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

>>Monitoring methodology *Monitoring Methodology for GHG Reductions Project for On-Farm Animal Waste Management Systems* has been analyzed and deemed appropriate for the proposed GHG reduction project. This decision considers the similarity of the accepted methodology applied to the manure management systems employed by Chilean hog producer, *Agrosuper,* and the project activity for Pronaca swine production facilities. Similarities exist between the baseline manure management practices and the data that will be required for monitoring project emissions.

The conditions under which this approved methodology AM0006 are applicable to potential projects other than that proposed in the case of Agrosuper, are those in which the following conditions are satisfied:

- The project context is represented by farms operating under a competitive market.
- Baseline and project scenario must act in accordance with the environmental framework of the host country.
- The complete set of possible baseline scenario alternatives that should be considered are those animal waste management systems listed in the IPCC Guidelines (Chapter 4, table 4.8) and the IPCC Good Practice Guidance and Uncertainty Management (Chapter 4, Table 4.11). By following the steps outlined in this methodology, two potential scenarios can be determined, that of the baseline and that of the project. This methodology considers the "most likely economically attractive scenario" to be the baseline scenario as sufficiently demonstrated through the outlined selection process.
- The approach is applicable for estimating emissions from waste treatment systems, in animal populations managed under confined conditions. Barn systems and barn flushing systems are not part of the methodology for which the described methodology calculates emissions reductions.
- This methodology is applicable to most combinations of water management practices at various stages of implementation, excluding discharge into natural water resources.
- This methodology can be applied to components considering anaerobic treatment, with the condition that they fix nitrogen content.
- This methodology is only applicable for livestock species such as cattle, buffalo and swine.

Swine production at Pronaca facilities is carried out under similar conditions as those outlined as being necessary for AM0006 to be considered appropriate as described above. Therefore AM0006 is considered an appropriate methodology for use in the Pronaca GHG reduction project case.

The monitoring methodology for AM0006 involves the active measurement of herd data including herd numbers, volatile manure solids, manure nitrogen excreted, and various measurements of the products of anaerobic digestion that may contribute to the overall reductions in GHG gained through the adoption of anaerobic treatment of swine manure. Direct quantification, through monitoring, of GHG emissions will not be possible for the current GHG reduction project for economic reasons, thus IPCC default values and equations will largely be utilized.

Table D.2.1.1 outlines the components of the methodology which will be required monitoring parameters for the proposed project activity.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

The equipment and time resources required to directly monitor GHG emissions from the baseline a project cases is extensive and an uneconomical and largely inaccurate endeavour. In order to monitor GHG emissions specific parameters will be measured and archived, allowing for the calculation of GHG emissions from the baseline and project cases which is outlined below.

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 *(Please use numbers to ease cross-referencing to D.3)*	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
PM-1	*Swine stock*	*Production data*	*# head*	*M*	*Weekly*	*100%*	*Electronic/paper*	*Swine herd inventories will be tracked weekly to account for herd inventory adjustments due to emptying, re-filling of rearing facilities and number of deceased animals*
PM-2	*Animal weight*	*Production data*	*kg*	*m, c*	*Monthly*	*100%*	*Electronic/paper*	*Based on the average weight of animals entering and leaving the rearing facilities, and the average daily weight gain, based on known growth rates, average animal weights can be actively calculated*
PM-3	*Vs*	*Default Value*	*Kg/da y*	*C*	*Once in the crediting period, as calculated in the PDD*		*Electronic/paper*	*As per the CDM Executive Board's instructions, and based on the decision made by the EB in response to the Deviation Request to the Monitoring Plan submitted by TUV-SUD prior to the first verification, the Vs value to be used is the one used in the estimation of project emissions as indicated in the PDD*
PM-4	*Rice husk added to the manure*	*Truck loads*	*Cubic metres*	*M*	*Yearly*	*100%*	*Electronic/paper*	*In order to cross-verify that sufficient rice husk has been added to the manure.*

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

>> Emissions reductions will be achieved through the transformation of the manure management system for the project barns from a system of liquid manure production, collection and treatment in anaerobic lagoons, to the production, collection and treatment of solid manure. As such, IPCC default calculations and coefficients corresponding to solid manure treatment system are used to determine the project emissions. The process for determining project emissions is identical to that used to determine baseline emissions, with the exception of substituting the methane conversion factor (MCF) for anaerobic lagoon manure treatment, with the MCF for solid manure treatment. Nitrous oxide production coefficients are also different for the baseline and project manure management scenarios. Thus, baseline and project GHG emission calculations will incorporate the variation in nitrogen emissions coefficients for both the baseline and project scenarios. The calculations used for determining project activity emissions are outlined below.

