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POTENTIAL CLIMATE CHANGE MITIGATION OPPORTUNITIES IN THE AGRICULTURE AND FORESTRY SECTOR IN VIETNAM

Background Paper

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Acronyms and Abbreviations

ALGAS	Asian Least-Cost GHG Abatement Strategy
AR-CDM	Afforestation and Reforestation under the Clean Development Mechanism
AWDI	Alternate wet/dry irrigation
CCM	Climate Change Mitigation
CH_4	Methane
CO_2	Carbon dioxide
CER	Carbon Emission Reduction
CDM	Clean Development Mechanism
DAP	Diammonium phosphate (fertilizer)
FPDS	Forest Protection and Development Strategy
GDP	Gross Domestic Product
GHG	Greenhouse gas
GSO	General Statistics Office
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HFCs	Hydrofluorocarbons
HMS	Hydrometeorological Service
INCU	Vietnam's Initial National Communication to UNFCCC
IPCC	Intergovernmental Panel on Climate Change
IPSARD	Institute of Policy and Strategy for Agricultural and Rural Development
IRRC	Irrigated Rice Research Consortium
IRRI	International Rice Research Institute
IWRE	Institute of Water Resources Engineering
LUCF	Land-use change and forest degradation
LULUCF	Land use, land-use change, and forest degradation
MAI	Mean annual increment
MAP	Monoammonium phosphate (fertilizer)
MARD	Ministry of Agriculture and Rural Development
MONRE	Ministry of Natural Resources and Environment
MPI	Ministry of Planning and Investment
N_2O	Nitrous oxide
NFIMAP	National Forestry Inventory, Monitoring, and Assessment Program
NGO	Non-governmental organization
NOCCOP	National Office for Climate Change and Ozone Protection
NPK	Nitrogen-phosphorus-potassium (fertilizer)
NTFP	Nontimber forest products
ODA	Official Development Assistance
PFCs	Perfluorocarbons
REDD	Reducing Emission from Deforestation and Forest Degradation
SA	Ammonium sulfate (fertilizer)
SF6	Sulfur hexafluoride
SSNM	Site-specific nutrient management

Units of Measure

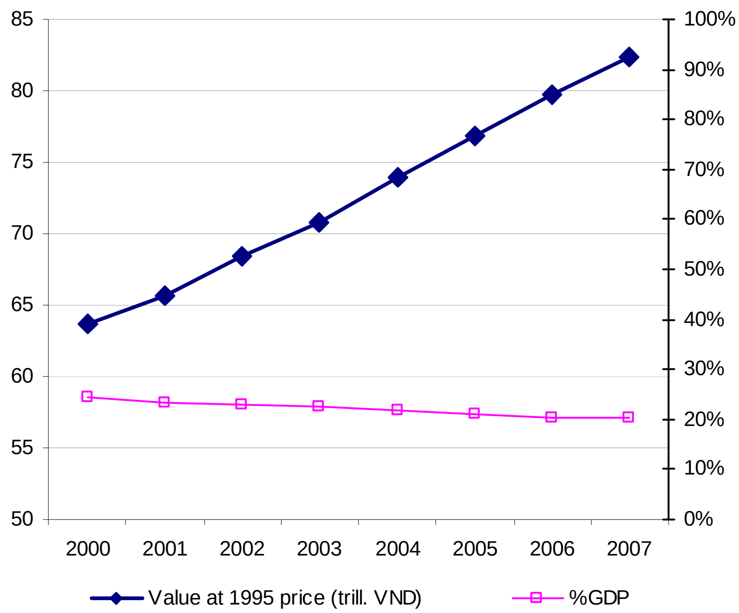
tCO2-e	Tons CO_2 equivalent

Brief Description of the Sector

Overview

Of the 33.1 million hectares of land area that make up Vietnam, 14.5 million hectares are covered with forest (forest land), 9.4 million hectares are used for agricultural production[1]. The agriculture, forestry, and fishing sectors accounted for 24.5 percent of GDP in 2000 and since that time, the sector grew at an average annual rate of 3.7 percent.[2] While its relative contribution to the country's economic growth has gradually declined due to the fast growth of the industry and service sectors, it accounts for a large proportion of the employed population (54% in 2005) and exports (30 percent in 2005)[3] and continues to be seen as an important tool for sustainable development and poverty reduction.

Figure 1: GDP Share by Agriculture, Forestry, and Fishing



Agriculture, which consists of cultivation (paddy, other annual crops, and perennial crops), husbandary and agricultural services, accounts for 53 percent of the greenhouse gas emissions in the country largely due to the methane released during rice cultivation but also due to methane emissions from animal husbandry, nitrous oxide emissions from nitrogen fertilizer use and emissions from management of agricultural residues. The forestry sector when considering the net balance of the *sinks* from forest cover and growth and the *emissions* from forest degradation and deforestation, contributes only 4 percent of emissions in the country. However the relative contribution of these two factors to the national emissions balance is significant. Forest cover and regrowth provides carbon sinks equivalent to 80 percent of the total net emissions in the country and emissions from deforestation and degradation are nearly as large[4]. This study will concentrate on the above agriculture and forestry activities, their magnitude and trends in light of their potential greenhouse gas emissions and the associated mitigation opportunities.

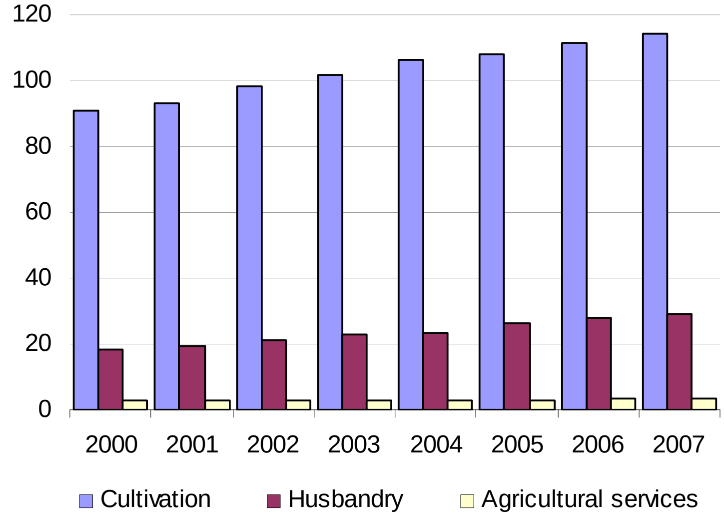
[1] GSO 2006

[2]. Calculations based on GSO statistical data.

[3]. URL: http://lcweb2.loc.gov/frd/cs/profiles/Vietnam.pdf.

[4] Based on 1994 figures. 2003 Initial National Communication to the UNFCCC for Vietnam.

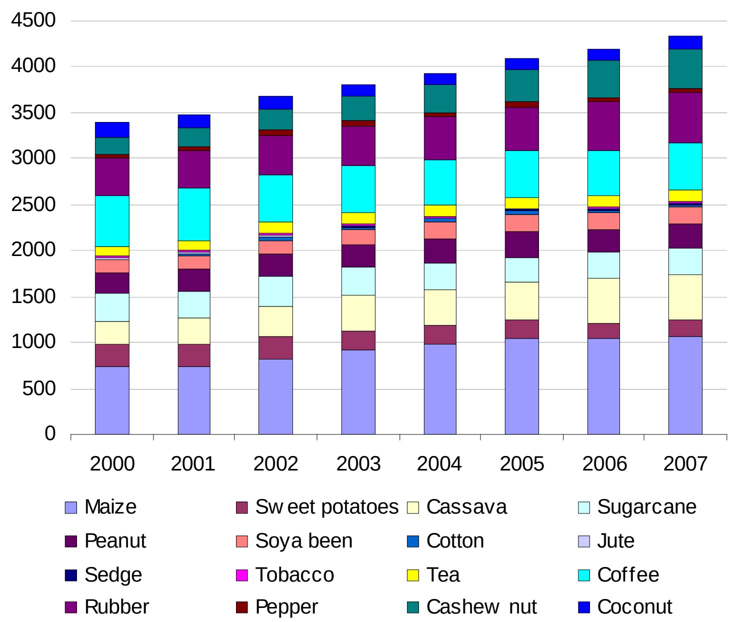
Figure 2: Production Value from Agricultural Activities (trillion VND)



Cultivation

Rice is the dominant crop, with nearly 80 percent of Vietnamese farmers growing rice and using 45 percent of the country's 9.4 million hectares of agricultural land. Other annual crops (maize, cassava, peanut, etc.) and industrial plantations (tea, coffee, rubber, etc.) use nearly 50 percent of the agricultural land. The area of land used for other main crops is increasing annually due to land conversion (mainly from deforestation), as depicted in Figure 3**Error! Reference source not found.**.

Figure 3: Planted Area of Main Crops (Except Paddy) in Vietnam (thousand hectares)



Doi Moi changed the centrally planned agricultural production system of state-owned large-scale farms and cooperatives into a more liberalized system. As a result the number of private farms increased to over 100,000 countrywide (see Table 1).

Table 1: Number of Farms by Kind of Activity

Year	Total	Of which			
		Annual crop farm	Perennial crop farm	Livestock farm	Fishing farm
2005	119,586	34,224	22,332	13,651	35,648
2006	113,730	32,611	18,206	16,708	34,202
2007	116,222	33,293	23,296	16,757	34,624

Source: *GSO 2008.*

Farm size varies. In 2001, 40 percent of farmers held between 0.2 and 0.5 hectare (ha) of production land; 25 percent held less than 0.2 ha; and about 30 percent held more than 1 ha. Only 5,639 farmers hold 10 ha of cropland or more. Regionally, small farms are more popular in the north and central regions, while larger farms are found in the south.

