METHODOLOGY TO REDUCE ENTERIC METHANE EMISSIONS IN BEEF CATTLE USING ORGANIC OR NATURAL FEED SUPPLEMENTS

Title	Methodology to reduce enteric methane emissions in beef cattle using organic or natural feed supplements
Version	V02
Date of Issue	1 December 2015
Type	Methodology
Sectoral Scope	15. Livestock and manure management
Prepared By	MGM Innova Brasil Consultoria Ltda
Contact	Rua Diogo Jácome, 95 Cj. 2703 Cep:04512-001 São Paulo – SP – Brazil sapolinario@mgminnova.com +55 11 2385-3590

Relationship to Approved or Pending Methodologies

Beef cattle release methane (CH_4) as a result of the digestion of feed materials in the rumen. These emissions are called enteric emissions. Methane and nitrous oxide (N_2O) are also emitted from manure storage and handling associated with beef cattle operations. The proposed methodology seeks to reduce these GHG emissions from both enteric fermentation and manure handling by reducing the number of days on feed for beef cattle, using a feed supplement. *The methodology is limited to cattle that are mainly range fed or semi-confined. The methodology excludes feedlots*.

Approved and pending methodologies under the VCS and approved GHG programs, that fall under the same sectoral scope, were reviewed to determine whether an existing methodology could be reasonably revised to meet the objective of this proposed methodology. Some 15 methodologies were identified, and are set out in Table 1 below.

Table 1: Similar Methodologies

Methodology	Title	GHG Program	Comments
AMS - III. BK	Strategic feed supplementation in smallholder dairy sector to increase productivity	CDM	Approved.
SSC-NM085	Strategic Supplementation of a Large Ruminant Dairy Sector for the Reduction of Methane	CDM	Submission not approved
SSC-NM094	Strategic supplementation of a small holder dairy sector to increase productivity and reduce methane emissions	CDM	Submission approved as AMS-III.BK
NM0260	Uganda Cattle Feed Project (UCFP)	CDM	Submission not approved
Large Scale methodology submission, no number assigned	Strategic supplementation of a large ruminant dairy sector for the reduction of methane	CDM	Submission rated 2. No further consideration
VCS module VMD0027	Estimation of domesticated animal populations	VCS.	Approved
VCS module VMD0028	Estimation of emissions from domesticated animals	VCS	Approved
	Reducing GHG emissions by feeding nitrates to beef cattle	CFI	Approved

	Reducing GHG emissions by feeding dietary additives to milking cows	CFI	Approved
	Reduced Carbon Intensity of Fed Cattle	ACR	In peer review
	Grazing Land and Livestock Management	ACR	Approved
	Quantification protocol for emission reductions from dairy cattle	Alberta	Protocol
	Quantification protocol for reducing the age at harvest of beef cattle	Alberta	Protocol
	Quantification protocol for reducing days on feed for beef cattle	Alberta	Protocol

The project proponent would be the manufacturer of feed supplements that reduce cattle fattening time. The manufacturer is the project proponent, since individual purchasers are unlikely to have sufficient scale for a viable VCS carbon credit project. The emissions reduction would take place at the sites where the feed supplement is used, not at the manufacturer's plant. This reduction thus refers to what is called "Downstream Scope 3 emissions". There are a few precedents for carbon credits to be issued for Downstream Scope 3 emissions reduction. See Appendix A for a brief review.

Carbon market methodologies (including the VCS) and protocols generally cover procedures for establishing the baseline scenario and additionality, for monitoring emissions reduction, and include other conditions. There are more limited procedures, which cover some aspects. In the case of the VCS, these are called Modules. There are no VCS methodologies covering the proposed project activity. Nor are there approved CDM (Clean Development Mechanism) methodologies or CAR (Climate Action Reserve) Protocols, which are recognized by the VCS.

However, there are two VCS Modules that are potentially relevant:

VMD0027 Estimation of domesticated animal populations

VMD0028 Estimation of emissions from domesticated animals

In each case, the Module allows certain calculations to be possible.

VMD0027 is described as (VCS, 2012a):

"The module provides methods for estimating domesticated animal populations on an average annual basis, broken down by type of animal, as well as the manure management systems associated with each population."

The Procedures for this module states:

"Project proponents must gather data on two basic variables: livestock populations by type, and manure management system."

In this case, there is one type of livestock population—beef cattle. The module requires the livestock population to be classified by annual average temperature: <15C (cool), 15-25C (temperate) and >25C (warm), since temperature affects manure emissions. The module also includes a list of manure management options. Since the project covers range-fed and semi-confined cattle, the range of manure management options are limited.

The summary description for VMD0028 states (VCS, 2012b):

*"The module provides methods for estimating the emissions of CH_4 and N_2O both from domesticated animals directly, and from emissions due to the decomposition of manure. Estimates for domesticated animal populations and associated manure management systems are determined using **VMD0027 Estimation of Domesticated Animal Populations**."*

Module VMD0028 includes four steps:

Step 1: Estimation of CH_4 emissions from enteric fermentation ($E_{l,CH4,ferm}$).

Step 2: Estimation of CH_4 emissions from manure management ($E_{l,CH4,manure}$)

Step 3: Estimation of N_2O emissions from manure management ($E_{l,N2O,manure}$) 4

Step 4: Summation of emissions.

The Steps in VCS Module 28 provide *annual* emissions from cattle, using default values for emissions factors, based on IPCC (2006, vol. 4, Chapter 10). The project activity would reduce the number of days needed for cattle growth. Thus, what is needed are emissions *over the entire growth cycle*, with the number of days as a parameter. Therefore, the procedure specified in this VCS Module cannot be used as specified.

In summary, the two VCS Modules are not directly applicable to the proposed project activity.

Similar in purpose to the VCS Modules are several "Quantification Protocols" approved by the Alberta Offset System:

- Quantification protocol for emission reductions from dairy cattle
- Quantification protocol for reducing the age at harvest of beef cattle
- Quantification protocol for reducing days on feed for beef cattle

These protocols provide detailed quantification procedures of which the last one listed (Quantification protocol for reducing days on feed for beef cattle) is most relevant to the proposed project activity. However, the Protocol is applicable only to feedlot cattle, so it needs to be adapted for cattle that are range fed and semi-confined.

Other relevant methodologies and protocols exist from the American Carbon Registry (ACR) and the Carbon Farming Initiative (Australia). Table 1 summarized all methodologies and measurement protocols in carbon markets. None are applicable to the proposed project activity.

In summary, there are no VCS or other methodologies, modules or protocols that can be directly applied to the project activity. However, the Alberta "Quantification protocol for reducing days on feed for beef cattle" can be adapted into a proposed VCS methodology.

Table of Contents

1 SOURCES

This methodology is based on the following "Quantification Protocol" approved by the Alberta Offset System:

- Quantification protocol for reducing days on feed for beef cattle

This methodology takes into account the latest versions of the following VCS modules:

- VMD0027: Estimation of domesticated animal populations
- VMD0028: Estimation of emissions from domesticated animals

The basis for determining emissions from enteric fermentation and animal manure is provided in the *2006 IPCC Guidelines for National GHG Inventories*. Of special relevance is Volume 4: Agriculture, Forestry and Other Land Use, Chapter 10: Emissions from livestock and manure management.

