of fish. Therefore, the price of slurry for these plants did not need standardization. In the case of type III plants, the actual prices being received by their owners for slurry and for further processed products were used in some instances. Note for the types I and II plants, slurry is for own use; and its benefits are reflected in savings in fertilizer costs (or feed in the case of fish). Therefore, there was no need to standardize the price of slurry for types I and II plants. For type III plants, the actual prices being received by their owners for slurry and further processed products in some instances were used.

⁴ Government of the People's Republic of China, Ministry of Agriculture. 2009. *Energy and Environmental Monitoring and Evaluation Plan, 30 August 2009*. Beijing. Taken from data in Table 2: Energy Saving Analysis in Foreign Economic Cooperation Centre prepared under the project. See also a willingness-to-pay price of CNY1.5 per m³ used in the financial and economic analyses.

interviews during the mission with officials, type III plant owners, and beneficiaries, an average rate of CNY50 per day was deemed an appropriate average value.

2. Base Case

3. The base case results of the financial analysis are presented in Table A8.1.

Table A8.1: FIRRs by Type of Biogas System

Item	Shanxi	Henan	Jiangxi	Hubei
Type I	10.1%	10.4%	...	...
Type II				
Orchard	14.0%	14.9%	17.5%	22.1%
Crop	...	12.0%	17.1%	24.7%
Vegetable	...	...	38.6%	40.1%
Fish	...	...	24.9%	34.2%
Type III				
	15.9%	23.2%		
	(Xinxing)	(Chuying 1)		
	18.5%	14.9%		
	(Huifengyuan)	(Chuying 2)		
	11.6%	9.0%		
	(Hongming)	(Mengzhou 1)		
	16.0%	14.8%		
	(Yunda)	(Mengzhou 2)		
	...	12.2%		
		(Dobeinong)		
	...	16.6%		
		(Tuo Cheng)		
	...	20.2%		
		(Jiali)		
	...	18.6%		
		(Xinghua)		
	...	13.4%		
		(Henchang)		

... = data not available.

Source: Asian Development Bank estimates.

4. The table shows that the type II models yield estimated FIRRs at or above 12% and, in some cases, significantly higher. Only in the cases of the Henan and Shanxi type II orchard models and the Henan type II crop models are the FIRRs lower than the 16.6% FIRR estimated for type II models at appraisal. The vegetable and fish variants in particular yield very high estimated FIRRs, reflecting the significant savings in fertilizer and feed costs and increased yields from using the slurry produced by the digesters. The type I models, while still yielding a rate of return of around 10% (currently comfortably above nominal interest rates), are less profitable than the type II models and lower than the 16.3% FIRR estimated for the type I model at appraisal. This is consistent with the shift in focus away from type I models at midterm review because of substantially increased greenhouse construction costs and reduced price premiums for out-of-season vegetables grown in greenhouses.

5. The estimated FIRR for the type III models range between 9.0% and 23.2% and these rates of return are also satisfactory. At appraisal, an FIRR of 15.9% was estimated for a representative type III plant.

3. Sensitivity Testing

6. Reducing the price of pork from CNY14 per kg to CNY12 per kg (i.e., by 14.3%) has a varying impact on the types 1 and 2 plant FIRRs, depending upon the relative importance of pork compared with other agricultural production in the models. Because of the heavy reliance on increased pork production relative to other agricultural production in the Shanxi and Henan type I models and the Henan orchard and crops models, the drop in assumed pork price essentially makes these investments uneconomic. For the other type II models, the FIRRs remain at or above 10%. Changes in the assumed price of pork do not affect the FIRRs for the type III plants because their incremental revenues from the project come from the sale or own use of biogas and slurry.

7. Farmers in the project area have already responded to the current depressed price for pork by switching to other livestock such as cattle, which are currently fetching a 50% price premium over pigs. Also, World Bank price forecasts⁵ are projecting real increases in the prices for beef of 16.8% and for chicken of 10.9% over the 2010–2020 period.