Formulae Used to Estimate Project Emissions

The process used for calculating the project GHG emissions follows the following 7 steps:

1. Determine annual livestock herd populations by animal class, and the average animal weight
2. Determine the annual volatile solids excretion
3. Determine the methane emissions factor based on the manure management system employed
4. Determine the annual project methane emissions from the herd based on populations, volatile solids excretion and methane conversion factor
5. Determine project nitrous oxide emissions
6. Calculate total project nitrous oxide emissions
7. Calculate the sum of project methane and nitrous oxide emissions

Step-1 Determine annual livestock population by animal class, and average animal weight

For the project case, the following table can be used to organize the date necessary to complete step-1.

Livestock Class	Average Weight (kg)	Duration in class (days/year)
Swine finishers	70	340

Step-2 Determine daily volatile solids excretion

As per instructed by the CDM Eexecutive Board in their response to the Deviation Request to the Monitoring submitted by TUV-SUD prior to the first verification, the Vs value to be used for the purposes of verification is that used in the PDD, which value is 0.4262 kg/day.

$$\mathbf{VS = 0.4262\ kg/day}$$

Where: VS = Volatile solids excretion (kg/day: Calculated)

Step-3 Determine the methane emission factor for the manure management system

The methane emission factor for a specific manure management system is determined using Equation 16 as outlined in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Emissions Inventories: Reference Manual. The emission factor (EF) is calculated according to Equation 16 for each pig class on the farm and is calculated as follows:

$$EF_i = VS_i * 340\ days/year * Bo_i * 0.67\ kg/m^3 * \Sigma_j \{MCF_j * MS_{ij}\}$$

Where:

EF_i = Emission factor for pig class *i (kg: Calculated)*
VS_i = Volatile solid excretion for the pig class *i (kg: Calculated)*
B_{0i} = Maximum methane producing capacity for pig class (m^3/kg of VS: IPCC)
MCF_j = Methane conversion factor for manure management system *j (unit less: IPCC)*
MS_{ij} = Fraction of animal species *i* which manure is handled using manure system *j (unit less: IPCC)*

Step 4 - Calculate methane emissions

The following equation is used to determine the methane emissions for the manure management system.

$$\mathbf{CH4\ Emissions_{CO2e} = EF * GWP_{CH4} * animal\ population/1000}$$

Where:

- $CH4\ emissions_{CO2e}$ = Total methane emissions (tonnes CO_2e: Calculated)
- EF = Emission factor for the manure management system in question (kg: Calculated)
- GWP_{CH4} = Global Warming Potential for methane
- Animal population = Annual swine population (#-head: Pronaca data)

Step 5 – Determine nitrous oxide emissions

When site specific data on the actual quantity of manure nitrogen excreted, IPCC default factors can be employed in the following equation to satisfy the nitrogen excretion per animal (NEX).

The average animal weight for the Pronaca farms differs from the IPCC default weight of 82 kg, therefore nitrogen output values are modified to suit the site specific case of Pronoca using the following equation:

$$\mathbf{NEX = (Weight_{ss} / Weight_{df}) * NEX_{df}}$$

Where:

- NEX = Site specific nitrogen excretion (kg/head/year: IPCC)
- $Weight_{ss}$ = Site specific animal weight (kg: Pronaca data)
- $Weight_{df}$ = IPCC default animal weight (kg: IPCC)
- NEX_{df} = IPCC Default nitrogen excretion (kg/head/year: IPCC)

Equations for calculating nitrous oxide emissions are taken from the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.

$$N_2O\text{-}N = NEX * N * EF_3 * CF/1000$$

Where:

N_2O-N = Emissions from manure management system (kg: Calculated)
N = Number of head in herd of consideration (#-head: Pronaca Data)
NEX = Annual average N excretion per head (kg/animal/year: Modified IPCC)
EF_3 = N_2O emission factor for direct emissions from the manure management system (kg N_2O-N/kg N: IPCC)
CF = Conversion factor for N2O-N to N (44/28=1.57)

Step 6 – Calculate nitrous oxide emissions

In order for the nitrous oxide emissions calculated to be expressed as tonnes of carbon dioxide equivalent (ton CO_2e) the following conversion equation must be applied:

$$N_2O\ Emissions_{CO2e} = N_2O\text{-}N_{total} * GWP_{N2O}$$

Where:

N_2O emissions$_{CO2e}$ = Total direct nitrous oxide emissions (tonnes CO_2e: Calculated)
N_2O-N_{total} = Emission factor for the manure management system in question (kg: IPCC)
GWP_{N2O} = Global Warming Potential for nitrous oxide

Step 7 – Calculate the sum of methane and nitrous oxide emissions for the project case

Total annual project GHG emissions, expressed as tonnes of carbon dioxide equivalents (tonnes CO_2e), are determined by summing the total project CH_4 and N_2O emissions using the following equation:

$$GHG\ Emissions_{(CH4,\ N2O)} = CH_4\ emissions + N_2O\ emissions$$

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	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
BC-1	*Swine stock (N)*	*Production data*	*# head*	*M*	*Weekly*	*100%*	*Electronic/paper*	*Swine herd inventories will be tracked weekly to account for herd inventory adjustments due to emptying, re-filling of rearing facilities and number of deceased animals*
BC-2	*Animal weight*	*Production data*	*kg*	*m, c*	*Monthly*	*100%*	*Electronic/paper*	*Based on the average weight of animals entering and leaving the rearing facilities, and the average daily weight gain, based on known growth rates, average animal weights can be actively calculated*
BC-3	*Vs Volatile Solids Excretion*	*Default Value*	*Kg/day*	*C*	*Once in the crediting period, as calculated in the PDD*		*Electronic/paper*	*As per the CDM Executive Board's instructions, and based on the decision made by the EB in response to the Deviation Request to the Monitoring Plan submitted by TUV-SUD prior to the first verification, the Vs value to be used is the one used in the estimation of project emissions as indicated in the PDD*
BC-5	*Bo*	*IPCC Default values*	*CH_4/kg VS*	*E*	*Daily*	*100%*	*Electronic/paper*	*In the absence of site-specific values, IPCC default values are deemed appropriate*

BC-6	*MCF*	*IPCC Default values*	*%*	*E*	*Daily*	*100%*	*Electronic/paper*	*In the absence of site-specific values, IPCC default values are deemed appropriate*
BC-7	*MS*	*Production data*	*%*	*M*	*Daily*	*100%*	*Electronic/paper*	*A single manure management practice is considered in the calculation, the MS value = 1*
BC-8	NEX	*IPCC Default values*	*Kg/head/day*	*C*	*Daily*	*100%*	*Electronic/paper*	*In the absence of site-specific values, IPCC default values are deemed appropriate*
BC-9	EF_3	*IPCC Default values*	*(kg N_2O-N/kg N excreted)*	*E*	*Daily*	*100%*	*Electronic/paper*	*In the absence of site-specific values, IPCC default values are deemed appropriate*

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

>> The process for calculating baseline GHG emissions involves the following 7 steps:

Formulae Used to Estimate Baseline Scenario GHG Emissions

The process used for calculating the baseline GHG emissions follows the following 7 steps:

1. Determine annual livestock herd populations by animal class, and the average animal weight
2. Determine the annual volatile solids excretion according to livestock class
3. Determine the methane emissions factor based on the manure management system employed
4. Determine the annual baseline methane emissions from the herd based on populations, volatile solids excretion and methane conversion factor
5. Determine baseline nitrous oxide emissions
6. Calculate total baseline nitrous oxide emissions
7. Calculate the sum of baseline methane and nitrous oxide emissions

Step-1 Determine annual livestock population by animal class, and average animal weight

For the baseline case, the following table can be used to organize the date necessary to complete step-1.