2 SUMMARY DESCRIPTION OF THE METHODOLOGY

The proposed project activity comprises the manufacture and use of any feed enriched with supplement certified for organic use or 100% natural (no antibiotics) use that reduces the beef cattle fattening time, thereby reducing methane emissions both from enteric fermentation as well as from animal manure. The reduced number of days of feeding should be demonstrated through monitored data on the number of days in pasture while maintaining or improving feed efficiency, carcass weight and lean meat yield. The proposed methodology is intended for production systems that are based on range-fed cattle, and semi-confined cattle; it is not applicable for feedlot raised cattle. The methodology proponent is PREMIX, a Brazilian company.

Additionality and Crediting Method	
Additionality	Standardized Method, using the Activity Penetration Option, as defined in VCS (2013, p. 12).
Crediting Baseline	Historic situation, prior to project implementation

3 DEFINITIONS

Animal groupings
Specific groupings of cattle at a cattle rancher, depending on the start date for entering the feeding regime affected by the feed supplement.

Concentrates
A broad classification of feedstuffs which are high in energy and low in crude fibre (<18 per cent crude fibre). This can include grains and protein supplements, but excludes feedstuffs like hay or silage or other roughage.

Diet
Feed ingredients or mixture of ingredients, including water, which is consumed by animals (Ensminger and Olentine (1980). It includes the amount of and composition for feed supplied to an animal for a defined period of time.

Edible oils

Are oils derived from plants that are composed primarily of triglycerides. Although many different parts of plants may yield oil, in commercial practice oil is extracted primarily from the seeds of oilseed plants. Whole seeds can be applied as a feed ingredient so long as the oil content is calculated on a dry matter basis to achieve the 4 to 6 per cent content in the diet.

Enteric emissions

Emissions of methane (CH_4) from the cattle as part of the digestion of the feed materials.

Feeding cycle

The combination of diets fed to animals over a set period of time. This is then repeated for a similar grouping of animals.

Feeding regimes

The whole system of diets fed to animals over the baseline/project period.

4 APPLICABILITY CONDITIONS

This methodology applies to project activities that reduce methane emissions from enteric fermentation by reducing the number of days on feed for beef cattle through the use of a feed supplement that is certified for organic use or 100% natural (no antibiotics) use.

This methodology is applicable under the following conditions[1]:

- Beef cattle is range fed or semi-confined;
- Any feed supplement should generally comprises the following main components: essential oils such as linoleic acid, oleic acid, linolenic acid; sea weed; live yeast; natural methionine; natural lysine; wall yeast (mannan oligo saccarides); chrome yeast or organic chrome; phosphatidyl choline / lecithin.
- Any food supplement to be used in the project activity should not contain antibiotics, ionophores, or β-agonists. This condition is needed since the methodology applies an activity penetration approach to demonstrate additionality;
- A recognized national or international institution should guarantee that any feed supplement or premixed feed to be used does not contain genetically modified organisms (GMO), and is suitable for organic or natural livestock;
- The number of days for growth using the feed (project scenario) should be based on monitored data and detailed records for animal groups entering and leaving each feeding regime and growth stage;
- The number of days for growth in the baseline should be determined from data from reliable, independent data sources.

[1] Items in blue are taken from the Alberta Protocol (Government of Alberta, 2011), Some conditions in the Protocol are specific to Canada and have been modified or eliminated.

This methodology is *not* applicable under the following conditions:

- The cattle is feedlot raised.
- The feed supplement contains genetically modified organisms (GMO); this condition is needed since the methodology applies an activity penetration approach to demonstrate additionality;

5 PROJECT BOUNDARY

The project comprises the use of feed supplements used by different cattle ranchers. Given that the cattle ranchers are located in different places, the project boundary includes a set of geographical locations where the ranchers operate. For each location, the boundary includes the space where the animals move about, including where they are given feed, including the supplements during the project activity.

For each cattle rancher included in the VPA, include geographical coordinates of on-site reference location (e.g. offices, see table below) and an approximate boundary where animals are raised, including grazing and feeding areas (e.g. indicated on www.googlemaps.com).

Table 2. The geographical boundary of cattle ranchers whose animals are included in each VPA

	Coordinates of rancher main location on site (e.g. offices)	
Cattle rancher name	Latitude	Longitude
	xx° xx' xx" S	xx° xx' xx" W

Include maps for each cattle rancher in an Annex to the Project document.

For each cattle rancher, animals included in the VPA would be identified by ear tags or other similar means. A set of animals would start taking the feed supplement on a certain date and stop taking it on another certain date, e.g. animal leaves ranch. This information would not be available when the project is submitted for validation, but would be a part of the monitoring. Thus the geographic project boundary would be known when the project is submitted but specific information on animals included would be collected during monitoring and available for verification.

The greenhouse gases relevant to the project are ruminant methane emissions as well as methane and nitrous oxide emissions from manure.

The project boundary does not include other upstream or downstream activities associated with cattle raising, since emissions from these sources are not affected by the project activity. There would be some small additional upstream emissions in feed supplement manufacture and transport, which are considered negligible in this methodology. See Appendix B for details.

The greenhouse gases included in or excluded from the project boundary are shown in Table 2 below.

Table 2: GHG Sources Included In or Excluded From the Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Source 1: ruminant methane	CO_2	No	This gas is not relevant for ruminant methane
		CH_4	Yes	Only GHG from ruminant methane.
		N_2O	No	Not emitted in ruminant methane
		Other	No	No other GHGs are involved
	Source 2: animal manure handling	CO_2	No	Any CO_2 emissions in manure handling is biogenic
		CH_4	Yes	Emitted in manure handling
		N_2O	Yes	Emitted in manure handling
		Other	No	No other GHGs are involved
Project	Source 1: ruminant methane	CO_2	No	This gas is not relevant for ruminant methane
		CH_4	Yes	Only GHG from ruminant methane.
		N_2O	No	Not emitted in ruminant methane
		Other	No	No other GHGs are involved
	Source 2: animal manure handling	CO_2	No	Any CO_2 emissions in manure handling is biogenic
		CH_4	Yes	Emitted in manure handling
		N_2O	Yes	Emitted in manure handling
		Other	No	No other GHGs are involved

6 BASELINE SCENARIO

The baseline scenario is a typical feeding regime without high level concentrate supplement. It is the time period required to complete a finishing diet regimen, i.e. the number of days on feed required to bring cattle to market. It is determined from data on growth days from reliable, independent sources. This is a control-group (rather than a historical) approach to determine the baseline.

7 ADDITIONALITY

This methodology uses an activity method for the demonstration of additionality.