8. Reducing the price of biogas from CNY1.5 per m³ to CNY1.0 CNY per m³ (i.e., by 33.3%) has a larger impact on the FIRRs for the type III plants, since biogas makes up a larger proportion of project benefits than in the type I and II farm models. The type III plant FIRRs generally decline by 4%–5% but remain above 12%, except for five plants—Hongning in Shanxi province, and Mengzhou 1 and 2, Debeinong, and Henchang in Henan province. For the type I and II plants, the reduction in FIRRs is much smaller, ranging between 0.5% and 1.5%. This is because gas production benefits are a much smaller part of incremental benefits, with increased pork and vegetables, fruit, crops, or fish being much more significant.

9. Reducing the price of greenhouse vegetables, fruit, crops, outdoor vegetables, and fish by 10% lowers the FIRRs for the types 1 and 2 models by between 0.3% and 5.4%. This change has its largest impact on the FIRRs for the type I (greenhouse) and type II orchard models since these involve new cultivated areas, whereas the other type II models involve only increased productivity of existing cultivated areas. The FIRRs are still all above 12%, except for the type I models in Shanxi (9.1%) and Henan (9.2%), and the type II crop model (10.6%) in Henan.

10. Lowering the price of slurry⁶ produced by the type III plants reduces their FIRRs by between 0.8% and 1.9%. However, the FIRRs remain above 10%, except for Mengzhou 1 (8.0%) in Henan.

B. Economic Analysis

1. Data and Assumptions

11. The economic analysis recalculates the economic internal rate of return (EIRR) for the project as a whole. Costs included in the economic analysis are not only the capital and operating costs of the types I, 2, and 3 plants (i.e., component A of the project) but also the costs of the project's five other components. To the extent that the other components of the project include training, rural infrastructure rehabilitation and construction, implementing environmental policy and enhancing environment awareness, and capacity building and so generate wider economic

⁵ World Bank. 2010. Global Commodity Markets—Review and Price Forecast. Washington. <http://www.worldbank.org/>

⁶ This also encompasses the processed slurry products at some plants.

benefits than the incremental biogas and agricultural production, the estimated EIRR is conservative. The analysis period used is from 2003 to 2023, including the 7-year 2003–2009 implementation period.

12. A reduction of 2% per year in economic benefits is applied from 2007 on to take account of the future non-use of digesters built under the project. The Ministry of Agriculture estimates that, although 500,000 digesters are built annually in the People's Republic of China (PRC) under the government's own program, as many as 50,000 (or 10%) fall out of use each year. Among other factors, this is due to (i) urbanization or road construction that damages or demolishes roadside digesters; (ii) poor construction materials or poor design; (iii) insufficient feedstock due to decreased pig raising; (iv) poor maintenance, especially during winter time; and (v) natural disasters, such as floods, earthquakes, and severe snow storms. It is assumed that the rate of attrition in biodigesters built under the project will be more limited because better construction methods and materials were used, operation and maintenance training has been provided, the digesters were integrated into the enhancement of farm productivity, and a network of appropriately qualified technicians continues to operate within the project area. Sensitivity testing considers the effect of assuming a higher attrition rate.

13. Economic costs and benefits are derived from the financial costs and benefits but nontradable costs and benefits were adjusted by a standard conversion factor of 0.93 that is consistent with that used in recent ADB projects for the PRC.⁷ Also, an opportunity cost factor of 0.9 was used for rural labor for the types 1 and 2 plants to take account of surplus labor in rural areas.⁸

2. Base Case Results

14. Table A8.2 presents the estimated EIRRs for the project as a whole under a range of assumptions. First, including only the increased agricultural production and biogas production as project benefits gives an estimated EIRR of 19.9%. (The comparative estimated EIRR at appraisal was 15.9%.) Second, the EIRR increases by 4.1%–24.0% if estimated benefits from saved cooking time are also included. (The comparative estimated EIRR at appraisal was 17.9%.) These benefits have been estimated on the basis of an hour saved per household per day, the average rural wage rate of CNY50 per day, and a 12-hour working day.⁹ Third, the EIRR increases by 0.1%–20.0%, if in addition, estimated medical expense savings are included. (The comparative estimated EIRR at appraisal was 16.0%.) These benefits are estimated at CNY36 per household per year.¹⁰ Fourth, the EIRR increases by 1.6%–21.5% if estimated benefits from the reduction in carbon dioxide (CO₂) emissions are added. (The appraisal report economic analysis did not quantify CO₂ reduction benefits.) These have been estimated assuming an economic benefit of \$15 per ton (CNY101.4 per ton) of CO₂ reduction.¹¹ If all four of these additional benefits are included, the estimated EIRR for the project as a whole is 25.5%.