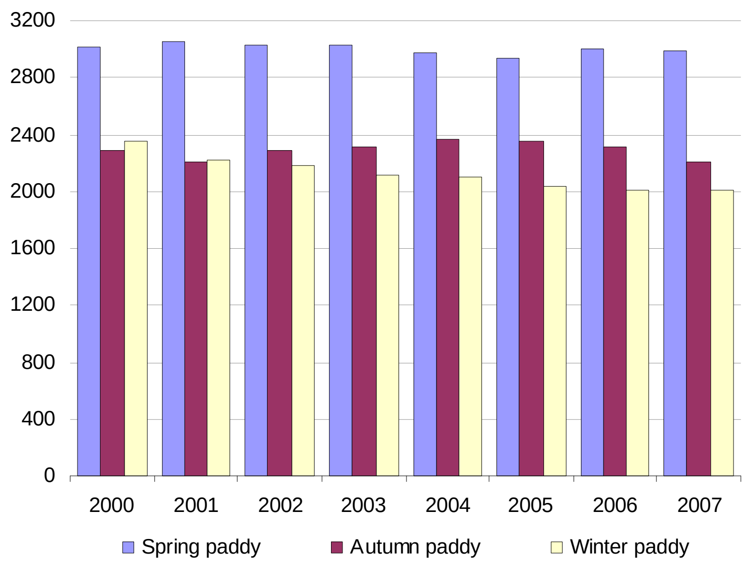
Rice cultivation

Production and area: Over the last 15 years Vietnam has been transformed from a net rice importer to the second largest rice exporter in the world with more than 30 million tons of rice produced annually[5]. The Red River Delta and the Mekong Delta are considered the country's two major granaries, accounting for 14 percent and 53 percent of rice cultivation area, respectively. With its high level of productivity, the Mekong Delta has in recent years contributed half of Vietnam's total rice production and about 90 percent of its total rice exports.[6]

Three seasons are generally suited to rice cultivation:[7]

- Spring (*dong-xuan*): late October to late April or May (cultivation during this season requires active irrigation);
- Autumn (*he-thu*): late April to late September; and
- Winter (*mua*): late May to mid-November.

Figure 4: Planted Paddy Area in Vietnam (thousand hectares)



(Source: GSO 2008)

[5]. FAOSTAT data, September 2008.

[6]. Nguyen Cong Thanh and Baldeo Singh, 2006, "Trend in Rice Production and Export in Vietnam," *OMONRICE Journal*14 (Jan.6). .

[7] URL: http://www.caylua.vn/01/11_cacvungluavn.htm.

The Red River Delta produces only spring and winter paddy (18.6 percent and 28.1 percent of the total production in terms of planted area, respectively), while the central coastal region and the Mekong Delta produce rice during all three paddy seasons (50.1 percent, 82.4 percent, and 18.1 percent) (see **Error! Reference source not found.**).

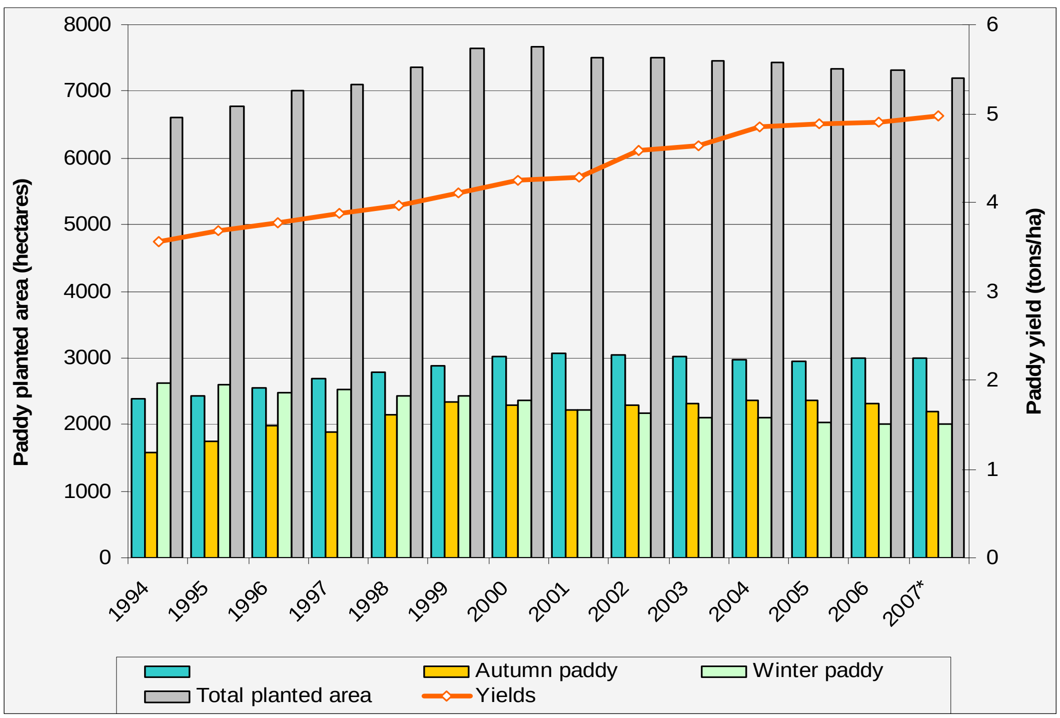
Table 2: Planted Paddy Area in Different Regions, 2006 (thousand hectares)

	Countrywide	Red River Delta	Mekong Delta	Other
Spring paddy	***2,995.5***	558.5	1,500.3	936.7
Autumn paddy	***2,317.4***	-	1,909.9	407.5
Winter paddy	***2,011.9***	565.5	363.7	1,082.7
Total	***7,324.8***	***1,124***	***3,773.9***	***2,426.9***

Source: GSO 2008.

An estimate by MARD showed that 50,000 hectares of rice-producing land are lost to other land-use purposes each year.[8] From 2003 to 2007 total annual rice production remained at around 36 million tons, while rice productivity gradually increased by as much as 770,000 tons per year thanks to the use of new rice varieties and fertilizers.

Figure 5: Changes in Rice Cultivation Area and Yield



Irrigation practices. According to the Vietnam Academy of Agriculture Sciences, more than 80 percent of the land used for rice production in Vietnam, contributing about 90 percent of total annual food production, is irrigated.[9] The total area of irrigated rice plantations has continuously increased from 3.96 million hectares in 1990 to 4.11 million hectares in 1995 to 4.26 million hectares in 2000. In 2003, some paddy was turned over to fish farming, reducing the total area

8. Vietnam News Agency, 2008.

9. Presentation to the annual meeting of the Executive Board of the Irrigated Rice Research Consortium (IRRC), Hanoi, October 2007.

for irrigated rice slightly, to 4.02 million hectares.[10] The Red River Delta has the largest proportion of irrigated area at 90 percent, while the corresponding rate for the Mekong Delta is around 70 percent.

1.2.2 Fertilizer Use Fertilizers used in crop production include both small volumes of organic fertilizers (manure, compost, etc.) and much larger quantities of inorganic fertilizers. According to MARD's National Institute for Soils and Fertilizers, Vietnam uses approximately 7.7 million tons of inorganic fertilizers each year. From 1985 to the present, the average annual increase in fertilizer consumption was 7.2 percent for urea (the most popular nitrogen fertilizer in Vietnam), 13.9 percent for phosphate based fertilizers, and 23.9 percent for potassium based fertilizer.[11] China and Russia, the two major fertilizer exporters to Vietnam, account for 50 percent and 10 percent, respectively, of total imported fertilizers. Urea, diammonium phosphate (DAP), monoammonium phosphate (MAP), and ammonium sulfate (SA) are the four most imported forms of fertilizers.

Table 3: Total N-Fertilizer Consumption (thousand tons)

	1994	1996	1997	1998	1999	2000	2005	2008
Urea	1,515.7	1,612.0	1,578.0	1,667.0	1,700.0	2,020.0	2,140.0	1,624.0
NPK	466.0	530.0	678.0	913.0	913.0	1,200.0	1,476.8	1,680.8

Source: National Institute of Soil and Fertilizers (2002) and Ministry of Industry and Trade (2008).

Local producers can only supply around 45 percent of the total demand, as illustrated in Table 4 below. Beside urea, NPK (nitrous-phosphate-potassium fertilizer) is widely used in Vietnam with different combinations of N:P:K ratio.

Table 4: Local Fertilizer Supply (thousand tons)

Type of fertilizer	Supplier	Annual capacity
Urea	Phu My Chemical and Fertilizer Ha Bac Chemical and Fertilizer	**750** **180**
Superphosphate	Lam Thao Superphosphate Long Thanh Superphosphate	**880** **180**
Melted phosphate	Van Dien Phosphate Fertilizer Ninh Binh Phosphate Fertilizer	**280–310** **240**
NPK	**Various**	**4,200**

Source: Vietnam Fertilizer Association (2008).

Crop Residues

Total crop residues generated in 2006 were about 68 million tons of which the largest proportions are paddy straw, maize trash, coconut shell, rice husk, and bagasse. Table 5 presents quantities of main crop residues and their related energy content for 2006.

Table 5: Production (ktons) of Main Crop Residues, 2006

	Crop production (ktons)	Crop residues generated (ktons)	Crop residues used[a] (ktons)

[10]. Report of the Minister of Natural Resources and Environment to the Permanent Council of the National Assembly on the Master Plan of Land Use, April 2004.

[11]. "Fertilizer Use in Vietnam," *Chemical Industry Magazine*, April 2008.

Main agricultural wastes:		**48,167**	**12,920**
Paddy straw	35,827	35,827	5,830
Rice (paddy) husk	35,827	7,170	3,360
Sugarcane bagasse	15,679	5,170	3,730
Others:		**19,800**	**4,900**
Cane trash	15,679	1,570	
Maize trash	3,819	9,550	
Cassava stem	7,714	2,310	
Coconut shells and leaves	982	5,890	
Peanut shell	465	140	
Coffee husk	854	340	
Total		**67,967**	**17,820**

a. P. K. Toan 2008.

Only 26 percent of the residues are utilized in some way. The current uses are as follows:

Rice husk. Inhabitants in rural areas collect and use rice husk as a cooking fuel. It is also used as “shock absorber” for fruit transportation and as fuel in brick kilns, paddy dryers, and similar equipment. In the Mekong Delta provinces, however, where rice husk residue is abundant during the milling season, a large amount of is thrown into rivers, representing a serious threat to the environment.

Bagasse. Sugar mills producing bagasse use it to generate their own heat and electricity using old inefficient low-pressure boilers. Bagasse could produce much more energy if used in higher efficiency cogeneration plants.

