**CLEAN DEVELOPMENT MECHANISM**
**PROJECT DESIGN DOCUMENT FORM (CDM-PDD)**
**Version 02 - in effect as of: 1 July 2004)**

## CONTENTS

## D. Application of a monitoring methodology and plan

### D.1 Name and reference of approved monitoring methodology applied to the project activity:

This project activity utilizes the CDM approved baseline methodology AM0016/Version 03 entitled "*Greenhouse gas mitigation from improved Animal Waste Management Systems in confined animal feeding operations*."

### D.2 Justification of the choice of the methodology and why it is applicable to the project activity:

This monitoring methodology was chosen because it offers a GHG emissions model that can be used to characterize baseline and project activity emissions. Specifically, the methodology is applicable because:

1. The captured gas is being flared; or
2. The captured gas can be used to produce energy (e.g., electricity/thermal energy), but no emission reductions are claimed for displacing or avoiding energy from other sources.[1]
3. The farms have livestock population managed under confined conditions and operate in a competitive market.
4. The livestock populations are comprised of swine animals, an applicable animal type.
5. The AWMS, including both the baseline scenario and the manure management systems introduced as part of the project activity, is in accordance with the regulatory framework in the country, excluding the discharge of manure into natural resources (e.g., rivers or estuaries).
6. The on-farm project systems introduce an AWMS practice and technology to reduce GHG emissions.
7. The project farm systems result in a reduction of GHG emissions due to the AWMS improvements.

[1] Although in this project no emission reductions are claimed for displacing or avoiding energy from other sources, all possible financial revenues and/or emission leakages will be taken into account in the analysis performed.

### D.2.1 Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

AM0016 monitoring methodology is a broad based methodology that can be applied to various animal categories, waste management systems, and data types. As such, the methodology defines a superset of ID numbered parameters available for application in individual project activity scenarios. Individual projects will not require monitoring of the entire superset of parameters. The selection of such parameters is dependent on the result of the data characterization and emission factor determination test. The following subset of parameters has been identified for use at the project activity sites:

**D.2.1.1 Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:**

| ID number | Data variable | Source of data | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? | Comment |
|---|---|---|---|---|---|---|---|---|
| 1. Population month | Integer, Classification | Herd/breed counts per type | #, Type | m | Entrance – exit records of animals to the barn | 100% | electronic | Animal counts by population classification and genetics. Classification data also includes mortality and days resident. |
| 6. BA | Classification | Type of AWMS | Type | m | Entrance – exit records of animals to the barn | 100% | electronic | AWMS type used to select appropriate parameters from IPCC lookup tables |
| 9. T | Integer | Temperature | $^{o}C$ | m | Monthly | 100% | electronic | Used to determine climate conditions for selection of appropriate parameters from IPCC lookup tables |
| 12. CF | Volume | Biogas produced | $m^3$ | m | Cumulative monthly production recorded monthly | 100% | electronic | This parameter enables verification of the anaerobic digestion process. Considered over several months, this parameter helps establish "typical" performance for an anaerobic digester. |
| 13. CD | Percent | $CO_2$ produced | % | m | Quarterly | 100% | electronic | This parameter monitors digester operation. |
| 14. INT | N/A | Operational status | N/A | m | Weekly | 100% | electronic | Operational status of all project equipment is checked. This parameter helps ensure proper digester operation. |
| 15. DR | Classifi | Referenced | Type | m | Entrance – exit | 100% | Electronic | Data from standard references and IPCC |

| ID number | Data variable | Source of data | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? | Comment |
|---|---|---|---|---|---|---|---|---|
| | cation | data from standard tables | | | records of animals to the barn | | | tables. |

### D.2.1.2 Description of formulae used to estimate project emissions (for gas, source, formulae/algorithm, emission units of $CO_2$ equ.)

Equations 9, 10, 11, 13, 14, 15, and 16 from Approved Methodology AM0016 are used to determine project activity emissions.

Four options are available for the determination of volatile solids ($V_s$) excretion rate used with equation 11. Two of the four originate from lookup tables, IPCC and country-specific. If lookup references were not available, then the $V_s$ could have been determined via calculation based on feed nutrition content and animal weight, e.g., equations 1 and 2 in AM0016. Values for $V_s$ were calculated for use at the project activity sites based on standard North American animal group weights. Furthermore, country specific factors are not available.

Two options are available for the determination of methane conversion factors (MCF) used with equation 11. One originates from IPCC lookup tables and the other can be calculated using equation 8 in AM0016. IPCC default values were selected for use at the project activity sites.