⁷ ADB. 2008. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to the People's Republic of China for the Qingdao Water Resources and Wetland Protection Project*. Manila; ADB. 2006. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to the People's Republic of China for the Inner Mongolia Autonomous Region Environment Improvement Project*. Manila; and ADB. 2008. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to the People's Republic of China for the Integrated Ecosystem and Water Resources Management in the Baiyangdian Basin Project*. Manila.

⁸ See Appendix 8, Financial and Economic Analyses.

⁹ These assumptions are as at appraisal, with the current wage rate incorporated. Information gathered in the field suggests that a saving estimated at 1 hour per day may be conservative.

¹⁰ This is as at appraisal but inflated to 2009 prices.

¹¹ This was used in the economic analysis and is based on a certified emissions reduction price of \$16 per ton and a certified emissions reduction monitoring cost of \$1 per ton.

3. Sensitivity Testing

15. Reducing the price of pork from CNY14 per kg to CNY12 per kg (i.e., by 14.3%) lowers the EIRR by 5.3%. However, even without the inclusion of the cooking time savings, the medical expenses savings, and the benefits of CO₂ emission reductions, the EIRR is still above 12% at 14.6%. Including these other benefits, the EIRR is 20.4% when this reduction in the price of pork is assumed.

16. Reducing the price of biogas from CNY1.5 per m³ to CNY1.0 CNY per m³ (i.e., by 33.3%) reduces the EIRR for the project by only 0.7% and the EIRR remains comfortably above 12% whether the additional benefits are included in the analysis or not.

17. Concurrently, reducing the prices for greenhouse vegetables, fruit, outdoor vegetables, crops, and fish by 10% reduces the EIRR for the project by 2.1% but, at 17.8%, it is well above 12%, even excluding the additional benefits of cooking time savings, medical expenses savings, and CO₂ emission reductions. Lowering the price of slurry¹² produced by the type III plants reduces the EIRR for the project by only 0.1%.

18. If the attrition rate for digesters built under the project is doubled from 2% per year to 4% per year, the project's EIRR falls by 2.4% from 19.9% to 17.5%, without the inclusion of savings in cooking time and medical expenses, and CO₂ reduction benefits. When these benefits are included with a 4% per year attrition rate, the project's EIRR is 23.5%.

19. Finally, as explained in para. 11, the results of the economic analysis are conservative in that there are wider benefits arising from the project that have not been included in the quantitative analysis.

¹² This also encompasses the processed slurry products at some plants.