Livestock Class	Average Weight (kg)	Duration in class (days/year)
Swine finishers	70	340

Step-2 Determine daily volatile solids excretion by animal class

As per instructed by the CDM Executive Board in their response to the Deviation Request to the Monitoring submitted, the Vs value to be used is a fixed value of 0.4262 kg/day.

Step-3 Determine the methane emission factor for the manure management system

The methane emission factor for a specific manure management system is determined using Equation 16 as outlined in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Emissions Inventories: Reference Manual. The emission factor (EF) is calculated according to Equation 16 for each pig class on the farm and is calculated as follows:

$$\mathbf{EF_i = VS_i * 340\ days/year * Bo_i * 0.67\ kg/m^3 * \Sigma_j \{MCF_j * MS_{ij}\}}$$

Where:

EF_i = Emission factor for pig class *i* (kg: *Calculated*)
VS_i = Volatile solid excretion for the pig class *i* (kg: *Calculated*)
B_{0i} = Maximum methane producing capacity for pig class (m^3/kg VS: *IPCC*)
MCF_j = Methane conversion factor for manure management system *j* (unit less: *IPCC*)
MS_{ij} = Fraction of animal species *i* which manure is handled using manure system *j* (unit less: *IPCC*)

Step 4 - Calculate methane emissions

The following equation is used to determine the methane emissions for the manure management system.

$$CH_4\ Emissions_{CO2e} = EF * GWP_{CH4} * animal\ population/1000$$

Where:

$CH4\ emissions_{CO2e}$ = Total methane emissions (tonnes CO_2e)
EF = Emission factor for the manure management system in question (kg: *Calculated*)
GWP_{CH4} = Global Warming Potential for methane
Animal population = Annual swine population (#-head: *Pronaca Data*)

Step 5 – Determine nitrous oxide emissions

When site specific data on the actual quantity of manure nitrogen excreted, IPCC default factors can be employed in the following equation to satisfy the nitrogen excretion per animal (NEX).

The average animal weight for the Pronaca farms differs from the IPCC default weight of 82 kg, therefore nitrogen output values are modified to suit the site specific case of Pronaca using the following equation:

$$NEX = (Weight_{ss} / Weight_{df}) * NEX_{df}$$

Where:

NEX = Site specific nitrogen excretion (kg/head/year: IPCC)
$Weight_{ss}$ = Site specific animal weight (kg: Pronaca data)
$Weight_{df}$ = IPCC default animal weight (kg: IPCC)
NEX_{df} = IPCC Default nitrogen excretion (kg/head/year: IPCC)

Equations for calculating nitrous oxide emissions are taken from the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.

$$\mathbf{N_2O\text{-}N = NEX * N * EF_3 *CF/1000}$$

Where:

N_2O-N = Emissions from manure management system (kg: *Calculated*)
N = Number of head in herd of consideration (#-head: *Pronaca data*)
NEX = Annual average N excretion per head (kg/animal/year: *Calculated*)
EF_3 = N_2O emission factor for direct emissions from the manure management system (kg N_2O-N/kg N: IPCC)
CF = Conversion factor for N2O-N to N (44/28=1.57)

Step 6 – Calculate nitrous oxide emissions

In order for the nitrous oxide emissions calculated to be expressed as tonnes of carbon dioxide equivalent (ton CO_2e) the following conversion equation must be applied:

$$\mathbf{N_2O\ Emissions_{CO2e} = N_2O\text{-}N_{total} * GWP_{N2O}}$$

Where:

N_2O $emissions_{CO2e}$ = Total direct nitrous oxide emissions (tonnes CO_2e: *Calculated*)
$N_2O\text{-}N_{total}$ = Emission factor for the manure management system in question (kg: *IPCC*)
GWP_{N2O} = Global Warming Potential for nitrous oxide

Step 7 – Calculate the sum of methane and nitrous oxide emissions for the baseline

Total annual baseline GHG emissions, expressed as tonnes of carbon dioxide equivalents (tonnes CO_2e), are determined by summing the total project CH_4 and N_2O emissions using the following equation:

$$\textbf{GHG Emissions}_{(CH4,\ N2O)} = \textbf{CH}_4 \textbf{ emissions} + \textbf{N}_2\textbf{O emissions}$$

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

Option 1 for determining project GHG emissions will be used instead of option 2. Due to a lack of equipment and resources necessary to directly monitor GHG emissions from the project activity, estimation of project GHGs will be done using the calculation methodology described in section D.2.1.2. As such, table D.2.2.1 has been left blank on purpose.