Other biomass. Other biomass, such as paddy straw and cane and maize trash, is used mainly as cooking fuel in rural households and to fuel brick kilns, pottery furnaces, and similar machinery for the production of building materials. Nonfuel applications include house roofing, mushroom cultivation, cattle feed, and so on.

Husbandry

Livestock husbandry grew at an average annual rate of 8.9 percent between 2001 and 2006 due to high domestic demand.[12] Growth has slowed in recent years, however, due to livestock epidemic outbreaks such as foot-and-mouth disease and avian flu. (See Table 6.)

Table 6: Livestock Populations in Vietnam (thousand heads)

	2001	2002	2003	2004	2005	2006
Buffaloes	2,807.9	2,814.5	2,834.9	2,869.8	2,922.2	2,921.1
Cattle	3,899.7	4,062.9	4,394.4	4,907.7	5,540.7	6,510.8
Pigs	21,800.1	23,169.5	2,4884	26,143.7	2,7435	26,855.3
Horses	1,13.4	110.9	112.5	110.8	110.5	87.3
Goats, sheep	571.9	621.9	780.4	1,022.8	1,314.1	1,525.3
Poultry	218,100	233,300	254,600	218,200	219,900	214,600

Source: GSO 2007.

Animal husbandry is still based on small farming with more than 73.8 percent of farms having 20 to 50 sow or 100 to 200 pig heads; 76 percent having 2,000 to 5,000 poultry heads; 86.9 percent have 20 to 50 dairy cow heads; and 88.6 percent having 100 to 150 goat or sheep

[12] Report of the Department of Husbandry, MARD, on concentrated farm-based husbandry, 2001–2006.

heads. The southeastern region has the highest number of large farms: 30 farms have sow levels of greater than 250 ; 22 farms have over 1,500 pigs; 80 farms have a poultry population of greater than 11,000; and about 10 farms have over 200 head of dairy cow.

Relevant strategy and national development programs

Vietnam has not yet completed a national strategy for agriculture and rural development.[13] Government initiatives, however, do indicate some trends in the promotion of agricultural subsectors, including the following:

- Considering the need to improve irrigation and conserve water resources, the National Assembly approved the Law on Water Resources, which came into force in January 1999. A national strategy through 2020 for improving irrigation systems to has also been developed. Irrigation systems, particularly those for wetland rice fields, have since been regularly improved. Channel systems at various levels (I, II and III, IV and V) have been established and put into operation to support crop production. The application of improved rational irrigation and drainage management (for example, draining water in two growing periods: stem spreading and before harvest) has helped to increase crop yields and reduce methane emission.
- The Government of Vietnam promulgated Decision No. 10/2008/QD-TTg on May 16, 2008, following formal approval of the Strategic Plan on Husbandry Development until 2020. This strategic plan aims to promote the development of industrialized and farming models and the conversion from traditional individual husbandry to industrialized husbandry and farming. According to this plan, husbandry will account for 32 percent of total agricultural production in 2010, 38 percent in 2015, and 42 percent in 2020.
- To deal with food security, MARD has submitted to the government the proposal "Rice Cultivation Development for Securing the National Food Security to years 2015–2020" and has established the National Food Security Council.[14] The proposal sets down minimum targets for rice cultivation areas for 2010, 2015, and 2020 of 4 million hectares, 3.8 million hectares, and 3.5 million hectares, respectively.[15]

Forestry

Current situation

Vietnam has low levels of forest coverage, averaging 0.15 hectare of forest per capita.[16] As reported by MARD, forest coverage declined by 10 percent during the last 30 years (1976 to 2006). However, as a result of strong progress in forest-sector reform, between 1995 and 2002, forest cover steadily increased from 8.3 to around 10 million hectares of natural forest and from one to two million hectares of plantation forest. Some 6.8 million hectares of land officially classified as forest currently has no forest cover, however.

[13]. Strategy for Agriculture and Rural Development of Vietnam; URL: http://www.mpi.gov.vn/ttkt-xh.aspx?Lang=4&mabai=1374).

[14]. Vietnam Institute for Water Resource Research; URL: http://www.viwrr.ac.vn/rss/index.php?pageid=630&topicid=5&pagenum=1.

[15]. *Lao Dong* [newspaper], 2009; URL: http://www.laodong.com.vn/Utilities/PrintView.aspx?ID=125137.

[16]. Vietnam Forestry Development Strategy 2006–2020, Hanoi, 2007.

Table 7: Forest Area and Forest Categories, as of December 31, 2006

Forest Categories	Area (hectares)	Classification		
		Special-use forest	Watershed forest	Production forest
Land area with forest	12,873,850	2,202,888	5,268,789	5,402,172
Natural forest	10,410,141	2,086,935	4,599,900	3,723,305
Production forest	2,463,709	115,953	668,889	1,678,867

Source: GTZ website, citing Statement of Minister of Agriculture and Rural Development through Decision Number 2530/QD/BNN-KL-LN, dated August, 27, 2007.

In spite of the increase in overall forest cover, the quality and biodiversity of its natural forests have been reported to be continuously deteriorating in many places. According to the FFSP's Indicator Database[17], between the 1999 and 2005 the area of natural forest classified as rich forest[18] decreased by 10.2 percent, while medium forest[19] was reduced by 13.4 percent. Furthermore, a vast area of primary forest was lost and became secondary forest with few remaining species and low timber volume. Reports from the National Forestry Inventory Monitoring and Assessment Program (NFIMAP) indicate that the percentage of commercial forest species has decreased over time and now stands at less than 25 percent of total species. In general, Vietnam's forests have degraded into young, poor forests with relatively low economic value.

Several causes contribute to this deforestation and forest degradation.

First, Vietnam's forest industries have been trying to meet the huge and growing demand in Europe, Japan, and North America (and, increasingly, Asia) for inexpensive furniture made from tropical hardwood. The growth rate of furniture exports in 2006–7 was 22.3 percent, reaching US$2.365 billion.[20] This demand places enormous pressure on Vietnam's few remaining forests.

Second, poor people, especially ethnic groups in Vietnam's uplands, use forest products for fuel and construction and convert forest land for agriculture. These basic needs and the lack of livelihood alternatives have resulted in a high degree of forest dependency and extensive natural forest degradation and clear-cutting. More sustainable forest management has been hampered by widespread lack of legal tenure over the forests, which ethnic minorities traditionally perceive as a common-pool resource.

Third, there is growing pressure on forest land for conversion to cash crops, especially coffee, pepper, rubber, and cashews. This is a very important driver of deforestation and degradation in some areas, especially the Central Highlands (Tay Nguyen). Migration from the populated lowland areas to the Central Highlands and other remote places with abundant land has significantly contributed to the deforestation of vast areas during the last decades. It is estimated that more than six million people migrated to the Central Highlands between 1980 and 2000. Inequitable forest land tenure and benefit-sharing arrangements exacerbate the detrimental effects on forests by discouraging users from investing in sustainable forest management.

Fourth, rapid economic development has increased the demand for energy and infrastructure improvements, putting additional pressure on forests. National demand for electricity and other forms of energy is increasing, and Vietnam has developed plans for more

[17] Viet Nam Forest Sector Indicators and 2005 Baseline Data Report. URL: http://www.vietnamforestry.org.vn/list_news.aspx?ncid=105

[18] "Rich forest" is defined as having a density greater than 150 cubic meters per hectare.

[19] "Medium forest" has a density between 100 and 150 cubic meters per hectare.

[20] Vietnam Timber and Forest Products Association Export Report 2007.

than 80 new hydroelectric power projects in addition to those already under construction and online. Dams cause tremendous deforestation in the uplands, not only from the reservoirs they create, but also from the associated infrastructure of roads and power lines and necessity to resettle whole communities. The general expansion of the road network and other infrastructure improvements as the country develops also results in enormous additional pressure on forests. The lack of interagency cooperation and planning results in a loss of forest and biodiversity to infrastructure and other lucrative development projects.

Furthermore, a lack of capacity among forest planners, managers, and protection staff and a lack of political will among local governments perpetuate this situation, and in some cases, collusion between officials and illegal users acts as an additional driver of deforestation and degradation.

Strategic and national development programs in the sector

Forests and forest land play an important role in the Government of Vietnam's socioeconomic development strategy for 2001 to 2015. Vietnam's failure to use its forest production potential fully may be attributed to unclear and suboptimal land-tenure arrangements and forest-management regulations. The solutions proposed in the Forest Development Strategy 2001–2010 are consistent with overall party and government policy priorities, focusing on poverty reduction and livelihood improvement, reducing conflict and fostering social harmony, and ensuring environmental sustainability. Clarification of land rights and forest-management regulations is essential for realizing these goals.

Decision 186/2006/QD-TTg, issued by the prime minister on August 14, 2006, provides clear regulations for managing each category. In addition, Decision 245/1998/QD-TTg, issued by the prime minister on December 21, 1998, mandated the forestry administration responsibilities of government agencies at central and local levels:

- *Central level:* The Ministry of Agriculture and Rural Development (MARD) is the primary agency of the Government for the administration, management, and development of the forestry sector.
- *Local levels (province, district, and commune):* The Chairman of People's Committees at all local levels has responsibility for forest management, protection, and development functions within their administrative units.

Realizing the negative consequences of forest resource depletion, the Government of Vietnam has issued a series of policies and programs to protect the remaining forests and restore deforested areas.

Table 8: Government of Vietnam Reforestation Programs

No.	Programs	Project timeline	Targets
1	Law on Forest Protection and Development	Approved on December 2004	
2	Re-Green Barren Hills and Mountains Program (Code: Program 327)	1993–1997	Reforestation of barren hills
3	Five Million Hectares Reforestation Program (Code: Program 661)	1998–2010	Reforestation; forest protection
4	Support for Development of Forest Plantations	2007–2015	Production forests

Partly as a result of these programs, MARD statistics indicate that Vietnam's total forest area has increased by 30 percent since 1990. This trend, however, seems to be the result of a rapid increase in plantation forests and of the expansion of natural forests regenerated from grass and shrub land. According to MARD, the area of bare lands and denuded hills in 2006 was 5.6 million hectares.