Table A8.2: Economic Internal Rate of Return for the Whole Project

	EIRR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Economic Benefits																			
Henan		0.000	0.543	3.552	5.540	17.352	23.534	26.319	27.447	27.527	19.177	19.177	19.177	19.177	19.177	19.177	19.177	19.177	19.177
Hubei		0.000	0.000	2.620	5.535	10.439	17.700	19.550	23.729	26.303	26.636	26.636	26.636	26.636	26.636	26.636	26.636	26.636	26.636
Jiangxi		0.000	0.202	2.064	5.260	16.538	25.571	31.725	34.658	37.433	38.068	38.068	38.068	38.068	38.068	38.068	38.068	38.068	38.068
Shanxi		0.000	0.000	0.000	0.557	3.790	16.399	34.897	52.493	66.464	75.766	79.020	79.020	79.020	79.020	79.020	79.020	79.020	79.020
Subtotal		0.000	0.745	8.235	16.892	47.157	79.908	105.876	127.588	142.573	141.422	141.419	138.590	135.818	133.102	130.440	127.831	125.275	122.769
Factor for digester use decline ^a						0.98	0.96	0.94	0.92	0.90	0.89	0.87	0.85	0.83	0.82	0.80	0.78	0.77	0.75
Total Economic Costs		15.935	89.753	90.516	107.740	113.952	73.166	42.852											
Net Economic Benefits																			
From agricultural and biogas production benefits only	19.9%	(15.935)	(89.008)	(82.281)	(90.848)	(66.795)	6.742	63.024	127.588	142.573	141.422	141.419	138.590	135.818	133.102	130.440	127.831	125.275	122.769
Households with biogas facilities		626	4,411	6,844	12,432	17,841	17,484	17,134	16,792	16,456	16,127	15,804	15,488	15,178	14,875	14,577	14,286	14,000	13,720
From cooking time savings of an hour per HH per day, 12-hour working day, and wage rate of CNY50/day = CNY1,520/HH/year	24.0%	(15.935)	(88.211)	(76.669)	(82.141)	(50.979)	29.440	85.268	149.387	163.936	162.358	161.936	158.697	155.523	152.413	149.364	146.377	143.449	140.580
From medical cost savings of CNY36/HH/year	20.0%	(15.935)	(88.987)	(82.133)	(90.619)	(66.379)	7.340	63.610	128.162	143.135	141.973	141.958	139.119	136.337	133.610	130.938	128.319	125.753	123.238
CO ₂ reduction (tons)		2,692	18,060	27,769	46,343	82,592	80,941	79,322	77,735	76,181	74,657	73,164	71,701	70,267	68,861	67,484	66,134	64,812	63,515
From CO ₂ reduction benefits at \$10/ton	21.5%	(15.689)	(87.360)	(79.747)	(86.619)	(59.258)	14.129	70.263	134.682	149.526	148.235	148.095	145.134	142.231	139.386	136.599	133.867	131.189	128.565
From cooking time savings, medical cost savings, and CO ₂ reduction benefits	25.8%	(15.689)	(86.542)	(73.987)	(77.682)	(43.025)	37.424	93.092	157.055	171.451	169.722	169.152	165.769	162.454	159.205	156.021	152.900	149.842	146.846

CNY =yuan, CO₂ = carbon dioxide, EIRR = economic internal rate of return, HH = household.

^a 2% loss per year.

Source: Asian Development Bank estimates.

BENEFICIARY IMPACT ASSESSMENT

A. The Beneficiary Impact Assessment Report

1. A beneficiary impact assessment (BIA) assessment of the financial and other socioeconomic impacts on beneficiaries of the Efficient Utilization of Agricultural Wastes Project was undertaken and published in 2008.¹ It covered a without-project baseline survey in 2006 but also collected information about pre-project socioeconomic conditions in 2003 and project benefits realized by late 2006 and late 2007. With 2 years still to go on project implementation when the 2007 data was collected and project benefits expected to build over a number of years after the installation of the biodigesters, project benefits could not be fully assessed. However, the study results are useful for gauging the project's preliminary socioeconomic impacts.

B. Poverty Reduction Impacts

2. According to the data obtained for the BIA, project beneficiaries' incomes indicated that the project had contributed to a decline in poverty even before it was completed. The BIA put the percentage of the beneficiaries who could be described as being among the absolute poor (those with per capita net income below CNY700 per year) at 15.00% in the baseline year of 2003, 11.25% in 2006, and 6.00% in 2007. The percentages of the poor (those with per capita net income of between CNY700 and CNY1,000 per year) were 9.25% (2003), 6.75% (2006), and 2.50% (2007), indicating another decline in poverty among beneficiaries. The percentages among the beneficiaries of those defined as the vulnerable poor (per capita net income of between CNY1,000 and CNY2,000 per year) were 15.00% (2003), 11.25% (2006), and 6.00% (2007). This data must be interpreted cautiously because general price inflation will have lifted some project beneficiaries out of their original categories and some incomes may have risen due to factors unrelated to the project, including other government programs and remittances from family members working in cities. However, the steady and substantial trend across the four categories does indicate early project success in reducing poverty.