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 *(Please use numbers to ease cross-referencing to table D.3)*	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
Described in section 2.1.2.								

The table above is not applicable

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

>> Not applicable, formulae used to estimate project emissions are found in section D.2.1.2.

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 *(Please use numbers to ease cross-referencing to table D.3)*	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
Not applicable	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*

As there are no potential sources of leakage within the project boundary, no consideration for quantifying leakage from the project is made. Therefore, no detailed information has been provided in Table D.2.3., rather, *Not applicable* has been inserted to denote the lack of data to be collected under the monitoring plan.

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

>>The potential for ammonia, methane and nitrous oxide emissions to be produced during the solid manure storage process does exist when anaerobic conditions occur within the manure windrow. Ammonia emissions may be produced if a proper C:N ratio for the raw manure entering the treatment process is not maintained between 20-30:1. By modifying inputs of raw manure into the solids handling process, if necessary, an efficient aerobic treatment environment will be maintained during solid manure storage and the emissions of methane and nitrous oxide will be kept within levels suggested through estimation using IPCC default values.

The project boundary considers the difference between manure methane emissions from the anaerobic treatment lagoon and the solid manure process only. The nitrogen balance of the proposed project, and potential emissions reductions resulting from improved manure nutrient management, has not been considered at this early stage of project development, but will be considered in future revised protocols. Potential leakage from the project through methane and nitrous oxide loss during the solid manure storage process, are much less than the emissions that would occur during the baseline, anaerobic lagoon treatment, process. Therefore, leakage is considered irrelevant due to the use of conservative IPCC default factors which already consider the emissions of methane and nitrous oxide due to solid storage in the project emission calculations.

CO_2 emissions that result from the solid manure stabilization process are not considered leakage due to the biogenic nature of the materials being used as a bedding material. CO_2 emitted from the process will be offset by the sequestration of CO_2 by rice crops during its growth and development.

The methane conversion and nitrogen emission factors used in determining the GHG emissions associated with the project consider that solid manure is removed from the barn and subsequently stacked in storage. Employing the MCF for solid, stacked manure provides significant conservativeness to account for any of the small emissions of methane and/or nitrous oxide which may be produced during solid manure storage.

Given that:

- Nitrogenous emissions due to barn management or field application of nutrients, are not included within the project boundary, and
- Methane leakage from the solid manure process are small and encompassed within the conservative methane conversion factor employed for project emission calculations, and
- Any CO_2 emitted during the solid manure storage are considered biogenic in nature

It is assumed that any potential leakage from the project has been accounted for in the calculation of project emissions. Based on the rationale provided in the leakage section here, estimates of project leakage are considered unnecessary for the current project.

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.)

Emissions reductions will be achieved through the transformation of the manure management system for the project barns from a system of liquid manure production, collection and treatment in anaerobic lagoons, to the production, collection and treatment of solid manure. As such, IPCC default calculations and coefficients corresponding to manure treatment using a solid manure system are used to calculate project emissions.

The following equation is used to estimate the total GHG emissions reductions achieved through the project activity. The steps and formulae used to estimate the baseline scenario and project GHG emissions are found in sections D.2.1.4 and D.2.1.4, respectively.

Once the baseline and project scenario GHG emissions of methane and nitrous oxide are determined using the procedures found in sections D.1.1.4 and D.2.2.2, the total project emissions reductions is determined by subtracting the total project emissions from the total baseline emissions as follows:

Emission reduction = Baseline emissions – Project emissions

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.
PM-1	*Low*	*QA/QC procedures are established. This data will be used to determine project specific GHG emissions within the project boundary*
PM-2	*Low*	*QA/QC procedures are established. This data will be used to determine project specific GHG emissions within the project boundary*
PM-3	*Low*	*No QA/QC procedures necessary, as this variable was calculated once in the PDD when estimating project emissions, and based on the decision made by the CDM EB in response to the Deviation Request to the Monitoring Plan, the EB has instructed to use the same value for future verification purposes*
PM-4	*Low*	*QA/QC procedures are established. This data will be used to determine project specific GHG emissions within the project boundary*

All data will be kept until at least 2 years after the last CER is issued.