Aiming at sustainable management, use, and development of the country's forests, in 2007 the prime minister approved the Vietnam Forestry Development Strategy 2006–2020, which contains the following objectives:

- One million hectares of new plantation will be established by 2010 and another 1 million hectares will be established in the next phase; 0.3 million hectares per year will be reforested after harvesting.
- Plantation forest area, representing 1.38 million hectares at the end of 2005, will reach 2.65 million hectares by 2010 and 4.15 million hectares by 2020. Afforestation of 1 million hectares of new land will be achieved by 2010, and 1.5 million hectares will be established in the next phase.
- Scattered tree planting of 200 million trees per year, the equivalent of 100,000 hectares of plantation, will be undertaken.
- Forest cover will increase to between 42 and 43 percent by 2010 and to 47 percent by 2020.
- Annual revenue from the environmental value of forests will increase, reaching US$2 billion by 2020, through clean development mechanisms (CDM), ecotourism, erosion control, water resource protection, and other means.

Current and Projected GHG Emissions from the Sector

Agriculture

Greenhouse gases (GHGs) emitted from agricultural activities mainly consist of methane (CH_4) and nitrous oxide (N_2O), followed by carbon dioxide (CO_2). The main sources are rice paddy, livestock, and agricultural conditions and activities, such as open-field burning of agriculture residue, savanna burning, and agricultural soil.

GHG emissions in agriculture are summarized in Table 9. In 1994, total GHG emissions were 53 million tCO2-e; they increased to 55 million tCO2-e in 2006, but they are expected to decline to 50 million tCO2-e in 2010.

Table 9: GHG Emissions in the Agriculture Sector (MtCO2-e)

Type of emission	1994	2000	2006	2010
CH_4 from rice paddy (organic)	29.94	27.90	26.24	19.79
N_2O and CO_2 from fertilizer use (urea, NPK)	2.81	3.60	3.82	3.43
CH_4 from enteric fermentation	7.07	7.96	10.57	12.13
CH_4 from manure management	2.71	2.86	3.77	4.36
N_2O and CO_2 from managed soils and other activities	9.91	10.30	10.73	10.22
Total emissions (mil. tCO2-e)	**52.45**	**52.62**	**55.13**	**49.93**

Source: MONRE 2003b and calculation by authors based on IPCC 2006.

Key factors affecting GHG emissions from agriculture include the following:

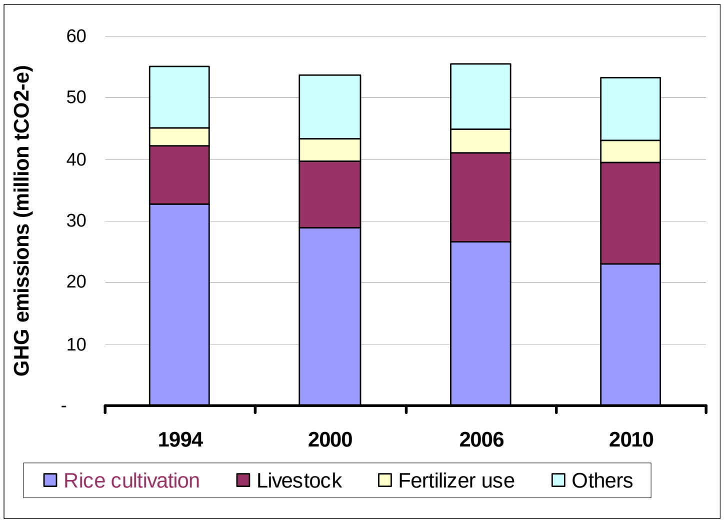
- High methane emissions due to rice cultivation, both because of the large area of irrigated rice cultivation and because 65 percent of the paddy is constantly subject to methane-intensive flooded irrigation;
- Methane emissions due to use of open-pit manure management systems; and

- Nitrous oxide and carbon dioxide emissions due to high and inefficient fertilizer application rates.

Trends in GHG emissions from agriculture can be summed up as follows:

- The area under rice production is decreasing slightly and methane emission intensive irrigation practices continue; higher annual crop yields are being obtained mainly by using increasing amounts of N-based fertilizers.
- The steadily increasing domestic demand for agricultural products combined with continued use of open-pit manure management methods contributes to increases in GHG emissions.

Figure 6: Trends in GHG Emissions from Agriculture



Forestry

Forests are both a source of and a sink for carbon dioxide (CO_2). Estimates of GHG emissions for the period 2010 to 2020 are based on the scenario that Vietnam will achieve the objectives of its Vietnam Forestry Strategy 2006–2020 and of the Five Million Hectares Reforestation Program.

Table 10: CO_2 Emissions or Uptake in Forestry and Land-Use Changes (MtCO2-e)

Type of emission (+) / uptake(-)	2000	2010	2020
CO_2 absorption by biomass growth	-81.492	-83.066	-63.899
CO_2 emission due to land-use change	+83.691	+59.872	+34.620
CH_4, N_2O emissions	+1.971	+1.526	+0.873
Total emissions (mil. tCO2-e)	**4.170**	**-21.668**	**-28.406**

Source: MONRE 2003b.

Key factors affecting GHG emissions from forestry include:

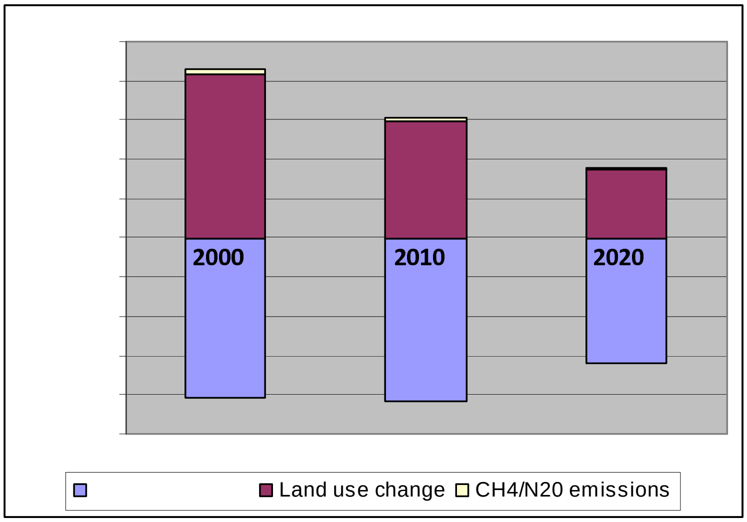
- Forest conversion accounts for 40 percent of the emissions from land-use change; and
- Plantation forests and regeneration of natural forests have increased forest areas substantially, in part due to government programs.

Trends in emission from the sector can be summed up as follows:

- Pressure for conversion of forest land will remain due to: (i) the continued growth of the wood-processing and wood-products industries; (ii) the conversion of forest land to cash crops (coffee, pepper, rubber, and cashew); (iii) shifting cultivation in the uplands; and (iv) infrastructure development;

- Implementation of government programs aimed to increase forest cover to 43 percent of national land area by 2015 will continue to increase biomass growth;

Figure 7: Trends in GHG Emissions from Forestry



Potential Climate Change Mitigation Opportunities in the Sector for 2010 to 2015

A list of potential typologies of interventions were evaluated to understand their potential for sector wide reductions in emissions of GHGs. Based on the sector potential and the relative challenges of implementing the typology in a portion of the sector, potentially feasible interventions were characterized based a set of criteria important to their implementation potential including estimates of potential emission reductions, in-roads institutionally, and methodology and additionality issues. While all interventions are believed to have potential as "win-win" or "no-regrets" interventions under the CDM, considerations on the related co-benefits and financial cost (if any) related to the intervention was also included in the evaluation and as summarized in the Annexes. All calculations of the emission reduction potentials were based on the sector structure over the time span of 2010 and 2015 and used CDM and IPCC methodologies where available and local emission factors where available.

Overview

CCM opportunities in agriculture

Methane reduction from wetland rice cultivation. As has been emphasized in the INCU, wetland rice agriculture is a major source of atmospheric CH_4 due to extended flooding periods resulting in anaerobic decay of organic material. The composition of the organic material in the soil depends on residue management and manure application, but—in most rice systems—the most important carbon source for CH_4 production is the rice plant itself as it grows in the field and supplies carbon for methanogenesis through root exudates and debris. For the rice plants, however, release of carbon represents a loss of valuable assimilates that would have otherwise been incorporated into plant tissue or grain. High-yielding plants use assimilates more efficiently and thus supply less organic material for microbial methane production.

Several field studies conducted by IRRI and other research institutions have shown that methane can be substantially reduced through modified water management techniques, such as midseason drainage or alternate wetting and drying. It is thus possible to combine the aims of reducing CH_4 emission and saving irrigation water, in line with the expected shortages of available irrigation water in many rice growing regions (IRRI 2006).

Effective use of nitrogen fertilizer. Nitrogen fertilizers (urea, NPK, etc.) are a significant direct source of greenhouse gases through N_2O emissions in the field. Excess application of nitrogen fertilizers will emit CO_2 and N_2O. Therefore, reducing the redundant fertilizers or improving the efficiency of fertilizer use will decrease emissions.

Urea is the most popular nitrogen fertilizer used in Vietnam, with more than two million tons consumed every year. Many studies have shown that when urea is applied to the rice field, only a portion of it (35 to 40 percent) is effectively used for rice plant growth; the remainder is volatized or disposed into water. Using a specialized fertilizer management method, namely site-specific nutrient management (SSNM), can help increase the efficiency of urea use and reduce methane emission from volatilization.

Other options on agricultural wastes and by-product management. Two further opportunities for mitigating GHG emissions relate to agricultural wastes or by-product management: (i) using agricultural residues for energy generation; and (ii) recovering methane at livestock farms. The first option is related to the generation of heat and/or electricity that can be consumed on-site, or exported to the grid or to a nearby facility. This type of project can avoid GHG emissions (mainly methane) caused by uncontrolled anaerobic processes in open air through controlled combustion of organic solid wastes in an incinerator/furnace and by utilizing combustion heat generated for electricity and/or thermal energy production. This type of project also includes gasification (i.e. combustion taking place in a low/insufficient oxygen environment) of organic solid wastes to produce syngas/producer gas which is used for electricity and/or thermal energy generation.