Step 1: Regulatory Surplus

Project proponents must demonstrate regulatory surplus in accordance with the rules and requirements regarding regulatory surplus set out in the latest version of the *VCS Standard*. These are set out in Sec. 4.6.3 of VCS Standard v3.4. Additionality is based on a Positive List (see Step 2 below), where a project would be additional until a certain % penetration is achieved in the market in question. Since the penetration is below this threshold level for additionality, it is clear that regulations do not require the project activity, since otherwise it would already be in place. In any case, to meet the condition for regulatory surplus, project proponent should show that laws and regulations do not require the feed supplement in the geographical area covered by the VPA.

Step 2: Positive List

The applicability conditions of this methodology represent the positive list. The project must demonstrate that it meets all of the applicability conditions, and in so doing, it is deemed as complying with the positive list.

The positive list was established using the activity penetration option in the *VCS Standard,* specifically, Guidance for Standardized Methods (VCS, 2013).

The proposed project activity comprises the manufacture and use of feed enriched with supplement suitable for organic or natural beef cattle, as indicated above in Sec. 4: Applicability conditions. Such feed supplements have been commercially available for at least a decade. Yet the market penetration is extremely low. This is likely because the product is more expensive, and potential purchasers have not seen the benefits from its use.

Thus, clearly there are barriers present, in terms of higher first cost, together with a lack of awareness and confidence in the potential benefits. Thus demonstrating additionality on a project-by-project basis would be onerous, since all potential users face the same barriers.

As noted in the VCS Guidance for Standardized Methods (VCS, 2013, p. 11):

> *"The carbon markets can have other interventions besides the GHG credit price signal. For example, the success of GHG projects can lead to greater awareness of the types of technologies used by successful projects."*

For this reason, we propose a Standardized Method approach to project design, using the Activity Penetration Option, as defined in the VCS Guidance, which further states (VCS, 2013, p. 12):

"The activity penetration option needs to be carefully specified. The term activity penetration is chosen because it is referring to the level of penetration of the specific project activity (eg, solar systems up to 100W capacity and installed in off-grid households in Southern Africa)."

The activity penetration needs to be specified within a geographical scope. The proposed methodology is intended for use in Brazil. In future versions it could be extended to other geographical regions.

Projects using the Standardized Method would be additional until the sale of the feed supplements meeting the conditions specified for the project activity reaches 5% of the total market for feed supplements in Brazil. As indicated in the VCS Guidance (VCS, 2013, p. 13):

> *"Five percent is chosen as a sufficiently conservative threshold and also follows what is considered a useful precedent established under the CDM.*
>
> *"Note that if the level of activity penetration is significantly lower than the five percent threshold value, it may be possible to make conservative assumptions in calculating the level, thus reducing the data requirement and cost of data collection (ie, if the real world level is low, it will be possible to demonstrate that the level is lower than five percent even if conservative assumptions are used in calculating the level)."*

Current use is considerably below 5%, as shown in Appendix D. Hence monitoring procedure is simple, based on. Statistics on total sales of feed supplements (TSFS) and sales of feed supplements qualifying under methodology requirements (TSQFS). The evaluation would be made every five years to ensure continued validity of additionality.

There are many potential purchasers of the feed supplement, each with their herd of cattle. Under the VCS Standardized Method, individual projects would comprise sets of purchasers of the feed supplement. Individual projects would qualify until the sales of the feed supplement reaches 5% of the market for feed supplements in Brazil. Project inclusion would be subject to approval by a Validation / Verification Body, as per VCS requirements.

8 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

[Note: the format for this section is different from that specified in the VCS form. It is necessary because of the procedure involved.]

The proposed methodology considers only emissions reduction from enteric fermentation. There are also emissions reduction from manure storage, handling, and land disposal. These are ignored here. This is conservative, since the reduced days of growth with the feed supplement in the project activity also means that there will also be less manure and therefore less manure emissions. This emissions reduction is neglected here.

The enteric emissions are given by an equation, equally applicable to the baseline and project activity, where many of the parameters are the same in the baseline and project[2]:

$$CEM = \Sigma\ [NP * DOF * DMI * GE\ Diet * (EF_{Enteric} / 100\%) / EC_{Methane}] \quad (1)$$

Where:

Parameter	Definition and units	Same in baseline and project
CEM	Cattle enteric methane emissions kg CH_4/ feeding period	No
NP	Number of head in each animal grouping	Yes
DOF	Days on Feed Number of days that the animal grouping is being fed in the baseline or project.	No
DMI	Dry Matter Intake. Kilograms per day	Yes
GE Diet	Gross Energy Content of Diet. MJ per kg of dry matter fed to each head	Yes
$EF_{Enteric}$	Enteric Emissions Factor. Percentage, that depends on the concentration of oils/fats in diet	Yes
$EC_{Methane}$	Methane Energy Content. MJ/kg of solids (constant)	Yes

As noted in the right column above, only the parameter "DOF" changes in the baseline and the project, and therefore determines cattle enteric emissions reduction.

Each project involves a number of cattle ranchers. Moreover, each cattle rancher raises many animals over time. Each animal is identified by an ear tag or other similar means; the animals may be grouped by date at which the group entered the feed regime affected by the supplement. Therefore, the accounting of emissions reduction needs to be segmented, considering the following parameters:

i	=	Identification of cattle rancher
j	=	Animal grouping, where each group has a certain start date for entering the feeding regime

Unlike most carbon credit projects where carbon credits are determined annually, in this case, the summation is for a set of cattle ranchers and a set of animal groupings, over the period that these animals go through feeding regime and are sent to the market.

Reduction in enteric emissions is based on Eq. (1) and is given by:

$$\sum_{i=1}^{N} \sum_{j=1}^{M_i} ER_{i,j} = CEM_{\ Proj}(\text{i, j}) - CEM_{\ BL}(\text{i, j}) \quad (2)$$

Where:

$CEM_{\ Proj}(\text{i, j})$ = Project enteric methane emissions from animal grouping "j" of cattle rancher "i" (tCO_2e)

$CEM_{\ BL}(\text{i, j})$ = Baseline enteric methane emissions from animal grouping "j" of cattle rancher *"i"*

[2] Equation (1) of the Alberta Protocol (Government of Alberta, 2011):

		(tCO_2e)
i	=	Cattle rancher, there are N in total (see table below)
j	=	Animal grouping for each cattle ranchers, from 1 to M_i, where there are "M_i" animal groupings for rancher *"i"* (see table below)

Table 3. Cattle rancher and animal groupings, schematic

	Animal groupings							
Cattle rancher 1	1	2	3	…		M_1		
Cattle rancher 2	1	2	3	…				M_2
Cattle rancher 3	1	2	3	…			M_3	
…								
Cattle rancher N	1	2	3	…		M_N		

Considering Eq. (1), Eq. (2) can be expressed as:

$$\sum_{i=1}^{N}\sum_{j=1}^{M_i} ER_{i,j} = NP(\mathbf{i},\mathbf{j}) \times \left(DOF_{BL}(i,j) - DOF_{Proj}(i,j)\right) \times DMI \times GE\ Diet \times \frac{EF_{Enteric}}{100\%} / EC_{Methane} \quad (3)$$

Below we consider the specifics for the determination of DOF, which is the only parameter relevant, for the baseline and project cases, so that emissions reduction can be determined.