C. Per Capita and Per Household Income Effects

3. The BIA survey also recorded that project beneficiary per capita incomes had increased over the baseline year by CNY729 in 2006 and by CNY2,534 in 2007. By comparison, non-project farmers' per capita incomes increased by considerably smaller amounts during the same period—by CNY228 in 2006 and by CNY1,672 in 2007—implying additional relative per capita income gains of CNY501 by 2006 and CNY862 by 2007 for beneficiary farmers.

4. Table A9.1 shows a summary of the average increases project farm household incomes (not per capita) in each province and for each of the types I and II farm models once full project benefits are achieved. The figures are drawn from the financial and economic analyses of the project described in Appendix 8. The average increase across all provinces and all farm model types is estimated at CNY8,510 per year. During the period when farmers are still paying off the loans that helped finance the digester and other project costs, the figures in the table and this average figure overstate the increase in their net disposable income. This is because some of their additional income will be used to meet interest and capital repayments. However, the data together with the generally high financial internal rates of return calculated for each of the farm model types

¹ Center for Integrated Agricultural Development. 2008. *Final Report on Beneficiary Impact Assessment and Socioeconomic Analysis of the Efficient Utilization of Agricultural Wastes Project*, Beijing: China Agricultural University, College of Humanities and Development.

shows that loans are serviceable from the increases in income generated and that, once the loans are paid off, the additional income for farm households from the project will be considerable.

Table A9.1: Increases in Farm Incomes

System of Technology Farm HH Model	Shanxi		Henan		Jiangxi		Hubei		Total	
	No.	Additional Income (CNY/HH)	No.	Additional Income (CNY/HH)	No.	Additional Income (CNY/HH)	No.	Additional Income (CNY/HH)	No.	Additional Income (CNY)
Type I										
Greenhouse	1,159	5,000.00	3,178	4,210.00					4,337	19,174,380.00
Type II										
Orchard	1,715	21,695.00	1,675	10,865.00	3,083	7,010.00	1,695	9,498.00	8,168	93,116,740.00
Crops			837	3,955.00	1,434	3,756.00	1,260	3,040.00	3,531	12,526,839.00
Vegetables					941	7,627.00	420	4,740.00	1,361	9,167,807.00
Fish					666	6,596.00	857	26,400.00	1,523	27,017,736.00
Total	2,874		5,690		6,124		4,232		18,920	161,003,502.00
Average (CNY/HH)										8,509.70

CNY = yuan, HH = household.

Source: Asian Development Bank estimates.

D. Fuel Consumption, Cooking Times, and Water-Boiling Times

5. Project beneficiary farmers reduced their consumption of conventional fuels. Compared with the baseline year (2003), project farmers in 2007 had cut coal consumption by 30%, firewood consumption by 61%, charcoal consumption by 88%, and liquefied petroleum gas consumption by 18%. Project farm households spent an estimated 44% less time cooking, with average meal cooking time reduced from 154 minutes to 87 minutes, and 48% less time boiling water, with the average water boiling time reduced from 55 minutes to 29 minutes. This was of particular benefit to women, who were mainly responsible for these tasks. Women were also freed from the need to collect or cut fuel wood. Non-project farmers were also surveyed to check that (i) these benefits were indeed project-related, and (ii) their average cooking time of 147 minutes per day and water boiling time of 52 minutes per day had not changed appreciably between 2003 and 2007.

E. Farmers' Spare Time

6. Project farmers surveyed generally indicated that the biogas plants had led to increases in their spare time. In 2007, 73% indicated that the use of biogas had led to an increase in their spare time. This was down slightly from the 79% who indicated this increase in 2006. However, the BIA report suggests that this change resulted from the increased labor requirements linked to the increased agricultural production under the project.

F. Household Environment

7. The BIA report records 76% of farm households in 2006 stated that the use of the digesters led to improved household environments and sanitation conditions, fewer flies and mosquitoes, and improved health for household members. This figure had increased to 78% in 2007. Again, women were the main beneficiaries here because they usually spend more time in their houses and could enjoy a better living and healthier environment. Women could also have more time to take care of other chores because of less time needed for cooking.