The second option concerns the recovery and destruction of methane from animal manure and waste that would be otherwise left to decay anaerobically producing methane that is released to the atmosphere. The recovered methane is flared or gainfully used as fuel for cooking and lighting (in household/small livestock farms) and for thermal or electrical energy generation (in large-scale livestock farms).

CCM opportunities in forestry

GHG emission mitigation in forestry can be achieved by developing and protecting carbon sinks.

Reforestation: Reforestation is the restocking of existing forests and woodlands which have been depleted, with native tree stock. The term reforestation can also refer to afforestation, the process of restoring and recreating areas of woodlands or forest that once existed but were deforested or otherwise removed or destroyed at some point in the past. The resulting forest can provide both ecosystem and resource benefits and has the potential to become a major carbon sink. The concept of forests as carbon sinks has drawn attention around reforestation as a possible tool in the fight against global climate change. Because trees draw carbon dioxide from the atmosphere in the process of photosynthesis, they can potentially remove this excess greenhouse gas from the atmosphere and help fight global warming[21].

REDD: Reducing emissions caused by deforestation and forest degradation (REDD) is identified as one of the most cost-effective ways to combat climate change and GHG emission. REDD presents the country’s efforts to reduce emissions from deforestation and forest degradation, which are the second leading cause of global warming, responsible for about 20% of global greenhouse gas emissions, which makes the loss and depletion of forests a major issue for

[21] http://wiki.idebate.org/index.php/Debate:Reforestation_as_a_solution_to_global_warming

climate change. Unlike afforestation and reforestation activities, which generally cause small annual changes in carbon stocks over long periods of time, stemming deforestation causes large changes in carbon stocks over a short period of time. Most emissions from deforestation take place rapidly, whereas carbon removal from the atmosphere through afforestation and reforestation activities is a slow process.[22]

Table 11 shows the most feasible GHG emissions mitigation options, according to ALGAS (Asian Least-Cost GHG Abatement Strategy) reports.

Table 11: GHG Emission Mitigation Options in Forestry

No.	GHG emissions mitigation options	Potential GHG mitigation (CER/hectare/year)
1	Natural forests regeneration	57.12
2	Reforestation	106.91 – 132.14
3	Reducing emissions caused by deforestation and forest degradation (REDD)	64.26 – 106.89

Typologies of Potential CCM Projects in the Sector

Possible project interventions are listed below:

Table 16: Typologies considered

Industry	Typology of Intervention		Description
Agriculture	A1	Reducing methane from rice fields	Reducing methane emissions from rice fields through active irrigation and drainage based on the water requirements for growing rice.
	A2	Improved fertilizer use efficiency	Improving fertilizer practices by applying site-specific nutrient management (SSNM), which increases nitrogen use efficiency by 30 to 40 percent.
	A3	Biomass power plant.	Using agricultural residues (bagasse and rice husks) to generate energy.
	A4	Manure management for livestock	Reducing methane emissions from large-scale livestock farms through construction of biogas digesters.
Forestry:	F1	Mangrove reforestation	Promoting afforestation and reforestation (AR-CDM) focusing on mangrove reforestation
	F2	Reducing emissions from deforestation and forest degradation.	Reducing forest degradation and deforestation through natural resource management and conservation programs.

[22] http://www.forestcarbonpartnership.org/fcp/node/30

Project type A1: Reducing methane emissions through irrigation management of wetland rice fields

Project technologies and activities

This project type involves a water management for rice cultivation termed "alternate wet/dry irrigation" (AWDI). Using the AWDI method of rice cultivation, rice fields are not kept continuously submerged but are intermittently allowed to dry during the rice growing stage. The term "AWDI" has been adopted in preference to "intermittent irrigation," which could also apply to irrigation practices that deliver water intermittently without necessarily creating dry conditions.[23]

Baseline and additionality issues

In the baseline scenario for this project type, Vietnam's traditional rice cultivation practices continue, where rice submerged in water for 70 to 80 percent of its growing period. Under the AWDI regime, in contrast, water is used as follows: (1) after it is transplanted, rice is submerged in 10 to 30 millimeters of water; (2) during tillage, water depths are kept at 20 to 40 millimeters; (3) after tillage, water is drained and the fields remain dry for five to seven days; (iv) after the panicle forms and until flowering, 20 to 60 millimeters of water covers the fields; and (v) after flowering, water depths remain at 10 to 40 millimeters.

Table12. Rice Cultivation Area with Different Water Management Regimes, 2006

(Unit: million hectares)

Water management regime	North Vietnam	South Vietnam	Total
Constantly flooded irrigation	1.957	2.353	4.310
Intermittently flooded irrigation	0.224	1.049	1.273
Rain fed	0.326	0.690	1.016
Total	2.507	4.092	6.599

Source: MONRE 2003a.

The additionality is based on the fact that traditional rice cultivation using constantly flooded and rain-fed irrigation, are common cultivation practices in most regions of Vietnam. Of the 4.3 million hectares using constant flooding irrigation, only approximately one thousand hectares, under a pilot program with IRRI, applied AWDI methods between 2005 and 2008.[24] The remaining areas are not likely to adopt this technique due to lack of skills and infrastructure. At present, no other government program aims at disseminating the new irrigation method nationwide.

<u>(iii) Assessment of Applicable CDM methodologies</u>

There is an approved methodology by CDM Executive Board for this intervention.

(iv) GHG emission reduction potential

Calculation of the GHG emission from rice cultivation is based statistical data on the area cultivated. The GHG emission reduction potential is calculated as the difference between the total methane emissions in the baseline scenario and the total methane emissions under the project scenario, in which all 2.5 million hectares of constantly flooded rice cultivation area are converted to intermittently flooded irrigation.

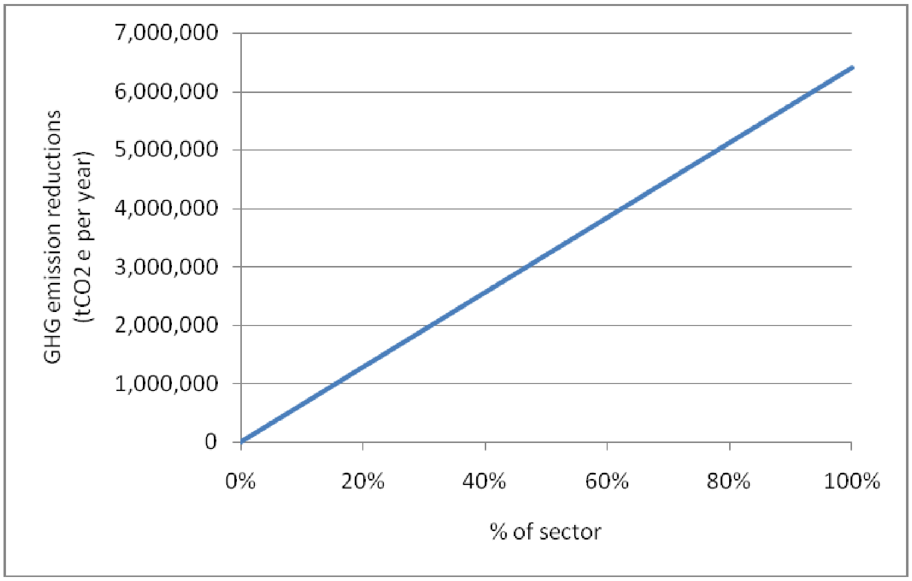
With an average crop growth duration of 118 days in both the Red River and Mekong deltas, the total GHG emission reduction will be 6.4 million tCO_2-e per year. The emission reduction potential per hectare will be 2.54 tCO_2-e per year. Figure 8 illustrates the correlation between

[23]. IWMI [International Water Management Institute], Research Report No. 47, 2001.

[24]. Duong Van Chin, "Saving Water for Irrigation of Winter Paddy in the Mekong Delta," *Vietnam Agricultural Newspaper*, January 23, 2008.

the GHG emission reduction potential and the total area of a specific project applying AWDI methods.

Figure 8: GHG Emission Reduction from Improving Water Management in Rice Cultivation



Current CDM pipeline in Vietnam

Vietnam currently has no irrigation management CDM project in the pipeline.

Potentially Feasible Sector-wide Intervention:

Intervention	Potential structure and in-roads	Estimated GHG reduction	Estimated CDM Revenues
Application of AWDI in 0.5 million hectares of paddy land	Work with MARD	1.26m tCO_2-e/yr	$ 12.6 million per year

Project type A2: Improving fertilizer practices in rice cultivation

Project technologies and activities

This project type involves a new approach to fertilizer use: site-specific nutrient management (SSNM) which was developed from recent research conducted by IRRI and its partners in various countries of Asia, SSNM allows farmers to analyze their farms' soil and crop conditions and then match their fertilizer use to those conditions. SSNM consists of three steps: (1) establishing an attainable yield target, which will indicate the total amount of nutrients that must be taken up by the crop; (2) making optimal use of existing (indigenous) nutrients available from the soil, organic amendments, crop residue, manure, and irrigation water; and (3) applying fertilizer to fill the deficit between crop needs and indigenous supply.

In Vietnam, the efficiency of urea use in rice cultivation is only around 35 to 40 percent. SSNM methods can increase the efficiency to 50 percent or even higher. (A recent study with the locally-made Dasvila microbiotic fertilizer showed that it can help reduce the amount of urea use in rice production by up to 50 percent, thereby increasing the efficiency of urea use by 70 to 80 percent.)[25] As a result, the amount of fertilizer used would be reduced, leading to reduced methane emissions.

Baseline and additionality issues

In the baseline scenario, two million tons of urea is used nationwide, with a practical efficiency of 40 percent (thus wasting 60 percent of the nitrogen); the rate of use increases annually by 7.2 percent.
No methodology has been approved as yet for this option.