8.1 Baseline days on feed (DOF_{BL})

The project feed supplement is marketed to a number of cattle ranchers, and historical data from these ranchers may not be available. Therefore, the baseline is a *control group* of animals fed with other diets. It is a static historic approach where baseline days on feed is held constant.

Annual, independent statistical data sources should be used for the determination of DOF_{BL}. An example is given in Appendix C. Since the value is an industry average, *DOF_{BL}(i, j) does not depend* on the parameters "i" and "j", and is a constant for each Project.

8.2 Project days on feed (DOF_{Proj})

Project activity would be monitored so that DOF_{Proj} (i, j) would be determined in terms of each cattle rancher (i) and for animal groups (j) for each rancher.

8.3 Leakage

No leakage emissions are expected for this project activity.

8.4 Net GHG Emission Reduction and Removals

Net GHG emission reductions and removals are calculated as follows:

$$\sum_{i=1}^{N}\sum_{j=1}^{M_i} ER_{i,j} = NP(\mathbf{i},\mathbf{j}) \times \left(DOF_{BL} - DOF_{Proj}(i,j)\right) \times DMI \times GE\ Diet \times \frac{EF_{Enteric}}{100\%} / EC_{Methane} \qquad (4)$$

Which is identical to Eq. (3), considering that DOF_{BL} is a constant, and that leakage emissions are zero.

Unlike most carbon credit projects where emission reductions (ER) are computed annually, in this case, the ERs are determined for the full growth period for each “i” and “j”.

The process is in Table 4 below illustrates a schematic timeline showing different animal groups entering and finishing the growth cycle, for a set of cattle ranchers. Each animal group contains a list of tagged animals

Start date: The start date of each project will be the day the first set of tagged animals included in the VPA starts the regime including the project feed supplement. This would be Day 1 in the schematic shown below.

End date: The end date of the project will be set to be the last date on which a set of animals included finishes the growth cycle. This would be Day 927 in the schematic shown below.

Emissions reduction of the project would be determined considering all animals starting on or after the start date and finishing the growth on or before the end date.

A single emissions reduction can be claimed for each project.

Table 4. For each cattle rancher, different animal groups (AG) start and end growth days differ, as illustrated below.

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8			Day 920	Day 921	Day 922	Day 923	Day 924	Day 925	Day 926	Day 927
Cattle rancher 1																		
	AG 1 start									AG 1 end								
		AG2																
				AG 3														
						AG 4												
								AG 8										
Cattle rancher 2																		
		AG 1																
					AG 2													
Cattle rancher 3																		
			AG 1															
						AG 2												
...																		
Cattle rancher N																		

9 MONITORING

9.1 Data and Parameters Available at Validation

Data / Parameter	DMI
Data unit	kg/day
Description	Dry matter intake
Equations	None
Source of data	
Value applied	7.48
Justification of choice of data or description of measurement methods and procedures applied	Based on the following assumptions: 2.2% weight gain per day. Initial weight 180 kg; final weight 500 kg; average weight 340 kg. 2.2% x 340 kg = 7.48
Purpose of Data	Calculation of baseline and project emissions and emissions reduction
Comments	The same value is used for baseline and project emissions, so no bias is introduced from value assumed.

Data / Parameter	GE Diet
Data unit	MJ/kg of dry matter
Description	Gross Energy Content of Diet
Equations	None
Source of data	Alberta Quantification protocol for reducing days on feed for beef cattle, p. 37
Value applied	18.5
Justification of choice of data or description of measurement methods and procedures applied	The cited Alberta Protocol states: "*This is a default factor, depending on the concentration of edible oils:/fats:* ☐ *Use 19.10 MJ per kg of dry matter feed if the edible oil concentration is between 4.0 and 6.0 per cent.* ☐ *Use 18.5 MJ per kg of dry matter fed to each head if the edible oil/fat concentration is less than 4 per cent.*" Since cattle projects using this methodology are range fed, the lower value (poorer diet) is assumed here.
Purpose of Data	Calculation of baseline and project emissions and emissions reduction
Comments	The same value is used for baseline and project emissions, so no bias is introduced from value assumed.

Data / Parameter	$EF_{Enteric}$
Data unit	Percentage
Description	Enteric Emissions Factor
Equations	None
Source of data	Alberta Quantification protocol for reducing days on feed for beef cattle, p. 37
Value applied	5.2%
Justification of choice of data or description of measurement methods and procedures applied	The cited Alberta Protocol states: "*A default factor, depending on level of concentrates in the diet and edible oil/fat content:* □ *Use 3.2 per cent for diets with* □*85 per cent concentrates and edible oils/fats as per above; and,* □ *Use 5.2 per cent for diets with less than 85 per cent concentrates and edible oils/fats as per above*." Since cattle projects using this methodology are range fed, the higher value (poorer diet) is assumed here.
Purpose of Data	Calculation of baseline and project emissions and emissions reduction
Comments	The same value is used for baseline and project emissions, so no bias is introduced from value assumed.

Data / Parameter	$EC_{Methane}$
Data unit	MJ/kg of solids
Description	Methane Energy Content
Equations	None
Source of data	The value is taken from Alberta Quantification protocol for reducing days on feed for beef cattle, p. 37
Value applied	55.65
Justification of choice of data or description of measurement methods and procedures applied	This is a standard property of methane.
Purpose of Data	Calculation of baseline and project emissions and emissions reduction
Comments	None

9.2 Data and Parameters Monitored

Data / Parameter:	NP (i,j)
Data unit:	Number (dimensionless)
Description:	Number of head in each animal grouping “j” for each cattle rancher “i”
Equations	None
Source of data:	Data records of cattle ranchers using project feed supplement
Description of measurement methods and procedures to be applied:	None
Frequency of monitoring/recording:	Single value depending on number of animals *finishing* growth regime using feed supplement. Number of animals *entering* growth regime should also be recorded.
QA/QC procedures to be applied:	Management and quality control system to be established by feed supplement supplier to cattle rancher at the start of project. It could include data recording and verification procedures. For example, the number of animals finishing growth regime should be equal to or less than number of animals starting growth regime.
Purpose of data:	Calculation of baseline emissions and emissions reduction
Calculation method:	No calculations are needed.
Comments:	Monitoring is established at the feed purchaser level. An appropriate and unique identification system for the purchasers, e.g. Client name, tax identification number, location of animals on a map, unique invoice number and date, etc. would avoid double counting of emissions reduction claimed. This could be supported by a management and quality control system.

Data / Parameter:	DOF_{BL}
Data unit:	Days
Description:	Period for growth in baseline (from independent data)
Equations	None
Source of data:	National statistics
Description of measurement methods	Annual, independent data sources should be used. An example is given in Appendix C. The parameter AB gives the time to

and procedures to be applied:	slaughter in months. There are small variations by state and type of cattle. A typical value is 36 months, which is equivalent to 1095 days which would be the value here.
Frequency of monitoring/recording:	Single value for each project, based on most recent statistics available.
QA/QC procedures to be applied:	None
Purpose of data:	Calculation of baseline emissions and emissions reduction
Calculation method:	No calculations are needed.
Comments:	The value can be made specific to the region or other parameter, as suggested by the example in Appendix C.