Four options are available for the determination of nitrogen excretion ($N_{ex}$) rate used with equations 15 and 16. Two of the four originate from lookup tables, IPCC and country-specific. If lookup references were not available, then the $N_{ex}$ could have been determined via calculation based on feed nutrition content and animal weight, e.g., equations 3 and 4 in AM0016. IPCC default values were selected for use at the project activity sites. Furthermore, country specific factors are not available.

- Equation 9, Baseline methane ($CH_4$) emissions in $CO_2e$:

$$CO_{2eq\ methane} = CH_{4\ annual} * GWP_{CH4}/1000$$

- Equation 10, Baseline methane ($CH_4$) annual emissions:

$$CH_{4\ annual} = \sum_{mj} EF_{month} * Population_{month} * MS\%j$$

- Equation 11, Animal group emission factor:

$$EF_{month} = V_s * n_m * B_0 * 0.67kg/m^3 * MCF_{month}$$

- Equation 13, Baseline nitrous oxide ($N_2O$) emissions in $CO_2e$:

$$CO_{2equiv\ N2O} = GWP_{N2O} * N_2O_{total\ annual}/1000$$

- Equation 14, Baseline nitrous oxide ($N_2O$) annual emissions:

$$N_2O_{total\ annual} = \sum_{mj} (N_2O_d + N_2O_i) * Population_{month} * MS\%j$$

- Equation 15, Direct nitrous oxide ($N_2O$) emissions:

$$N_2O_d = N_{ex\ month} * EF_3 * (1- F_{gasm}) * C_m$$

- Equation 16, Indirect nitrous oxide ($N_2O$) emissions:

$$N_2O_i = N_{ex\ month} * EF_4 * F_{gasm} * C_m$$

**D.2.1.3 Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHG within the project boundary and how such data will be collected and archived.**

| ID number | Data variable | Source of data | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? | Comment |
|---|---|---|---|---|---|---|---|---|
| 1. Population month | Integer, Classification | Herd/breed counts per type | #, Type | m | Entrance – exit records of animals to the barn | 100% | electronic | Animal counts by population classification and genetics. Classification data also includes mortality and days resident. |
| 6. BA | Classification | Type of AWMS | Type | m | Entrance – exit records of animals to the barn | 100% | electronic | AWMS type used to select appropriate parameters from IPCC lookup tables |
| 9. T | Integer | Temperature | $^oC$ | m | Monthly | 100% | electronic | Used to determine climate conditions for selection of appropriate parameters from IPCC lookup tables |

| ID number | Data variable | Source of data | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? | Comment |
|---|---|---|---|---|---|---|---|---|
| 15. DR | Classification | Referenced data from standard tables | Type | m | Entrance – exit records of animals to the barn | 100% | Electronic | Data from standard references and IPCC tables. |
| 20. F | Flow rate | Biogas flow extracted by digester | $m^3$ | m | Continuously | 100% | Paper | This parameter enables verification of the correct performance of digester and gas recovery. |
| 21. %CH4 | Percent | Percentage of biogas that is methane | % | m | Periodical measurement | | Paper | As periodical measurement is adopted, the confidence level is at least 95%. |
| 22. %FE[2] | Percent | Flare efficiency determined by the operation hours (1) and the methane content in the exhaust gas (2) | % | m and c | (1) Continuously,<br>(2) Quarterly, monthly if unstable | n/a | Electronic | This parameter enables verification of the correct performance of digester and gas recovery.<br>(1) Continuous measurement of operation time of flare using a run time meter connected to a flame detector or a flame continuous temperature controller.<br>(2) Periodic measurement of methane content of flare exhaust gas. |

### D.2.1.4 Description of formulae used to estimate baseline emissions (for gas, source, formulae/algorithm, emission units of $CO_2$ equ.)

Equations 9, 10, 11, 13, 14, 15, and 16 from Approved Methodology AM0016 are used to determine baseline emissions.

[2] The flare efficiency shall be calculated as fraction of time the gas is combusted in the flare multiplied by the efficiency of the flaring process. If the efficiency for the flare process can't be measured, a conservative destruction efficiency factor should be used – 99% for enclosed flares and 50% for open flare.

Four options are available for the determination of volatile solids ($V_s$) excretion rate used with equation 11. Two of the four originate from lookup tables, IPCC and country-specific. IPCC default values for $V_s$. were selected for use at the project activity sites. Furthermore, country specific factors are not available.

Two options are available for the determination of methane conversion factors (MCF) used with equation 11. One originates from IPCC lookup tables and the other can be calculated using equation 8 in AM0016. Values for $V_s$ were calculated for use at the project activity sites based on standard North American animal group weights.