Annex 4

MONITORING PLAN

The monitoring plan for the project again relies heavily on that proposed for use in approved methodology AM0006, entitled *Monitoring Methodology for GHG Reductions Project for On-Farm Animal Waste Management Systems* which follows closely that presented in IPCC Guidelines for National Greenhouse Gas Inventories, revised 1996, Chapter 4.

1. **Brief Description of the methodology**

The monitoring methodology is compatible with a host of project activities which make use of approved baseline methodology *Monitoring Methodology for GHG's Reduction Project for On-Farm Animal Waste Management Systems*

The conditions under which this methodology is applicable to potential projects other than that proposed in the case of Agrosuper, are those in which the following conditions are satisfied:

- The project context is represented by farms operating under a competitive market.
- Baseline and project scenario must act in accordance with the environmental framework of the host country.
- The complete set of possible baseline scenario alternatives that should be considered are those animal waste management systems listed in the IPCC Guidelines (Chapter 4, table 4.8) and the IPCC Good Practice Guidance and Uncertainty Management (Chapter 4, Table 4.11). By following the steps outlined in this methodology, two potential scenarios can be determined, that of the baseline and that of the project. This methodology considers the "most likely economically attractive scenario" to be the baseline scenario as sufficiently demonstrated through the outlined selection process.
- The approach is applicable for estimating emissions from waste treatment systems, in animal populations managed under confined conditions. Barn systems and barn flushing systems are not part of the methodology for which the described methodology calculates emissions reductions.
- This methodology is applicable to most combinations of water management practices at various stages of implementation, excluding discharge into natural water resources.
- This methodology can be applied to components considering anaerobic treatment, with the condition that they fix nitrogen content.
- This methodology is only applicable for livestock species such as cattle, buffalo and swine.

This monitoring methodology describes the procedures for data collection, and auditing required for the project in order to determine and verify emissions reductions achieved by the project compared to the baseline scenario.

The methodology presented is compatible with the baseline methodology Baseline *Methodologies for GHG's Reduction Project for On-Farm Animal Waste Management Systems*

The majority of the calculations used to monitor and calculate project GHG emissions are adopted from IPCC Default algorithms and coefficients. The methodology has been designed to be applicable to any number of manure management alternatives, and in this case will be considered applicable to the use of deep bedded and stacked solid manure management systems. The project boundary considers the GHG emission resulting from the manure management practices only after it has been evacuated from the barn and prior to being applied to cropland as a crop nutrient. The project boundaries consider the emissions from the stacked solid manure only, but do consider both methane and direct nitrous oxide emissions.

Applicability of Default Values

A number of IPCC default coefficients are applicable for use in project GHG emissions calculations when project specific data for volatile solids and nitrogen excretion are not available. Details of these coefficients are provided here:

Volatile Solids (VS) – When it is not possible to establish project specific values for volatile solids excretion, the IPCC default values offered in IPCC Guidelines Reference Manual (Tables B1-B7) can be used instead. These factors were developed under conditions of average feed intake and energy digestibility and are considered accurate enough for the purposes of calculating VS output. Project specific data on feed intake and animal digestibility are used wherever possible in VS equations to further increase the accuracy of calculations

Nitrogen excretion (NEX) – It is possible, through mass balance calculations, to determine project specific nitrogen excretion values. In the case that these calculations cannot be completed due to inaccurate or lack of data, IPCC coefficients for nitrogen excretion are considered appropriate for use in project emissions calculations.

Maximum methane production potential (Bo) – It is most often the case the project specific values of Bo are not available for use in project based GHG emissions calculations. This is due to the difficulty in collection, analysis and interpretation of data appropriate to determine project specific Bo values. Bo values are therefore taken from Appendix B of the IPCC Guidelines Reference Manual. In order to maintain conservativeness is calculations using default values, when developing country Bo values are close to those of developing countries, the developed country coefficients will be used.