Data / Parameter:	DOF_{Proj} (i,j)
Data unit:	Days
Description:	This is the number of growth days needed for animals in grouping “j”, belonging to cattle rancher “I” being fed feed supplement.
Equations	None (only data records of start and end dates for each animal group)
Source of data:	Data records of cattle rancher using project feed supplement
Description of measurement methods and procedures to be applied:	None
Frequency of monitoring/recording:	Once for start date and once for end date, for each animal grouping
QA/QC procedures to be applied:	None
Purpose of data:	Calculation of project emissions and emissions reduction
Calculation method:	None
Comments:	None

Data / Parameter:	TSFS
Data unit:	tonnes
Description:	Total sales of feed supplements in Brazil for the most recent year with data available
Equations	None
Source of data:	1. Government of Brazil; or

	2. Extrapolation of data from ASBRAM (Brazilian Association of Mineral Supplement Producers)
Description of measurement methods and procedures to be applied:	None (official data sources)
Frequency of monitoring/recording:	Every five years
QA/QC procedures to be applied:	None
Purpose of data:	For establishing additionality using activity penetration level
Calculation method:	None
Comments:	None

Data / Parameter:	TSQFS
Data unit:	tonnes
Description:	Total sales of qualified feed supplements, i.e. qualifying under the methodology in Brazil for the most recent year with data available (same year as the previous parameter)
Equations	None
Source of data:	1. Audited annual reports of producing companies (preferable); or 2. Government agencies; or 3. Industry organizations (e.g. ASBRAM) presenting statistics.
Description of measurement methods and procedures to be applied:	None, reliable data sources.
Frequency of monitoring/recording:	Every five years
QA/QC procedures to be applied:	None
Purpose of data:	For establishing additionality using activity penetration level
Calculation method:	None
Comments:	None

9.3 Description of the Monitoring Plan

There are very few monitoring parameters involved as listed above in Sec. 9.2. No additional procedure is needed.

10 REFERENCES

Government of Alberta, 2011. Quantification Protocol for reducing days on feed for beef cattle. Version 2, July 2011. Climate Change Secretariat, Alberta Environment, Edmonton, Alberta.

Hristov, A.N., Oh, J., Lee, C., Meinen, R., Montes, F., Ott, T., Firkins, J., Rotz, A., Dell, C., Adesogan, A., Yang, W., Tricarico, J., Kebreab, E., Waghorn, G., Dijkstra, J. & Oosting, S. 2013. "Mitigation of greenhouse gas emissions in livestock production – A review of technical options for non-CO_2 emissions". Edited by Pierre J. Gerber, Benjamin Henderson and Harinder P.S. Makkar. FAO Animal Production and Health Paper No. 177. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. http://www.fao.org/docrep/018/i3288e/i3288e.pdf Last accessed 9 March 2015.

IPCC, 2006. IPCC Guidelines for National GHG Inventories. Intergovernmental Panel on Climate Change. Specifically, Volume 4: Agriculture, Forestry and Other Land Use, Chapter 10: Emissions from livestock and manure management. Available from: http://www.ipccnggip.iges.or.jp

IPCC, 2014: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. & de Haan, C. 2006. "Livestock's long shadow – Environmental issues and options". Food and Agriculture Organization of the United Nations, Rome, Italy.

VCS, 2012a. VCS Module VMD0027. "Estimation of domesticated animal populations", Version 1.0, 16 Nov. 2012.

VCS, 2012b. VCS Module VMD0028. "Estimation of emissions from domesticated animals" Version 1.0, 16 Nov. 2012.

VCS, 2013. "Guidance for Standardized Methods" Version 3.3., 8 Oct. 2013.

WRI/WBCSD, 2011. Corporate Value Chain (Scope 3) Accounting and Reporting Standard, Supplement to the GHG Protocol Corporate Accounting and Reporting Standard. World Resources Institute and World Business Council for Sustainable Development.

APPENDIX A: SCOPE 3 METHODOLOGIES IN CARBON MARKETS

Greenhouse gas inventories may be undertaken as Scope 1 (direct emissions of company or organization), Scope 1 and Scope 2 (including emissions at power plants from electricity purchased by company or organization), or to also include Scope 3 (emissions upstream and downstream in other companies or organizations, associated with the activities of the company or organization). See Figure A.1.