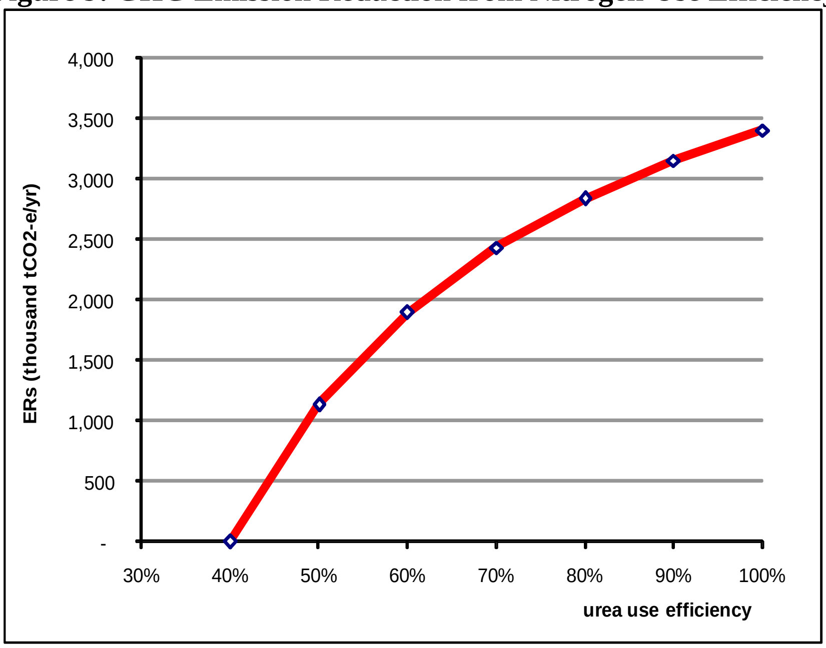
(iii) Assessment of Applicable CDM methodologies

There is an approved methodology by CDM Executive Board for this intervention.

(v) GHG emission reduction potential

To estimate the GHG emission reduction potential, it is assumed that under the SSNM approach, nitrogen use efficiency will increase from current levels of 40 percent.

Figure 9: GHG Emission Reduction from Nitrogen-Use Efficiency



Current CDM pipeline in Vietnam

Currently no fertilizer-efficiency projects are in the Vietnam CDM pipeline.

Feasible interventions:

Intervention	Potential structure and in-roads	Estimated GHG reduction	Estimated CDM Revenues
Increase fertilizer use efficiency by 10%	Work with MARD	1.13m tCO2-e/yr	$ 11.3 million per year

[25]. *Lao Dong Newspaper* 2009; accessed at http://www.laodong.com.vn/Utilities/PrintView.aspx?ID=126425.

Project type A3: Using agricultural residues to generate energy

Project technologies/activities

This project technology/activity is a biomass power generation plant. The generated electricity is either consumed on-site to displace electricity supplied from an electricity distribution grid, exported to the grid and/or exported to a nearby facility. As biomass has low bulk density, its transport is costly. Therefore, this project will focus in rice husk and bagasse because these types of biomass can be collected and used at the site, where they are generated, i.e. in or very near the sugar mills and rice mills. The project activities involve both the construction of new facility and upgrading/modification of an existing facility using agricultural solid wastes for energy generation. In Vietnam, this technology is most suitable for rice husk and bagasse that are generated in rice mills and sugar mills. The use of other types of agricultural solid wastes such as paddy straw, maize trash, coconut husks, etc. for energy generation is complicated by problems related to their collection and transportation from the fields to the energy plants.

Baseline Practices and Additionality

The baseline scenario is the situation where, in the absence of the project activity, the power grid generates electricity through the operation of the planned power plants on the grid. Recent statistics showed that about 1.4 million ton/yr of rice husk can be used for electricity generation. However, there are no rice husk-fired power plants built up to now. In addition to this prevailing practice barrier, the main barrier is that the electricity generation cost of the rice husk power plant is high relative to purchase price for selling electricity to the grid. At present, the cost of electricity generation by a rice husk power plant is around 1,400 VND/kWh (US$0.084/kWh) while the maximum tariff for sale of electricity to the grid is only 750 VND/kWh (US$0.045/kWh). Even if the Government of Vietnam increases the tariff of electricity sale to the grid to 1,000 VND/kWh (US$0.06/kWh), none of rice husk power projects appear to be economic. The economical and financial analysis of the rice husk-fired power projects showed that they may become feasible if the ash produced from rice husk combustion can be sold at reasonable prices, and the sales of CER are taken into account.

At present, the total amount of bagasse produced at all sugar mills in Vietnam is estimated at 3.1 million ton/yr. It is being used for generation of electricity and heat (steam) to supply the energy demand of the sugar mills. The total installed power capacity of existing cogeneration systems in the sugar mills is around 150 MW. However, due to the age and low efficiency of the cogeneration systems, the generated electricity is about 440,000 MWh/yr only (generation of 1 kWh of electricity requires 7 kg of bagasse). In case, the existing old and low-efficiency cogeneration systems in sugar mills are upgraded or replaced by high-efficiency cogeneration technologies, the electricity generated would increase to 775,000 MWh/yr. The surplus electricity of 335,000 MWh/yr could then be sold to the grid. However, the current electricity generation cost of the cogeneration system is 800-950 VND/kWh, which is still higher than the tariff of electricity sold to the grid. It makes it unattractive for the sugar millers to invest in the upgrading their existing cogeneration plants or in the construction of new projects. It was estimated that if the tariff of electricity sale to the grid could be increased up to 1000 VND/kWh, and the CER could be sold at about US$15/tCO2-e, the bagasse-fired cogeneration projects would be feasible.

In addition to the above barriers, other problems of the implementation of the grid-connected biomass power project are:

- The difficult access to finacing sources for the project;
- The regulations and procedures for selling electricity to the grid is still complicated.
- The high cost of rice husk collection and transport.

Assessment of Applicable CDM methodologies

Several approved methodologies and tools do exist. They can be used for the demonstration and assessment of additionality of this type of CCM projects:

- AM0007: Analysis of the least-cost fuel options for seasonally-operating biomass cogeneration plants;
- AM005: Baseline methodology (barrier analysis, baseline scenario development and baseline emission rate, using combined margin) for small grid connected zero-emissions renewable electricity generation;
- ACM0006: Consolidated methodology for electricity generation from biomass residues;
- AMS-I.D (Small scale projects): Grid connected renewable electricity generation.

GHG emission reduction potential

The GHG emission reduction potential is estimated for two agricultural solid residues: rice husk and bagasse.

The selected baseline scenario is the situation where, in the absence of the project activity, the electricity would have been supplied by the national power grid.

The project activity includes:

- the construction of new rice husk fired power plants.
- the replacing or upgrading of the existing old and low-efficient cogeneration systems in sugar mills by using high-efficient cogeneration technologies.

According to the Draft Master Plan of Renewable Energy Development in Vietnam up to 2015 with an orientation until 2025, about 1.5 million tons of rice husk and 4.4 million tons of bagasse could be used for energy generation in 2010. 33 rice husk-fired power plants and 27 bagasse-fired cogeneration plants could be built by 2025.

The total installed capacity of 33 rice husk-fired power plants would be 169 MW. The total annual electricity generation would be 1,000,000 MWh. It is planned that all amount of electricity generated by rice husk-fired power plants will be sold to the grid.

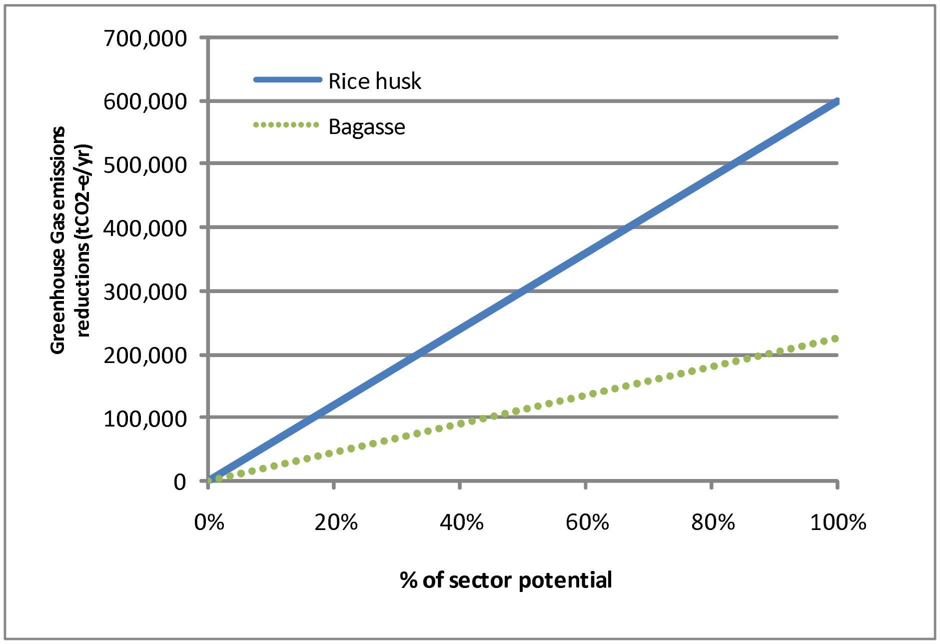
The total installed capacity of 27 bagasse-fired cogeneration plants could be 250 MW. The total annual electricity generation would be 800,000 MWh. However, 420,000 MWh (53%) of this amount of electricity will be used by the sugar mills to cover their own electricity demand. The remaining 380,000 MWh of electricity could be sold to the grid.

The estimation of emission reduction potential from the use of rice husk and bagasse for energy generation is shown in the table below.

Table 13: Potential emission reduction from the use of rice husk and bagasse for energy generation

Type of	No. of	Range of	Total	Total	Emission	Potential

waste	projects	capacity (MW)	installed capacity (MW)	electricity sold to grid (MWh/yr)	factor of Vietnam power grid (tCO2-e/MWh)	emission reduction (tCO2-e/yr)
Rice husk	33	1-15	169	1,000,000	0.656	656,000
Bagasse	27	5-16	250	380,000	0.656	249,280
Total	**60**		**419**	**1,38,000**	**0.656**	**905,280**



Potentially feasible sector-wide intervention

Intervention	Potential structure and in-roads	Estimated GHG reduction	Estimated CDM Revenues
Utilization of 20% of rice husk production and 40% of bagasse production for power generation	Through intermediary bank.	150,000 tCO2-e per year	$1.5 million per year

Project type A4: Reducing methane emissions from large-scale livestock farms

Project technologies/activities

The technologies/activities of this type of project involve the construction of a new biogas digester system, replacement and/or modification of an existing biogas digester to achieve methane recovery and its use for electricity and/or thermal energy generation. This project type is recommended to apply for the large-scale livestock farms.