Methane conversion factor (MCF) – MCF is another variable which is exceedingly difficult to obtain from production specific data. As such, two sources of MCF coefficients can be relied upon for MCF values corresponding to the manure management system in question. These sources are IPCC Guidelines for different manure management systems and Climate Zones (Table 4-8) and the IPCC Good Practice and Guidance Document (Tables 4.10 and Table 4.11)

The following decision tree can be used to determine whether project specific or IPCC default values should be used to calculate project emissions.

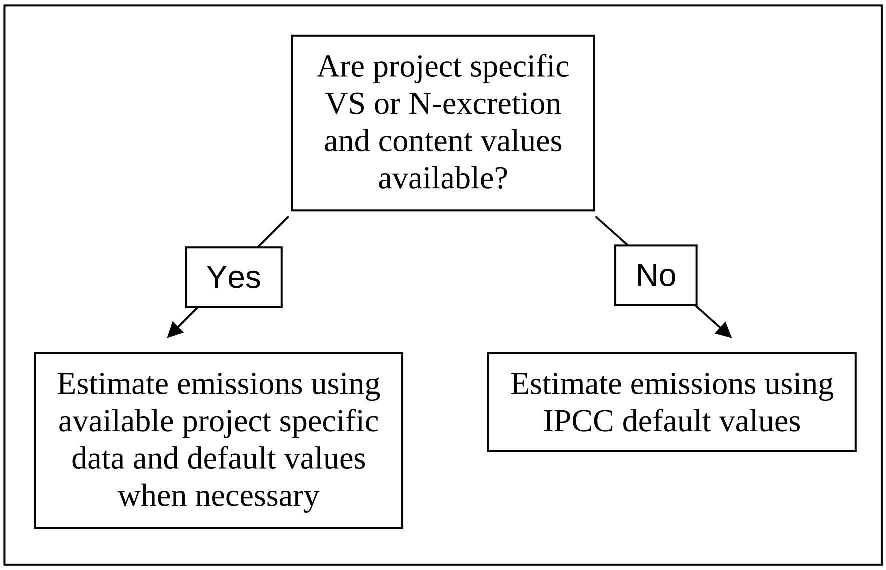

Figure A4-1 Decision tree for determination of appropriate coefficient sources

2. Information on data collection and archiving procedures

The following table outlines the data to be collected for the purposes of monitoring project specific GHG emissions, details of these coefficients and the method that will be employed for archiving this data.

Table A4-1 Data to be collected, data detail and archiving procedures

ID number *(Please use numbers to ease cross-referencing to table D.3)*	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
PM-1	*Swine stock*	*Production data*	*# head*	*M*	*Weekly*	*100%*	*Electronic/paper*	*Swine herd inventories will be tracked weekly to account for herd inventory adjustments due to emptying, re-filling of rearing facilities and number of deceased animals*
PM-2	*Animal weight*	*Production data*	*kg*	*m, c*	*Monthly*	*100%*	*Electronic/paper*	*Based on the average weight of animals entering and leaving the rearing facilities, and the average daily weight gain, based on known growth rates, average animal weights can be actively calculated*
PM-3	*Vs*	*Default Value*	*Kg/day*	*C*	*Once in the crediting period, as calculated in the PDD*		*Electronic/paper*	*As per the CDM Executive Board's instructions and based on the decision made by the EB in response to the Deviation Request to the Monitoring Plan submitted by TUV-SUD prior to the first verification, the Vs value to be used is the one used in the estimation of project emissions as indicated in the PDD*
PM-4	*Rice husk added to the manure*	*Truck loads*	*Cubic metres*	*M*	*Yearly*	*100%*	*Electronic/paper*	*The amount of rice husk will be monitored by keeping a log of the amount loaded in the trucks*

3. Potential sources of emissions which are significantly and reasonable attributed to the project activity but which are not include in the project boundary, and identification of how data will be collected and archived on these emission sources.