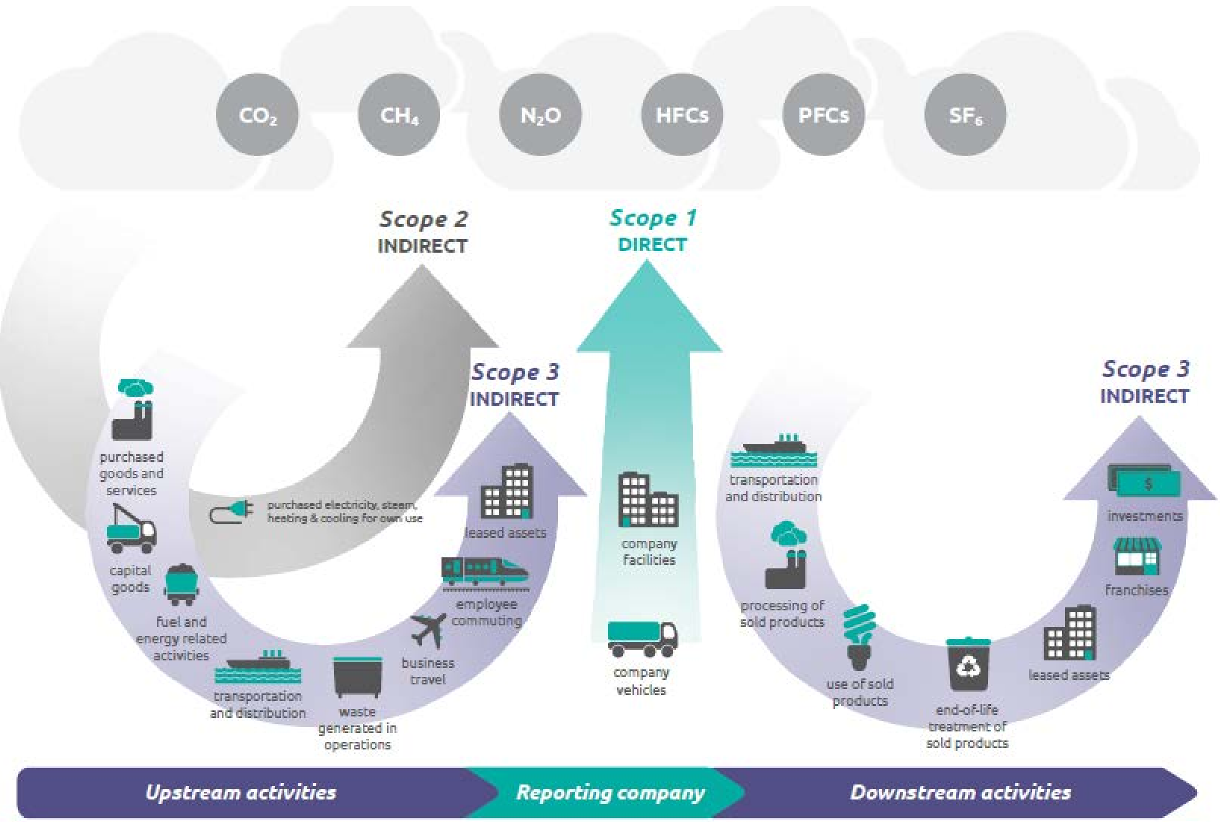

Figure A.1. Different "Scopes" for the determination of GHG emissions inventories or carbon footprints: Scope 1 includes only on-site emissions. Scope 2 also includes power plant emissions from on-site electricity use. Scope 3 could include emissions upstream and/or downstream of the activity site.

Source: WRI/WBCSD, 2013, GHG Protocol, Figure 1.1.

The proposed methodology involves emissions reduction in the use of the sold products, i.e. in Scope 3 indirect, downstream activities. The VCS has its own approved methodologies, and many CDM methodologies are also eligible under the VCS. However, none would apply directly to the proposed project. The CDM provides some prior experience that is relevant to the proposed project idea. This section provides an overview of (a) approved CDM methodologies, focusing on three which allow crediting of scope 3 emission reductions; and (b) two other approved CDM methodologies that are relevant.

Review of CDM Scope 3 Methodologies

Within the CDM pipeline of projects, as of March 1, 2015, there are 8638 "live"[3] Scope 1 and Scope 2 projects and only two Scope 3 projects (both involving the manufacture of energy efficient refrigerators using the CDM methodology AM0070, see below). The CDM includes 217 approved baseline and monitoring methodologies of which a small number involve Scope 3 emissions reduction projects.[4]

One issue that affects carbon credits for both Scope 2 and Scope 3 emissions reduction (ER) is that the emissions correspond to Scope 1 emissions of some other entity (or entities). There are two consequences of this point: (1) in principle, the emissions reduction could be claimed by another party, leading to double counting of emissions reduction; and (2) the emissions and their reduction may be difficult to determine, since they are outside the direct control of the project proponent. In the case of a new power plant involving renewable electricity, emission reductions take place at all power plants connected to the grid. Since all power grids need to be administered, emissions from the power grid are usually easy to determine. Moreover, a renewable power plant added to the grid does not reduce emissions of a specific other power plant, so that there is no risk of double counting emissions reduction. The CDM has established procedures for determining emissions reduction in renewable power generation projects, and these procedures are accepted in Joint Implementation (JI) as well as the voluntary carbon markets. This is why it has been possible to generate a large number of projects involving renewable power generation, i.e. Scope 2 ER projects.

The proposed project would consider generating carbon credits through reductions in Scope 3 emissions. Scope 3 ER projects face the issues mentioned above, specifically that the emission reductions may be difficult to measure and that someone else may claim emission reductions as carbon credits. The issues of monitoring and doubling counting are resolved in three approved CDM methodologies as follows:

[3] Meaning that they have not been rejected or withdrawn.
[4] We exclude forestry projects, which comprise a different category.

Table A.1: Treatment of Scope 3 Emissions in CDM Methodologies

CDM Scope 3 Methodology		**Resolution of issues of double counting and monitoring**
AM0070	Manufacturing of energy efficient domestic refrigerators	Electricity savings occur at households, whose emissions are too small to comprise carbon credit projects. Emissions reduction from electricity savings appear at power plants, for which the CDM procedures, for determining emissions reduction related to renewable electricity generation, can be adapted. Specific monitoring procedures are described in the methodology and include laboratory tests as well as household surveys.
AM0071	Manufacturing and servicing of domestic and/or small commercial refrigeration appliances using a low GWP refrigerant	Emissions from refrigerant leakage would take place in households, whose emissions are too small to comprise carbon credit projects. While the emissions take place elsewhere, they depend on the refrigerant charge and its global warming potential. Therefore determining emissions reduction does not involve third parties, and procedures are specified in the methodology.
AMS-II.O	Dissemination of energy efficient household appliances	Similar to AM0070, discussed above, except dealing with the dissemination not the manufacture of efficient appliances.

There is also an approved Gold Standard methodology, based on Scope 3 emissions reductions[5]: “Reducing vessel emissions through the use of advanced hull coatings”. In this case, the manufacturer of the hull coating is generally the project proponent in a Programme-of-Activities (PoA) mode, with each project (Voluntary Project Activity, VPA) being a set of ships to which the advanced hull coating is applied[6]. Each ship is identified by a unique number and monitoring is undertaken at the ship level. Thus both double counting and monitoring issues are resolved. The PoA and first VPA are currently under validation.

There are no Scope 3 methodologies approved by the VCS so far.

[5] The methodology was developed by MGM Innova, the proponent of this PIN. The methodology was initially approved in 2012, and Version 2 approved in 2014.

[6] Fleet owners with a sufficient number of ships may also apply the methodology, in which case it is not a case of Scope 3 emissions reduction. Double counting is avoided since each ship is uniquely identified.

APPENDIX B. PROJECT BOUNDARY

Note: This section is based on Alberta Quantification Protocol for Reducing Days on Feed for Beef Cattle (Government of Alberta, 2011)

The Alberta Quantification lists a number of sources of emissions associated with the baseline (see figure below), and a similar set for the project condition. As noted in green in Figure B.1 below, only on-site emission sources are considered in the Protocol, since all other sources are not affected by the project activity. These main baseline emission sources are described further in Table B.1.