The project activities shall satisfy the following conditions: (i) the final sludge must be handled aerobically. In case of soil application of final sludge, the proper conditions and procedures (not resulting in methane emissions) must be ensured; (ii) technical measures shall be used to ensure that all biogas produced by the digester is used or flared.

The recovered methane from the above project activities will be utilized for electricity and/or thermal energy generation. The generated energy will be used to supply the energy demand of the farm that in baseline case should be supplied from the grid or by fossil fuels.

Baseline Practices and Additionality

At present, the open anaerobic lagoons are commonly used for treatment of animal manure generated in large-scale livestock farms. These lagoons are usually poorly maintained. The effluents from lagoons, which obviously still contain high organic matter are discharged into the rivers or canals.

The main barriers to implementation of this project type are:

- The investment costs of the systems are high, that the farms usually cannot bear.
- The price of electricity purchased from the grid is still low that do not stimulate interest of the farm in recovery of biogas for electricity generation.

Assessment of Applicable CDM methodologies

There are some approved methodologies and tools that can be applicable for the demonstration and assessment of additionality of CCM projects in animal waste management sub-sector:

- ACM0010: Consolidated methodology for GHG emission reductions from manure management systems;
- AMS-III.D (Small scale projects): Methane recovery in animal manure management systems;
- AMS-III.R (Small scale projects): Methane recovery in agricultural activities at household/small farm level.

GHG emission reduction potential

The GHG emission reduction potential is estimated for three types of livestock: pig, cattle, and buffalo. The estimated emission reduction potential from methane recovery and electricity generation in large-scale livestock farms in Vietnam is presented in Table 29. The total GHG emission reduction potential could be 1,317,215 tCO2-e/yr. The GHG emission reduction potential per each farm is as follows:

- Pig farms: 3,840 tCO_2-e/yr per farm.
- Cattle farms: 383 tCO_2-e/yr per farm.
- Buffalo farms: 166 tCO_2-e/yr per farm.

Also the emission reductions for implementing interventions in all piggeries including commercial and household were estimated. The entire sector potential amounted to 7.2 million tCO2-e per year.

Table 14: Estimated emission reduction potential from methane recovery from large scale livestock farms

Farm	No. of farm	Animal heads	Manure generation (ton/yr)	Emission reduction potential (tCO2-e/yr)		
				From methane recovery	From electricity generation	Total
Pig	200	1,000,000	1,000,000	673,986	93,480	767,466
Cattle	1,000	500,000	1,250,000	336,993	46,740	383,733
Buffalo	1,000	100,000	460,000	148,816	17,200	166,016
Total				**1,159,795**	**157,420**	**1,317,215**

The emission reduction according to the percentage of manure digested in large-scale livestock farms in Vietnam is shown in Figures 15 and 16.

Figure 10: Emission reduction from methane capture and flaring vs. % of manure to be digested (for commercial livestock farms only)

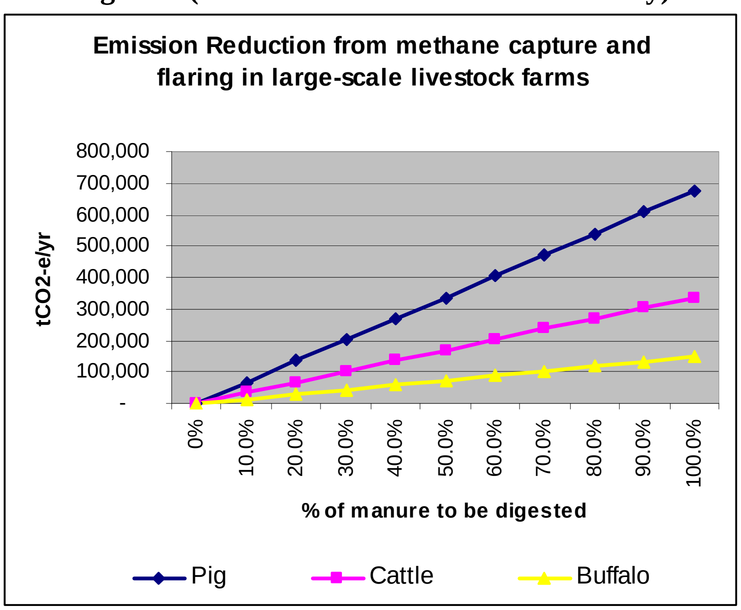


Figure 11: Emission reduction from methane capture and electricity generation vs. % of manure to be treated (for commercial livestock farms only

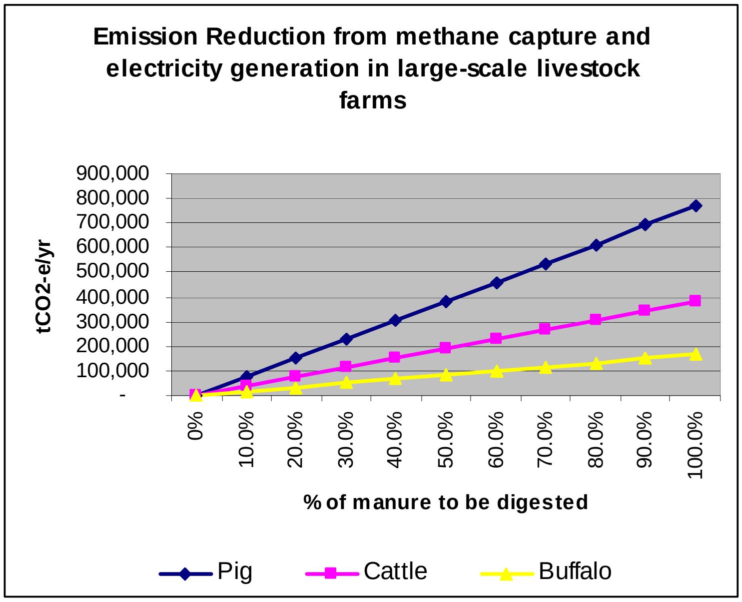
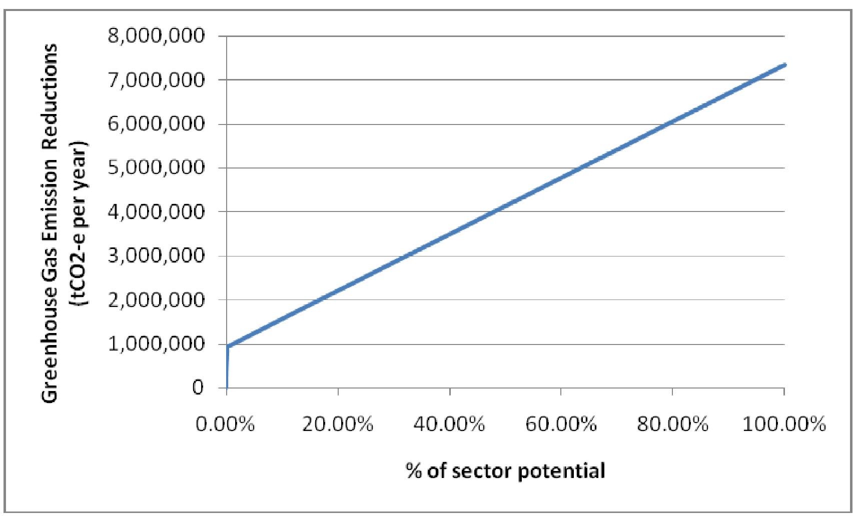


Figure 12: Emission reduction from methane capture and electricity generation vs. % of manure to be treated (for commercial and household piggeries)



Potentially feasible sector-wide intervention

Intervention	Potential structure and in-roads	Estimated GHG reduction	Estimated CDM Revenues
Methane capture and electricity generation in large-scale livestock farms (200 pig farms with 1,000,000 heads; 1,000 cattle farms with 500,000 heads;	Through MARD	1,320,000 tCO2-e per year	$13.2 million per year

and 1,000 buffalo farms with 100,000 heads)			

Project type F1: Promoting afforestation and reforestation (AR-CDM)

Project technologies and activities

The objectives of reforestation projects are to create carbon sinks, protect the natural environment, and condition the air. The project activities also generate additional income for the local populations while raising local awareness of the need to protect forests. In addition to general afforestation programs, mangrove programs are being considered by international and governmental organizations and MARD.

Baseline and additionality issues

The baseline for such AR-CDM projects is current or historical (whichever applies) changes in carbon stocks in the carbon pools within the project boundary. These include the following:

- Changes of carbon stocks in the carbon pools within the project boundary from a land use that represents an economically attractive course of action, taking into account barriers to investment; or
- Changes of carbon stocks in the carbon pools within the project boundary from the most likely land use at the time the project starts.

For additionality analysis, the following constraints have been defined for AR-CDM projects:

- Such activities require large investment and long gestation period, which are not attractive in term of financing.
- Risks of natural and man-made disasters (forest fire, typhoon, etc.).
- Poor accessibility to sites leading to high cost, and therefore not financial-attractive either.