G. Specific Impacts on Women in the Project Area

8. The significant social impacts of the project on women were reductions in the time they required to cut and collect fire wood and to boil water and cook. This increase their time available for other activities. The BIA survey's 2007 data indicated women used this time predominantly for tending to crops and livestock. Other main uses included visiting relatives, working in another city, looking after children, and sleeping.

9. The proportions of their spare time used for each of these main activities were much the same for men and women, with two exceptions: a larger proportion of men used spare time for work in another city; a larger proportion of women used the time for looking after children.

10. Women were also questioned in the BIA survey about their views regarding the project's impact on household sanitation. In 2007, 76% of women surveyed thought the household environment (including the reduction of smoke in the kitchen and courtyard sanitation) had improved and 68% thought the health of family members had improved.

11. Women participated in training sessions provided under the project, although to a lesser degree than men. In 2007, women accounted for 32% of those attending training courses, up from only 29% in 2006. The training sessions not only improved the women's' knowledge of the production and use of biogas, animal husbandry, and crop production but also gave them opportunities to better communicate with each other and become more involved in farm production and management. Together with their improved income potential from the growing agricultural production under the project, this enhanced their family status and livelihoods.

H. Scale of Operation for Pig Raising

12. The BIA report discusses two specific problems encountered in raising pigs in the project area. Some farmers encountered problems relating to pig diseases while other farmers were affected by the considerable fluctuation of prices of pigs for slaughter due to changing markets. These problems particularly affected small pig farmers. Larger-scale pig farmers were able to handle the price fluctuations better and had the resources to implement effective disease prevention measures.

13. The BIA report therefore suggested that biogas plants could still be introduced for small-scale farmers in future when they no longer raised pigs. Instead, they would need to continue buying dung from other pig breeders to be used in their systems.

ENVIRONMENTAL IMPACT ANALYSIS

A. The Energy and Environmental Monitoring Plan

1. An energy and environmental monitoring plan (EEMP) report was prepared for the Efficient Utilization of Agricultural Wastes Project in the People's Republic of China (PRC).¹ It records the results of a survey of before-project, with-project, and without-project environmental conditions across a wide range of environmental monitoring variables. This was part of component D of the project, which was to improve environmental policy implementation and awareness. It was funded by a grant from the Global Environment Facility. The survey work was completed at the end of April 2008 before the project was completed. It covered the four project provinces—Henan, Hubei, Jiangxi, and Shanxi. This appendix presents the EEMP survey's main findings.

B. Energy Consumption

2. Before the project, energy consumption averaged 2.03 tons per year, measured in tons of coal equivalence but covering all forms of energy, including coal, crop residue, firewood, electricity, and liquefied petroleum gas. The average cost per household was CNY886 per year. With the project, these traditional forms of energy use had fallen to 0.95 tons of traditional fuels, a reduction of 53.5%. Total energy consumed, including biogas, had declined to 1.44 tons, or by 29.1%. Energy costs per household had fallen by 44.8% to CNY489 per year.

3. Compared with without-project households, traditional energy consumption per project household was 51.5% lower, total energy consumption 26.2% lower, and energy costs 45.2% lower.

4. No households in the project areas were consuming biogas before the project. After the project, the annual average biogas consumption per project household was equivalent to 0.5 tons of standard coal (transferred into standard coal equivalent).

5. After the project, the average number of months that the biogas energy production could substitute for over 80% of traditional energy in Henan, Hubei, and Jiangxi provinces was 9.22. The number in the Shanxi province was zero because of cheaper coal costs and a colder climate.

C. Water Usage

6. The annual average irrigation requirement per project household decreased by 8.5% from before project.

D. Fertilizer and Pesticide Usage

7. The amount of chemical fertilizer usage per *mu* before the project averaged 197 kilograms (kg) per *mu* at a cost of CNY369 per *mu*.² With the project, this declined to 124 kg per *mu* (a reduction of 37.1%) and CNY224 per *mu* (a reduction of 39.3%).

8. Compared with without-project households, chemical fertilizer use per *mu* was 41.4% lower and chemical fertilizer costs per *mu* was 48.3% lower.

¹ Government of the PRC, Ministry of Agriculture, Foreign Economic Cooperation Center. 2009. *Energy and Environmental Monitoring & Evaluation Plan*. Beijing.