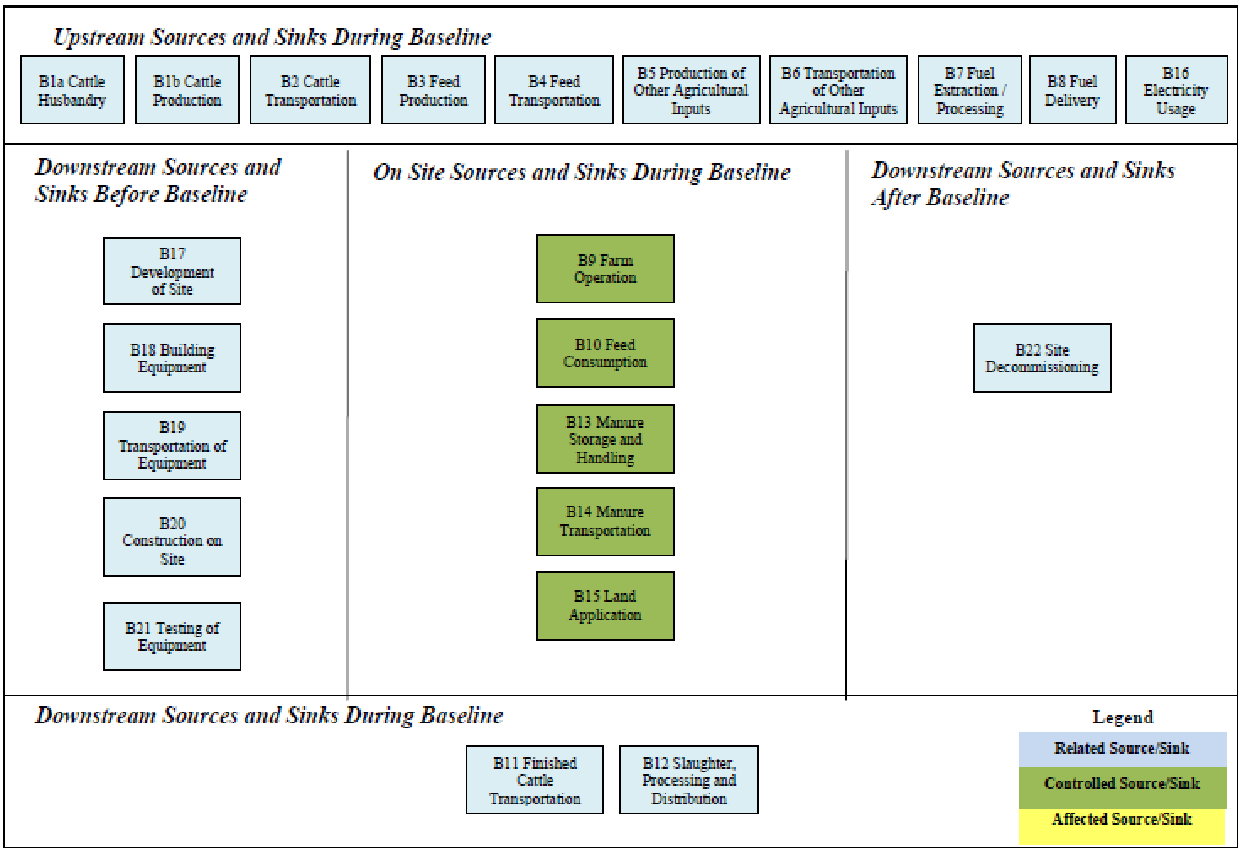

Figure B.1. Baseline condition sources and sinks for reducing the days on feed for beef cattle
Source: Government of Alberta, 2011, Fig. 2

Table B.1. Controlled sources of GHG emissions, as shown in green in Figure XX.1.
(Source: Extract from Government of Alberta, 2011, Table 4)

B9 Farm Operation	Greenhouse gas emissions may occur that are associated with the operation and maintenance of the beef production facility operations. This may include running vehicles and facilities at the project site for the distribution of the various inputs. Quantities and types for each of the energy inputs would be tracked.
B10 Feed Consumption	Feed consumption includes the enteric emissions from the cattle and related manure production. The feed composition would need to be tracked to as would the length of each type of feeding cycle.
B13 Manure Storage and handling	Greenhouse gas emissions can result from the operation of manure storage and handling facilities. This could include emissions from energy use, and from the emissions of methane and nitrous oxide from the manure being stored and processed. Operational aspects of the manure storage and handling systems may need to be tracked.
B14 Manure Transportation	Manure may need to be transported to the field for land application from storage. Transportation equipment would be fuelled by diesel, gas or natural gas. Quantities for each of the energy inputs would be tracked to evaluate functional equivalence with the project condition.
B15 Land Application	Manure may then be land applied. This may require the use of heavy equipment and mechanical systems. This could include emissions from energy use, and from the emissions of methane and nitrous oxide from the manure being stored and processed. Operational aspects of the manure land application systems may need to be tracked.

The emission sources are similar for the project case. There would be some small additional upstream emissions in feed supplement manufacture and transport, which are considered negligible in this methodology.

APPENDIX C. PERIOD OF GROWTH IN BASELINE

An example of period of growth in baseline for the case of Brazil can be taken from the Annual Report of the (ANUALPEC, 2013). The relevant tables for range fed cattle (“Extensiva”) are shown below for two production scales: 500 animal units and 5000 animal units. The relevant column is “AB” which is the age of slaughter in months.

Table C.1. Table showing data for production scale of 500 Animal Units.

Source: ANUALPEC, 2013, Chapter 5, p. 172

ANUALPEC 2013

Recria/Engorda Extensiva sem Escala (500 UA) em 2012

UF	Região	Raça	Pasto	Índices Zootécnicos			Produção	Custo Anual			Lucro Anual		Retorno
				AB(1)	PA(2)	CS(3)	@/UA/ano	@/UA	R$/cab	R$/@	@/UA	R$/ha	Rentabilidade
RS	Alegrete	Compostos	Nativo+Artif.	35	459	0,5	6,8	4,6	279	59,3	2,2	114	1,8%
PR	Paranavaí	Compostos	Braquiarião	34	463	1,0	6,8	3,8	251	51,8	3,0	308	2,0%
MS	Camapuã	Nelore	Braquiarião	39	458	0,9	5,9	3,8	226	55,6	2,1	187	2,8%
MS	C. Grande	Nelore	Braquiarião	37	459	1,0	6,2	3,8	228	53,3	2,4	220	1,8%
MS	Corumbá	Nelore	Nativo+Artif.	45	460	0,1	4,6	3,2	184	58,6	1,3	14	1,2%
MS	Naviraí	Compostos	Braquiarião	34	463	1,0	6,8	3,8	236	49,0	3,0	275	2,4%
MT	B. Garças	Nelore	Braquiarião	38	457	0,9	5,8	4,1	243	60,0	1,7	145	2,7%
MT	A. Floresta	Nelore	Braquiarião	37	466	1,0	6,1	4,0	233	54,2	2,1	198	3,9%
MT	P. Lacerda	Nelore	Braquiarião	37	466	1,1	6,0	3,9	230	54,0	2,1	204	3,1%
MT	Poconé	Nelore	Nativo+Artif.	45	457	0,1	4,2	3,8	221	75,9	0,4	4	0,1%
SP	P. Prudente	Compostos	Braquiarião	33	463	1,0	7,0	3,8	250	50,5	3,2	329	2,2%
RJ	Campos	Nelore	Humid+tang	38	455	0,7	5,9	3,0	187	46,0	2,8	187	1,9%
MG	Ituiutaba	Nelore	Braquiarião	39	462	1,0	5,6	3,9	241	60,9	1,7	160	1,3%
MG	7 Lagoas	Nelore	Braquiarião	39	458	0,9	5,6	3,6	227	58,6	1,9	169	2,8%
MG	M. Claros	Nelore	Colonião	39	454	0,7	5,6	3,6	215	55,8	1,9	124	2,6%
GO	Caçu	Compostos	Braquiarião	35	464	1,0	6,8	3,4	210	43,9	3,3	303	3,6%
GO	Goiânia	Nelore	Braquiarião	39	458	0,9	5,7	3,5	209	53,3	2,2	186	1,6%
GO	N. Crixás	Compostos	Braquiarião	36	457	0,8	6,1	4,0	235	54,4	2,1	149	1,8%
TO	Gurupi	Nelore	Braquiarião	40	457	0,7	5,6	3,2	200	52,3	2,4	171	3,1%
PA	Redenção	Nelore	Braquiarião	36	465	1,0	6,2	4,0	247	56,5	2,2	201	3,6%
PA	Paragominas	Nelore	Braquiarião	38	462	0,8	6,0	3,8	229	55,2	2,2	167	3,3%
TO	Araguaína	Nelore	Braquiarião	36	465	1,0	6,4	4,3	256	57,2	2,1	198	4,8%
RO	Ariquemes	Nelore	Braquiarião	36	465	1,0	6,5	3,2	210	46,3	3,3	355	6,2%
BA	Barreiras	Compostos	Braquiarião	35	456	1,1	6,6	2,9	197	43,0	3,7	435	5,4%
BA	Itapetinga	Nelore	Colonião	39	457	0,7	5,5	2,8	193	50,6	2,8	216	3,5%

