Technical Protocol Plan (TPP)
for
Selection for residual feed intake in beef cattle quantification protocol

Part B

Description of Technical Protocol Plan Content

This section is an overview of the proposed Quantification Protocol including: project type, project-specific technology, quantification methodology and how the projects using the protocol will reduce GHGs and meet requirements of the Alberta Offset System.

B.1. Description of the Project Type: (The **project type** is a set of project practices or technologies that represent the change from a normal business operation/practices or common industry practice.)
The opportunity for generating carbon offsets with this protocol arises from the direct and indirect reductions of greenhouse gas (GHG) emissions from selecting beef cattle with increased feed efficiency through the genetic merit trait known as low residual feed intake (RFI).
Description of how real reductions or removals will be achieved: (The Protocol Developer must ensure the GHG(s) that will be reduced by the activities for this project type are within the scope and criteria of the Alberta Offset System and the Specified Gas Emitters Regulation.)
This protocol quantifies emission reductions in methane emissions from calves, cows and bulls (cattle) and emissions reductions from manure handling, storage and application within the beef supply chain. GHG reductions (primarily methane from enteric fermentation) are due to the reduced feed intake of cattle that utilize their feed more efficiently. This also results in less manure production from low RFI cattle. In beef cattle, residual feed intake (RFI) is defined as the difference between an animal's actual feed intake and its expected feed intake based on its size and growth, hence efficient animals having lower (negative) RFI values. Relative to high RFI cattle, low RFI cattle have been scientifically verified to emit less methane. Cattle with low RFI produce less methane from enteric fermentation and also less manure, relative to high RFI cattle, due to that fact that they consume less feed. To demonstrate that a project meets the requirements under this Quantification Protocol, the project developer must supply sufficient evidence to demonstrate that: 1. The Project Developer has had beef animals in the project condition tested for RFI at an established individual animal feed intake facility specified within the protocol to achieve a certified RFI EBV, classified as Post-weaning RFI (RFI-P). These will be measured on breeding cattle (bulls and replacement heifers) when they are 8 to 13 months of age. RFI requires the **measurement of actual individual animal feed intake over a specific time period (according to criteria contained within the protocol).** Animals with certified RFI EBVs from other countries can be used within breed or genetic strain. 2. The Project Developer must identify and provide full information and documentation from the facility generating the certified EBV(s) on any RFI tested animal(s) or purchased bulls/semen with certified RFI-EBVs. This information will simplify any verification and/or auditing requirements.

3. All qualifying cattle to be included under this protocol must have ***actual birth dates*** registered with the Canadian Cattle Identification Agency (CCIA) and/or an Alberta registry, confirmed by operational records. The date of first calf born or season of calving for a group is not acceptable for the purposes of this protocol. This will also simplify any verification and/or auditing requirements.

4. Credit duration – first generation only within Alberta's eight year crediting period. This means that ***reductions may be claimed on the animals with low RFI EBVs and their first generation progeny only.***

5. All farms in the project are currently storing manure and applying manure or custom applying manure to land as confirmed by an affirmation from the project developer.

6. The quantification of reductions achieved by the project is based on actual measurement and monitoring (exceptions where noted) as indicated by the proper application of this protocol.

Project proponents must demonstrate that they can meet the Alberta Offset System eligibility criteria as specified in Alberta Carbon Offset Solutions' *"Offset Credit Project Guidance Document".* **TABLE B. 1** summarizes the criteria and justifications for eligibility.

TABLE B. 1 Criteria and Justification for Protocol

Criteria	Justification
Results from actions taken on or after January 1, 2002	Projects will be eligible only if implemented after January 1, 2002.
Credited on or after January 1, 2002	Projects will be implemented after this date and credited for a period of 8 years.
Are real, demonstrable, and quantifiable	Project emissions will be based on actual measurement and monitoring that can be verified by an independent third party. The Project Developers are required to have animals tested at an established RFI testing facility that follow guidelines for testing and measurement. The animals are required to be registered within an approved identification system. The GHG emission reductions will cover only the main GHGs covered under the Specified Gas Emitters Regulation.
Are not required by law	There are no regulations or laws requiring the reduction of greenhouse gases within the beef cattle industry.
Have clear ownership	It is the responsibility of the project developer to demonstrate ownership through records or contracts that can be verified.
Will be accounted once for compliance purposes	Projects will be registered in Alberta's Offsets System Registry.
Will be verified by a qualified third party	Offsets will be verified by a third party. In addition,

	the testing of selected animals and determination of the genetic merit (EBVrfi) values are to be conducted at Alberta-based facilities accepted by Alberta Agriculture.
Will have occurred in Alberta	Eligible projects will be commissioned in Alberta.