² A *mu* is a Chinese unit of measurement (1 *mu* = 666.67 square meters, 1 *mu* = 1/15 hectare, 15 *mu* = 1 hectare).

9. The beneficiary impact assessment (BIA) report produced similar results but on a more disaggregated basis (Appendix 9).³ In 2007, the use of fertilizers such as diammonium phosphate (-35.7%), phosphorous fertilizer (-10.2%), potassium fertilizer (-9.2%), urea (-11.6%), and compound fertilizer (-20.4%) was significantly lower than in 2003, reflecting substitution by digested sludge and effluent.

10. Pesticide usage with the project compared with before the project was slightly higher (5.5%) but only 2% higher than for nonproject farms because of the increase in the cropping area of project farmers.

E. Effluent Disposal

11. Before the project, the survey showed that 97.2% of livestock manure of project households was stored in the open air with only 2.8% used to produce methane in methane pools. After the project, 83.7% of livestock manure was used to produce methane. This not only improved the general rural environment but reduced health risks and the emission of methane gas into the atmosphere.

F. Emissions

12. Methane emissions were recorded to have declined 76.7% from the levels before the project and to be 64.1% lower in project households than in those outside the project. Compared with the before-project situation, average carbon dioxide emissions were down by 45.4%, sulphur dioxide by 69.9%, and nitrogen dioxide by 52.7%. Compared with without-project households, the decreases were more marked—50.3% for carbon dioxide, 60.1% for sulphur dioxide, and 70.4% for nitrogen dioxide. In volume and value terms, the carbon dioxide emission reductions were the largest, accounting for more than 98% of emission reductions overall.⁴ By decreasing the emission of pollutants, the project has improved the quality of the rural environment in the project area.

G. Soil Quality

13. Soil samples showed that project farm soils contained higher quantities of the minerals and metals that crops need than non-project farm soils. Those with relatively higher levels included phosphate (54.5%), copper (16.7%), manganese (2.7%), soil organic matter (30.7%), total nitrogen (20.6%), and zinc (8.3%). Quantities of potassium (-0.3%) and iron (-11.8%) were lower for project farm soils than for nonproject farm soils, as were harmful metals such as lead (-13.9%) and mercury (-13.7%).

H. Indoor Air Quality

14. Compared with non-project residences, the indoor air of project household contained less ammonia, 49.1% less carbon monoxide, 23.3% less fluorides, 39.2% fewer particles of 10 micrometers, and 12.9% sulphur dioxide. This indicated better living conditions for project farm families.

³ Center for Integrated Agricultural Development. 2008. *Final Report on Beneficiary Impact Assessment and Socioeconomic Analysis of the Efficient Utilization of Agricultural Wastes Project*, Beijing: China Agricultural University, College of Humanities and Development.

⁴ The EEMP report has also valued these emission reductions using unit values from *Administrative Regulations on Pollution Discharge Fee Levy* for each of the pollutants.

I. Crop Produce Quality

15. Analysis was undertaken in the survey of detection rates of pesticides in crop produce. The monitoring data showed that the residue and detection rates of pesticides in crop samples from project farms were lower than from nonproject farms.

J. Soil and Water Pollution

16. The monitoring data showed that the contents of suspended solids and chemical oxygen demand in the yard runoff of project farms were 15.5% and 4.6% lower than for nonproject farms. The content of total nitrogenous and total phosphorus in yard runoffs for project households was higher than for nonproject households, reflecting increased animal manure being generated by increased livestock operations.

K. Recommendations

17. The EEMP report noted the increase of non-point pollution from runoff of nitrogenous and phosphate from project household farms as a consequence of increased livestock raising and expanded crops and orchard planting. It recommended more attention be given by project households to keeping yards clean and reducing nitrogen and phosphorus runoff.

18. Because of higher than desirable levels of lead, arsenic, and mercury in the sampled slurry, the report recommended that the slurry be diluted before being applied to farm land.

19. The EEMP noted that there were insufficient environmental technical personnel in some counties to ensure continual operation and monitoring of the project's environmental impacts. The strengthening of the professional training of county personnel was recommended.