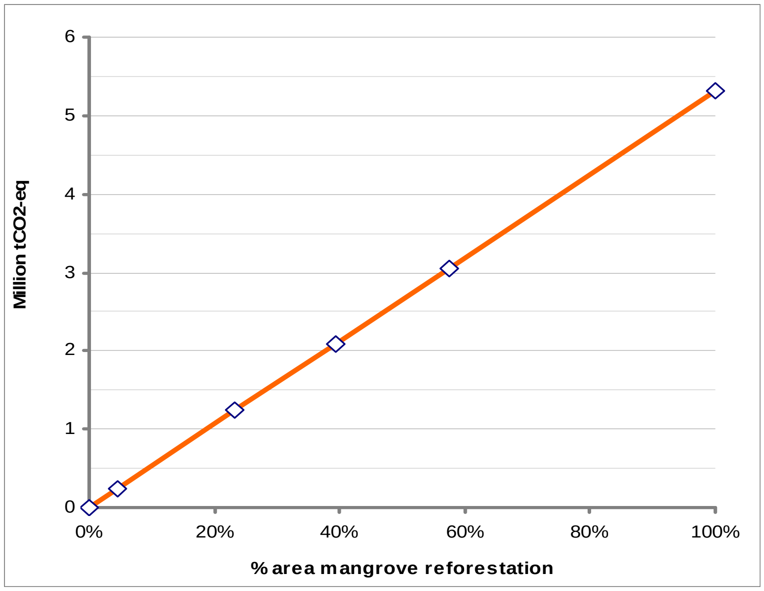
Assessment of Applicable CDM methodologies:

The approved methodology AR-AMS0003, "Simplified Baseline and Monitoring Methodologies for Small-Scale Afforestation and Reforestation Activities Implemented on Wetlands," can be used to calculate the baseline for such AR-CDM projects.

GHG emission reduction potential

Estimates of the GHG emission reduction potential of mangrove reforestation is based on the following assumptions: a combination of 80 percent of rhizophora and 20 percent of avicenia; and potential plantation areas (as of the beginning of year 2000) include 22,681 hectares in the Red River Delta and 111,873 hectares in the Mekong River Delta. The expected GHG emission reduction from mangrove forest projects would be 90.24 tCO2-e per hectare per year.

Figure 12: GHG Emission Reduction from Mangrove Reforestation



Baseline and additionality issues

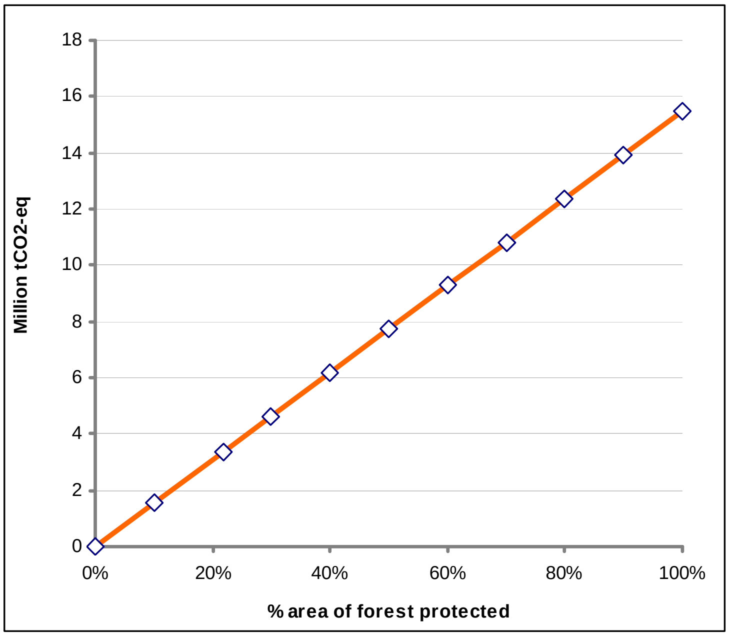
REDD strategies will help address the gaps and challenges faced by current programs involved in a variety of monitoring and enforcement activities. There are financial and technical barriers, and REDD methodologies are under development.

Assessment of Applicable CDM methodologies: There are no approved CDM methodologies for this type of project, however, some are under development under the REDD programs.

GHG emission reduction potential

GHG emission reductions are calculated based on the assumption of reduction of the forest lost based on 2000 annual rates —during which time the equivalent of 33,800 hectares of evergreen forest was estimated to be lost.

Figure 13: GHG Emission Reduction from Avoided Deforestation



Current CDM pipeline in Vietnam

Currently, no REDD projects are in Vietnam's CDM project pipeline.

Feasible interventions:

Intervention	Potential structure and in-roads	Estimated GHG reduction	Estimated CDM Revenues
Avoiding deforestation of 6,760 hectares of evergreen forest	Work with MARD	3.38m tCO2-e/yr (20% reduction in forest loss in 2000)	$ 33.8 million per year

Annex 1: Selected Bibliography

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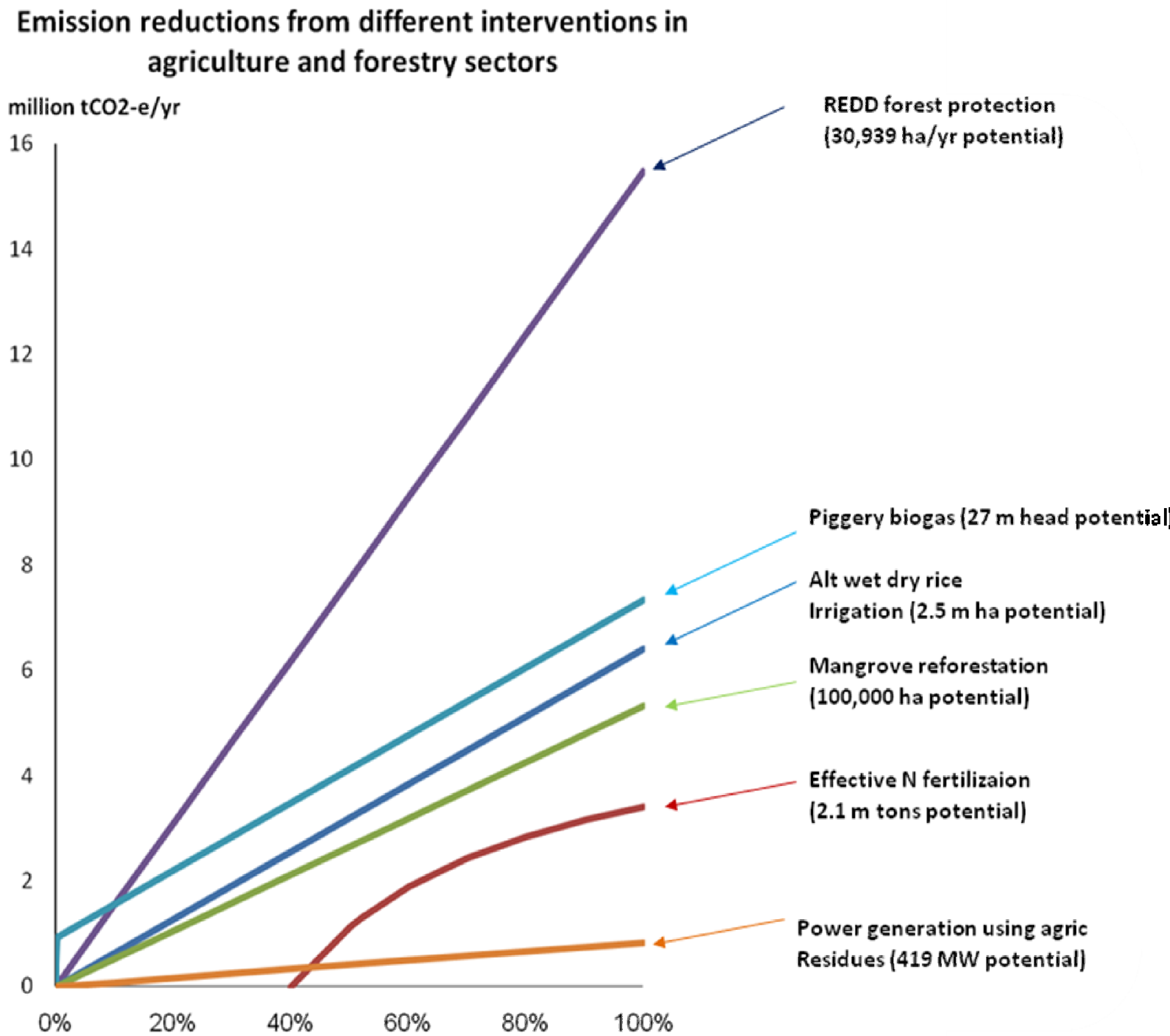
Annex 2: Summary of Potential Emission Reductions From Interventions in Agriculture and Forestry.



Note: Estimates based on annual reductions during 2010-2015

Annex 3: Summary of Potentially Feasible Sector Wide Interventions in Agriculture and Forestry.

	Sector	Program Intervention	GHG emissions in 2010 (million tCO2-e)	GHG reduction potential (2010 to 2015)		Co-benefits and Financial cost
				Total Potential (million tCO2-e/y)	For program idea (million tCO2-e/y)	
	Agriculture		***53.0***	***9.8***	***2.4***	
A1	Reducing methane emissions from rice fields	Introducing AWDI technical for irrigation management of 500,000 ha of wetland rice fields out of 2.5m ha to reduce methane emission		6.4	1.3	Water resources use efficiency; Profitability is unproven in Vietnam.
A2	Reducing nitrous oxid emissions from fertilizer application	Improving the efficiency of fertilizer use in rice cultivation from 40% to 50% (whole country)		3.4	1.1	Reduced costs of fertilizer; Reduced runoff; Profitability is unproven in Vietnam.
A3	Agricultural waste to energy	Agricultural solid residues: Utilization of 20% of rice husk production and 40% of bagasse production for power generation		0.91	0.15 0.06 (20% rice husk) 0.09 (40% bagasse)	Electrification, reduced pollution in rivers and of air; Typically profitable with CDM
A4	livestock waste	Livestock waste: Methane capture and electricity generation in large-scale livestock farms (200 pig farms with 1,000,000 heads; 1,000 cattle farms with 500,000 heads; and 1,000 buffalo farms with 100,000 heads)		7.80	1.32 0.767 (pig farms) 0.384 (cattle farms) 0.166 (buffalo farms)	Power savings for farmers; reduced water pollution; Typically profitable with CDM
4	**Forestry**		**-22.0**	**21.1**	**4.6**	
F1	Afforestation/ Reforestation	Reforestation of 22,000 ha of mangrove forest		5.3	1.2	Improved biodiversity; improved fisheries; disaster risk management; Involves costs financially.

				GHG reduction potential (2010 to 2015)		
F2	Forest protection	Introducing "Reducing Emissions from Deforestation and Forest Degradation" (REDD) to protect 30,000 ha of evergreen forest		15.8	3.4	Improved biodiversity; supports some forest livelihood; Involves costs financially.