(1) AB= Idade de Abate em meses (2) PA=Peso de Abate dos Machos em kgPV (3) CS=Capacidade de Suporte das pastagens em UA/ha/ano

Fonte: Informa Economics FNP

Table C.2. Table showing data for production scale of 5000 Animal Units.
Source: ANUALPEC, 2013, Chapter 5, p. 172

Recria/Engorda Extensiva com Escala (5000 UA) em 2012

UF	Região	Raça	Pasto	Índices Zootécnicos			Produção	Custo Anual			Lucro Anual		Retorno
				AB(1)	PA(2)	CS(3)	@/UA/ano	@/UA	R$/cab	R$/@	@/UA	R$/ha	Rentabilidade
RS	Alegrete	Compostos	Nativo+Artif.	35	454	0,5	7,3	4,6	271	55,2	2,7	135	2,1%
PR	Paranavaí	Compostos	Braquiarião	34	458	1,0	7,4	3,4	219	43,2	4,0	387	2,5%
MS	Camapuã	Nelore	Braquiarião	39	453	0,9	6,4	3,1	178	42,2	3,3	274	4,1%
MS	C. Grande	Nelore	Braquiarião	37	454	0,9	6,7	3,1	181	40,7	3,6	310	2,6%
MS	Corumbá	Nelore	Nativo+Artif.	45	455	0,1	4,9	2,7	149	45,7	2,2	22	2,0%
MS	Naviraí	Compostos	Braquiarião	34	458	0,9	7,4	3,2	193	38,3	4,1	365	3,2%
MT	B. Garças	Nelore	Braquiarião	38	453	0,9	6,3	3,5	200	47,4	2,8	225	4,2%
MT	A. Floresta	Nelore	Braquiarião	37	461	1,0	6,6	3,2	176	39,4	3,4	309	6,2%
MT	P. Lacerda	Nelore	Braquiarião	37	461	1,0	6,5	3,2	182	40,9	3,3	306	4,7%
MT	Poconé	Nelore	Nativo+Artif.	45	453	0,1	4,5	3,6	204	67,0	0,9	9	0,2%
SP	P. Prudente	Compostos	Braquiarião	33	458	1,0	7,6	3,5	223	43,1	4,1	402	2,6%
RJ	Campos	Nelore	Humid+tang	38	450	0,7	6,3	2,9	170	40,0	3,5	222	2,2%
MG	Ituiutaba	Nelore	Braquiarião	39	458	0,9	6,1	3,4	205	49,8	2,6	232	1,9%
MG	7 Lagoas	Nelore	Braquiarião	39	454	0,9	6,0	3,2	193	47,9	2,8	234	3,9%
MG	M. Claros	Nelore	Colonião	39	450	0,7	6,0	3,1	176	43,8	3,0	181	3,8%
GO	Caçu	Compostos	Braquiarião	35	459	0,9	7,3	3,0	176	35,4	4,3	377	4,5%
GO	Goiânia	Nelore	Braquiarião	39	454	0,9	6,1	3,1	179	43,8	3,0	248	2,1%
GO	N. Crixás	Compostos	Braquiarião	36	453	0,7	6,6	3,5	200	44,2	3,1	209	2,5%
TO	Gurupi	Nelore	Braquiarião	40	453	0,7	6,0	2,7	161	40,6	3,4	229	4,2%
PA	Redenção	Nelore	Braquiarião	36	461	0,9	6,7	2,9	171	37,4	3,8	333	6,1%
PA	Paragominas	Nelore	Braquiarião	38	457	0,8	6,4	2,8	165	38,3	3,6	262	5,2%
TO	Araguaína	Nelore	Braquiarião	36	461	1,0	6,9	3,5	202	43,3	3,4	302	7,4%
RO	Ariquemes	Nelore	Braquiarião	36	460	1,0	7,0	2,3	146	30,9	4,7	482	8,6%
BA	Barreiras	Compostos	Braquiarião	35	452	1,1	7,2	2,2	146	30,6	4,9	559	7,0%
BA	Itapetinga	Nelore	Colonião	39	452	0,7	6,0	2,3	153	38,6	3,7	278	4,6%

(1) AB= Idade de Abate em meses (2) PA=Peso de Abate dos Machos em kgPV (3) CS=Capacidade de Suporte das pastagens em UA/ha/ano

Fonte: Informa Economics FNP

APPENDIX D. PENETRATION OF QUALIFYING FEED SUPPLEMENTS IN BRAZIL

The methodology uses an activity penetration method for the demonstration of additionality. The geographical scope is Brazil.

Total sales of feed supplements from companies associated with the Brazilian Association of Mineral Supplement Producers (Associação Brasileira das Indústrias de Suplementos Minerais, ASBRAM) were 888,000 tonnes in 2014, and 438,000 tonnes in the first half of 2015. An annual extrapolation of the latter figure is 876,000 tonnes. We may suppose annual sales of supplements from ASBRA

M companies to be 880,000 tonnes.

ASBRAM represents some 50% of the Brazilian producers. Therefore extrapolating for the whole production we infer a total market for supplements of 1,76 million tonnes. A draft report, pending publication, indicates total sales to be around 2.6 million tonnes was 2014.

The annual sales of feed supplements qualifying under this methodology is currently 30,000 tonnes.

If we consider the total supplement sales of 1,76 million tonnes, qualifying feed supplements represent only 1,7%. If total supplement sales were in fact 2.6 million tonnes, the percentage would be even lower, 1.1%. In either case, the penetration level is considerably below the 5% threshold for the project activity to be additional.

Another way of considering penetration level is as follows:

The 30,000 tonnes of feed supplements that meets the methodology requirements would meet the requirements of 1,15 million head of cattle. Total beef cattle in Brazil is 150 million. Therefore the project activity represents 1.15/150 = 0.767% of the potential market.

Since penetration level is considerably below the 5% threshold, a simplified monitoring procedure can be justified.