B.2. Description of Background Information/Best Practice Guidance Used:

Best Practice Guidance

1. Document Title	2. Publishing Body/Date	3. Description
Canada's National Inventory	Government of Canada, 2006	Description of IPCC Tier 2 and 3 applications for quantifying GHGs from sectors at a national level.
ISO 14064-2: Specification with Guidance at the Project Level for Quantification, Monitoring and Reporting of Greenhouse Gas Emission Reductions or Removal Enhancements	Intergovernmental Panel on Climate Change, United Nations Framework Convention on Climate Change / 2006	The ISO standard provides the basic framework used by the majority of offset systems worldwide.
2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry, and Other Land Use	Intergovernmental Panel on Climate Change, United Nations Framework Convention on Climate Change/ 2006	This protocol has used IPCC guidance, along with ISO framework, to achieve "accuracy in aggregate". That is, the quantification of GHG emissions using the Dairy Protocol is not intended to achieve the site-specific predictive capability of a process model. It is understood that the emission coefficients and equations used have underlying uncertainty preventing site-specific accuracy. However, using the IPCC guidance and imposing the discipline of the ISO standard ensures the uncertainties of quantification are minimized as the Dairy Protocol is applied over a large number of participating farms.
SCIENCE DISCUSSION PAPER: Reduction in greenhouse gas emissions associated with selection for residual feed intake in beef cattle in Alberta (http://www.carbonoffsetsolutions.ca/pdf/Apr1509/RFI-Science_Discussion_Document_Mar09_Worksho	Dr. Paul Arthur Elizabeth Macarthur Agricultural Institute NSW Department of Primary Industries Camden NSW Australia 2570 Email: paul.arthur@dpi.nsw.gov.au	Dr. Paul Arthur was commissioned to develop a Science Discussion Document with the objective to compile and review the state of the science relating to selection for residual feed intake (RFI) and its association with reduction in GHG emission in beef cattle. The scope for the work included the assessment of the scientific feasibility of selection for RFI in beef cattle, and its link to quantified GHG reductions using a combination of the above information and scientific expert opinion.

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Technical Expert Workshop Consultation held March 16, 2009	Science Coordination Workshop in Leduc, Alberta.	The purpose of this workshop was to identify proposed options and engage key scientific researchers, technical experts, and qualified industry experts to provide advice and agreement on standardized quantification methods and best available science on greenhouse gas (GHG) emission reductions associated with residual feed intake in cattle. Consensus (>80% majority) was reached on various technical aspects of proposed quantification protocol. (workshop notes available at: http://www.carbonoffsetsolutions.ca/pdf/Apr1509/SCIENCE_COORDINATION_WORKSHOP_Notes.pdf)
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B.4. Regulatory, Legal Requirements and/or Government Incentive/Grant Programs:

List of potentially relevant regulations/legal requirements: There are currently no legal requirements for Canadian beef farms to regulate GHG emissions, thus, any GHG emission reduction effort is strictly voluntary. Requirements for manure management, however, do exist in some provinces and such regulations may disallow some Protocol activities for some farms. For example, if application of manure in fall is prohibited by regulation, a participating farm in this jurisdiction may not necessarily generate GHG reduction credits by applying the manure in spring. Protocol participants are required to document that their activities to decrease GHG emissions are not mandated by regulation.

List of potentially relevant climate change incentives: There are currently no direct climate change programs or (other than other quantification protocols under the Alberta Offset System) incentives for improving genetic efficiencies in the Alberta beef sector in order to reduce GHG emissions.

B.5. Barriers to Implementation: (Review and discuss the barriers impeding the projects outlined in the protocol from being implemented)

Most economic analyses show a positive return on investment in selection for low RFI in beef cattle. However the level of adoption remains low. There are some real as well as perceived barriers to adoption of selecting for low RFI beef cattle, and these include:

i. The complexity of the operation of automatic feed intake recorders limits the use of such equipment on-farm, to be operated by the seedstock breeder.
ii. The general lack of appreciation in the beef industry of the importance of feed costs to enterprise profitability.
iii. The lack of accurate individual animal pasture intake measurement.
iv. The practical limitations, animal health concerns and cost associated with

centralized RFI testing.

v. The reluctance of many seedstock breeders to hand over the management of their high value seedstock cattle to central test operators.

vi. The minimal use of artificial breeding technologies in the beef industry results in the lack of opportunity to recoup costs through high volume dissemination of superior genetics.

vii. The high cost of identifying animals with superior RFI. In Australia the most expensive trait to measure used to be ultrasound scanning in the live animal. The cost is between AUD25 to AUD45, for information on rib fat, rump fat, eye muscle area and intramuscular fat. Currently the actual cost of measurement of RFI is around AUD150. The measurement cost for RFI in Alberta is currently around 70 – 85 Canadian dollars (CAD) per head or CAD1 per head per day on test.

viii. Related to the high cost of identifying animals with superior RFI is the long period required for the investment in feed efficiency technology to return economic benefit. In the data presented by Exton et al. (2000) one of the assumptions was that a bull genetically superior for feed efficiency commands a AUD153 premium over a standard bull. The premium is equivalent to the amount required by the seedstock breeder to recoup the cost of testing elite candidate bulls in a two-stage selection program and paying AUD300 for the cost of measuring feed intake on each bull tested for feed efficiency (Exton et al. 2000). The results indicate that there is a negative cash flow in the first 10 years of investing in superior feed efficiency genetics (Arthur and Herd 2005).