No appreciable GHG emissions from the project are considered as potential leakage outside of the project boundary. The project boundary has been constructed to include the use of a deep bedded swine production system, as opposed to the traditional liquid manure/anaerobic lagoon system, and the GHG emissions which result from the storage of this solid manure only. The emission calculations described in the monitoring methodology for the project activity consider the methane and direct nitrous oxide, which can be attributed to the stack storage of solid manures.

The potential for additional GHG production does exist if further processing of the manure solids, or land application of the manure as a crop nutrient source are considered. As neither additional treatment nor land application of the stacked solid manure are considered within the project boundary, no additional monitoring procedures are necessary to quantify these emissions.

4. Assumptions used in elaborating the project monitoring methodology

Project case volatile solids (VS) production

The primary source of methane emissions from swine manure management systems is the degradation of excreted manure solids under anaerobic conditions. The average animal weight and the associated feed conversion efficiencies of animal class, coupled with the average feed intake of the animal class were used to determine the amount of volatile solids excretion. The calculation has considered the use of IPCC default coefficients as applicable to the mentoring methodology considering the difficulties which exist in collecting project specific values for VS excretion. Project specific data is used for animal weights and feed intake, in conjunction with IPCC coefficients to develop the most accurate project emissions estimations possible. As per the decision made by the CDM Executive Board in response to the Deviation Request to the Monitoring submitted by TUV-SUD prior to the first verification, the Vs value to be used for verification purposes is that calculated in the PDD.

Project case manure excretion

Direct nitrous oxide emissions during the storage of stacked solid manure are a source of GHG emissions considered with the project boundaries. IPCC coefficients are used to estimate the total nitrogen excretion per animal considered within the project boundaries. The total nitrogen excretion values are subjected again to IPCC default calculations to determine the total amount of nitrous oxide emissions that can be expected from the project manure treatment process.

5. Indicate whether quality control (QC) and quality assurance (QA) procedures are undertaken for the items monitored

Quality control and assurance procedures will be undertaken to ensure that any data collected is sufficiently accurate for the purposes of calculating project GHG emissions within the project boundary.

The following table suggests the QA/QC procedures which will be carried out on measured project data:

Table A4-2 Quality Assurance and Quality Control Data Archiving

Data Identification	Data variable	Uncertainty level of data variable	QA/QC procedures planned?	Outline explanation why QA/QC procedures are or are not being planned
PM-1	*Swine stock*	*Low*	*Yes*	*QA/QC procedures are established. This data will be used to determine project specific GHG emissions within the project boundary*
PM-2	*Animal weight*	*Low*	*Yes*	*QA/QC procedures are established. This data will be used to determine project specific GHG emissions within the project boundary*
PM-3	*Vs*	*Low*	*No Applicable*	*No QA/QC procedures necessary, as this variable was calculated once in the PDD when estimating project emissions, and based on the decision made by the CDM EB in response to the Deviation Request to the Monitoring Plan, the EB has instructed to use the same value for future verification purposes*
PM-4	*Rice husk added to the manure*	*Low*	*Yes*	*QA/QC procedures are established. This data will be used to determine project specific GHG emissions within the project boundary*

6. What are the potential strengths and weaknesses of this methodology?

The relative simplicity of the monitoring methodology is certainly considered a strength to the approach.

The methodology allows for significant flexibility in the use of project specific data, where possible, or IPCC coefficients in the case that project specific data is not available. Where project specific data is not available, IPCC coefficients can still be applied with acceptable level of uncertainty to calculate project GHG emissions.

7. Has the methodology been applied successfully elsewhere, and, if so, in which circumstances?

Similar methodologies have been applied in the case of Agrosuper and Granja Becker GHG mitigation projects in Chile and Brazil, respectively. These methodologies have been largely studied and used to construct this current methodology. Both of these project cases have involved the use of anaerobic digestion technology as a GHG mitigation technique, as opposed to the deep bedding solid manure management used in this project case. Although this project varies considerably in the method of manure management planned to provide GHG emissions reductions, compared to these other two project cases, the monitoring methodologies involved in the characterization of raw manures is similar. These methodologies were also constructed to allow for their applicability under a wide range of manure management practices. Therefore, the methodology presented here is largely similar to other approved manure management methodologies, which have been applied under similar conditions including baseline practices.