Four options are available for the determination of nitrogen excretion ($N_{ex}$) rate used with equations 15 and 16. Two of the four originate from lookup tables, IPCC and country-specific. IPCC default values were selected for use at the project activity sites. Furthermore, country specific factors are not available.

- Equation 9, Baseline methane ($CH_4$) emissions in $CO_2e$:

$$CO_{2eq\ methane} = CH_{4\ annual} * GWP_{CH4}/1000$$

- Equation 10, Baseline methane ($CH_4$) annual emissions:

$$CH_{4\ annual} = \sum_{mj} EF_{month} * Population_{month} * MS\%j$$

- Equation 11, Animal group emission factor:

$$EF_{month} = V_s * n_m * B_0 * 0.67kg/m^3 * MCF_{month}$$

- Equation 13, Baseline nitrous oxide ($N_2O$) emissions in $CO_2e$:

$$CO_{2equiv\ N2O} = GWP_{N2O} * N_2O_{total\ annual}/1000$$

- Equation 14, Baseline nitrous oxide ($N_2O$) annual emissions:

$$N_2O_{total\ annual} = \sum_{mj} (N_2O_d + N_2O_i) * Population_{month} * MS\%j$$

- Equation 15, Direct nitrous oxide ($N_2O$) emissions:

$$N_2O_d = N_{ex\ month} * EF_3 * (1- F_{gasm}) * C_m$$

- Equation 16, Indirect nitrous oxide ($N_2O$) emissions:

$$N_2O_i = N_{ex\ month} * EF_4 * F_{gasm} * C_m$$

**D.2.2 Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E):**

**D.2.2.1 Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:**

| ID number | Data variable | Source of data | Data unit | Measured (m), calculated (c), estimated (e), | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

**D.2.2.2 Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emission units of $CO_2$ equ.):**

**D.2.3 Treatment of Leakage in the Monitoring Plan.**

**D.2.3.1 If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity**

| ID number | Data variable | Source of data | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|
| 16. $EP_y$ | Electricity | Power | kWh | m or c | Monthly | 100% | electronic | Electricity used for project equipment. If calculated, assume that all relevant electrical equipment operates at full rated capacity, plus 10% to account for distribution losses, for 8760 hours per annum. |
| 19. $EP_p$ | Electricity | Power | kWh | m | Monthly | 100% | electronic | Electricity produced through co generation of the |

| ID number | Data variable | Source of data | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | captured methane |

**D.2.3.2 Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emission units of $CO_2$ equ.)**

Equations 17 to 23 from Approved Methodology AM0016 are used to determine project activity leakage.

Equation 17 will be used to determine electrical leakage on a continual basis.

The project developer used equations 18 through 23 in a one-time analysis to confirm that the change in AWMS (project activity) did not adversely affect GHG emissions due to land application, runoff and ammonia volatilization. The results of the analysis show that there is no change in GHG emissions in these areas by the incorporation of an anaerobic digester.

- Equation 17, Project activity electricity emissions in $CO_2e$:

$$EE_y = (EP_{y\text{-}project} - EP_{p\text{-}project} - EP_{y\text{-}baseline}) * EC_y / 1000$$

- Equation 18, Land leakage:

$$Land\ Leakage = Project\ activity\ land\ emissions - Baseline\ land\ emissions$$

- Equation 19, Direct nitrous oxide ($N_2O$) emissions from land application:

$$N_2O_{land} = N_{ex} * N * (1\text{-}F_{gasm}) * EF_1 * C_m$$

- Equation 20, Indirect nitrous oxide ($N_2O$) emissions from runoff:

$$N_2O_{runoff} = N_{ex} * N * (1\text{-}F_{gasm}) * F_{leach} * EF_5 * C_m$$

- Equation 21, Indirect nitrous oxide ($N_2O$) emissions from ammonia volatilization:

$$N_2O_i = N_{ex} * N * EF_4 * F_{gasm} * C_m$$

- Equation 22, Total nitrous oxide ($N_2O$) emissions:

$$N_2O_{total} = (N_2O_{land} + N_2O_i + N_2O_{runoff}) / 1000$$

- Equation 23, Total nitrous oxide ($N_2O$) emissions in $CO_2$ equivalent:

$$N_2O_{CO2\text{-}equiv} = GWP_{N2O} * N_2O_{total}$$

- And, the following equation was used to sum the land application and electricity leakage:

$$L_o = EE_y + N_2O_{CO2\text{-}equiv}$$

**D.2.4 Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)**

Equations 24 and 26 from Approved Methodology AM0016 are used to determine project activity emission reductions:

- Equation 24, Total emissions in metric tonnes $CO_2e$:

$$Total\ Emissions_{mt} = CO_{2eq\ methane} + CO_{2equiv\ N2O}$$

- Equation 26, Net emission reductions:

$$ER_{net} = BE - PE - L_o$$

The ex-ante baseline and project methane emissions and to be reported in the CDM-PDD are based on estimation equations defined earlier. Whereas, for the purpose of claiming emissions reductions, the baseline methane emissions are the lower of the actual methane captured and flared or those estimated by equations estimating baseline methane emissions. The value of the actual methane captured and flared should be multiplied by the flare efficiency. Flare efficiency is estimated as per procedure explained below and monitored as per the monitoring methodology. If actual methane captured and flared is lower than the estimated baseline methane emission, the project methane emissions for the project AWMS where the biogas is captured is considered as zero.

Where

| | |
|---|---|
| $ER_{net}$ | Net emission reduction due to the project activity |
| $BE$ | Total baseline emissions |
| $PE$ | Total project emissions |
| $L_o$ | Leakage losses outside the boundary |

| D.3 Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored. | | |
|---|---|---|
| Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)* | Uncertainty level of data (High/Medium/Low) | Explain QA/QC procedures planned for these data, or why such procedures are not necessary. |
| Table D2.1.1-1 | Low | Work instructions for the collection of this data point are available in O&M Manual MS004 |
| Table D2.1.3-1 | Low | Work instructions for the collection of this data point are available in O&M Manual MS004 |
| Table D2.1.1-6 | Low | Work instructions for the collection of this data point are available in O&M Manual MS004 |
| Table D2.1.3-6 | Low | Work instructions for the collection of this data point are available in O&M Manual MS004 |
| Table D2.1.1-9 | Low | Work instructions for the collection of this data point are available in O&M Manual MS004 |
| Table D2.1.3-9 | Low | Work instructions for the collection of this data point are available in O&M Manual MS004 |
| Table D2.1.1-12 | Low | Work instructions for the collection of this data point are available in O&M Manual MS004 |
| Table D2.1.1-13 | Low | Work instructions for the collection of this data point are available in O&M Manual MS004 |
| Table D2.1.1-14 | Low | Work instructions for the collection of this data point are available in O&M Manual MS004 |
| Table D2.1.1-15 | Low | Based on revisions and notification from IPCC. Lookup values updated as appropriate. |
| Table D2.1.3-15 | Low | Based on revisions and notification from IPCC. Lookup values updated as appropriate. |
| Table D2.3.1-16 | Low | Work instructions for the collection of this data point are available in O&M Manual MS004 |
| Table D2.3.1-19 | Low | Work instructions for the collection of this data point are available in O&M Manual MS004 |
| Table D2.1.1-20 | Low | Work instructions for the collection of this data point are available in O&M Manual MS004 |
| Table D2.1.1-21 | Low | Work instructions for the collection of this data point are available in O&M Manual MS004 |
| Table D2.1.1-22 | Low | Work instructions for the collection of this data point are available in O&M Manual MS004 |

**D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity**

Metering devices used for measurement of biogas are positive displacement; rotary impeller-type gas meters designed for continuously measuring and indicating the accurate measurement of gas flow and are specially designed for corrosive environments. Meters are received from the factory fully-calibrated and retain calibration for the service life of the unit. Volumetric accuracy of the meter is permanent and non-adjustable. Accuracy is not affected by low or varying line pressures. Accuracy of the flow meters utilized exceeds 99 percent across the entire measured rate curve with an uncertainty range of less than ± 1 percent. Bearing oil is changed as required on the unit, as required, to assure optimal operation and achieve specified performance. Differential pressure tests are conducted by maintenance technicians to periodically substantiate that the original accuracy of a meter has remained unchanged. If flow is less than optimal, the unit is replaced.

Methane concentration is determined with $CO^2$ content testing and is obtained with a gas analyzer using the "Orsat" method of volumetric analysis involving chemical absorption of a sample gas. The equipment and test procedures will provide an accuracy with a ± ½ percent uncertainty range. The chemical sampling/testing unit is used and calibrated prior to each test according to the manufacturer's specifications and procedures.

The following table outlines overall CDM related responsibilities:

| D.4. CDM Process (Overall Responsibility: Director, Climate Change Programs) | | | | | |
|---|---|---|---|---|---|
| **Step** | **Duration** | **Activity** | **Comments** | **Responsible Office** | **Co responsibility** |
| **1** | 120 - 180 Days | Farm Aggregation | Sign LOI<br>Form A (Initial Producer Data)<br>Env Permits/Op License<br>Legal Entity Docs | Aggregation | Producer |
| **2** | | Contract Execution | Sign Contract | Aggregation | Producer<br>AgCert Itn'l Executive Staff<br>Quality |
| **3** | | Farm Assessment | Assess Farm - Form B<br>Collect production data (3 yr) | Assessment | Producer |
| **4** | | Data Entry | Enter data into SMS | Data Entry (Host Country) | |
| **5** | | Data quality check | Check data for accuracy | Quality (Host Country) | Project Co-ordinator |
| **6** | | PDD Assignment | Assign Farm System/Site to PDD | Host Country Manager | Project Coordinator |
| **7** | | Stakeholder's Meeting | Send Invitations<br>Prepare & conduct meeting<br>Take Minutes/Photos | Aggregation | AgCert Int'l |
| **8** | | Prepare PDD | Using data | Technical Documentation | Host Country Project co-ordinator |
| **9** | | Confirm PDD | Check accuracy of PDD | Project Co-ordinator / QA | Host nation staff |
| **10** | | Submit PDD to DOE & to DNA for LOA | PDD not submitted to DNAs that require validation reports at this time (See step 12) | Regulatory | Host Country Manager |
| **11** | | Validation Audit | On-site Visit<br>Pre Screening<br>30-Day Pubilc Review<br>Formal Report | DOE | Regulatory<br>Host Country Project co-ordinator<br>Site Assessment |
| **12** | | Submit PDD to DNA (that require validation report) for LOA | 6-8 week process | Regulatory | Host Country Manager |
| **13** | | Submit Project Activty Package for Registration | Collect and submit LOAs, Validation Report, Public Comments, etc. | Regulatory / DOE | Host Country Project co-ordinator<br>Technical Documentation |
| **14** | | Eight Week Public Review | Formal Pre-registration Requirement | UNFCCC / DOE | Regulatory |
| **15** | | Project Registered | Automatic after 8-wk period if no comments received | UNFCCC / DOE | Business Development |
| **16** | 90 - 120 Days | Start Project Activity Constuction | May begin earlier but at AgCert's risk if project not registered. | Host Nation Construction Manager | AgCert Int'l Construction Manager<br>Producer |
| **17** | | Conduct Project Activity Transfer | Construction Complete<br>System Quality Checks<br>Configuration Management<br>Documentation<br>Producer Training | Host Nation Construction Manager<br>Host Nation O&M Manager<br>Host Nation Quality Supervisor | AgCert Int'l Construction Manager<br>AgCert Int'l O&M Manger<br>AgCert Int'l Quality Manager |
| **18** | 10 Years | Monitoring (Site Activities) | Collect data<br>Document systems checks<br>Conduct Monitoring Plan and O&M Activities | Host Nation Monitoring Manager | AgCert Int'l Quality Manager |
| **19** | | Prepare Monitoring Report | Prepare Periodic Montioring Report for Verification Audit | AgCert Int'l Monitoring Manger | Host Country Project co-ordinator<br>IT |
| **20** | | Schedule and Conduct Periodic Verification Audit(s) | | DOE | Regulatory<br>Host Country Project co-ordinator |
| **21** | | Certify Emission Reductions | | DOE | Regulatory<br>Host Country Project co-ordinator |
| **22** | | Transfer CERs | Send distribution instructions | Business Development<br>Sales | DOE/EB |

AgCert has a trained staff located in the host nation to perform O&M activities including but not limited to monitoring and collection of parameters, quality audits, personnel training, and equipment inspections. The associated O&M Manual has been developed to provide guidance (work instructions) to individuals that collect and/or process data. An AgCert staff will periodically perform audits of farm operations personnel to ensure proper data collection and handling.

AgCert has designed and implemented a unique set of data management tools to efficiently capture and report data throughout the project lifecycle. On-site assessment (collecting Geo-referenced, time/date stamped data), supplier production data exchange, task tracking, and post-implementation auditing tools have been developed to ensure accurate, consistent, and complete data gathering and project implementation. Sophisticated tools have also been created to estimate/monitor the creation of high quality, permanent, ERs using IPCC formulae.

By coupling these capabilities with an ISO quality and environmental management system, AgCert enables transparent data collection and verification.

**D.5 Name of person/entity determining the monitoring methodology:**

AgCert determined the monitoring methodology for use at this project activity.