B.6. Risks to Implementation: (Review and discuss the risks associated with the protocols project-type and how these risks are being addressed / mitigated)

Currently only 3.5 generations of selection have been achieved in the selection lines, so it is too early to know how long selection can continue before the responses to selection plateau (therefore protocol only applicable to first generation progeny).

B.7. Review of Technology/Scientific Knowledge: (Describe the applicable practice(s) or technology producing the GHG emission reductions and the scope of activities considered for the protocol)

Residual feed intake is the amount of feed consumed, net of the animal's expected requirements for maintenance of body weight and production. There is conclusive scientific evidence that cattle with low RFI consume less feed at the same level of production as high RFI cattle. There is genetic variation in RFI in most cattle breeds, and it is a heritable trait. This means that genetic improvement in RFI can be made through selection, and that progeny of low RFI cattle will consume less feed without compromising growth and other economically important traits. Cattle with low RFI produce less methane from enteric fermentation and also less manure, relative to high RFI cattle, due to that fact that they consume less feed. Selection for low RFI can therefore be used as a GHG mitigation strategy in beef cattle. Please refer to the Science Discussion Paper for complete listing of research and studies conducted on residual feed intake (http://www.carbonoffsetsolutions.ca/pdf/Apr1509/RFI-Science_Discussion_Document_Mar09_WorkshopV.pdf)

B.8. Review of Existing Projects: (Review of trends and statistics on existing practices/projects in the Alberta and/or Canadian context.)

To date there are no reliable publicly available survey data on the use of RFI technology (both testing and measurement of RFI and cow-calf operator / feedlot operator replacement of low RFI animals) in the beef industry, to work out actual levels of adoption and adoption rates.

In the beef industry, the availability of well characterized low RFI breeding animals for sale to the cow-calf sector is one of the ultimate measures of adoption by the seedstock sector. One of the measurable indicators is the number of cattle tested for RFI and/or the number within that sector with RFI EBVs, with a reasonable degree of accuracy. In Alberta only 4,300 cattle have been tested for RFI to date with another 3,600 projected to be tested within the next four years, for research purposes. Unfortunately, only 1220 potential breeding bulls were tested for RFI over a nine year period from 2000 to November of 2008. The number of bulls, steers and heifers tested at the known 7 locations for RFI testing facilities in Alberta.

In beef cattle there is only the one population in the world in which RFI selection lines have been developed and maintained. This is the Angus RFI divergent selection lines at Trangie in New South Wales, Australia. About 10,000 cattle have been tested for RFI (Trangie demonstration herd), with Angus breed having the most cattle tested. Since 2002, Australia's beef genetic improvement program, BREEDPLAN, has been providing Trial EBVs for residual feed intake. There are no other RFI selection lines in beef cattle in the world, however results from other major single generation studies where cattle have been phenotypically classified into Low and High RFI groups have confirmed the results of the selection lines.

B.9. Summary of Quantification Approaches: (Include a summary of GHG quantification approaches and methodologies. At a broad level, not exact formulae and emission factors, but where formulae will come from, activity data and emission factors, ie. Best Practice Guidance, any special considerations for quantification and gaps in knowledge.)

This protocol quantifies emission reductions in methane emissions from calves, cows and bulls (cattle) and emissions reductions from manure handling, storage and application.

The preferred method of calculating greenhouse gas production from enteric fermentation and manure production in the baseline and project conditions for groupings of animals on similar rations is through collecting actual DMI intakes from farm data. However, estimates of Dry Matter Intake (DMI) from IPCC Tier 2 (IPCC 2006), calculated form Cowbytes or similar computer programs, can also be used in standard equations (e.g. IPCC 2006) to estimate the greenhouse gas production from enteric fermentation and manure production (performance standard approach to baselines).

The Project Developer is required to have the animals in the project condition tested for RFI at an established individual animal feed intake facility specified within the protocol to achieve a certified RFI EBV, classified as Post-weaning RFI (RFI-P). RFI requires the **measurement of actual individual animal feed intake over a specific time period,** resulting in animals with certified RFI EBVs .

Thus the next step in calculating emission reductions in this protocol is to estimate the expected ***percentage reduction*** in DMI for the project animals, relative to that of the base year animals – for cattle groupings of similar weight and ration. The second step is to estimate actual reductions in DMI for the year of interest (typically the current year for which a GHG assertion will be made, e.g. 2009).

These estimates of DMI can then be used in the standard IPCC (2006) equations to estimate the greenhouse gas production from enteric fermentation due to feed consumption and manure production (per the methodologies and equations in Table 2.5 of the quantification protocol). The greenhouse gas production of these animals can then be compared with those obtained from using the estimated DMI for the year of interest.

B.10. Other Impacts and Co-Benefits: (Include other air emissions, odours, risks, environmental impacts on vegetation, wildlife, water resources etc.)

There are no known negative impacts in relation to selecting for low RFI beef cattle.

There is the potential to continually and permanently reduce methane emission by cattle through selection for low RFI. In addition, unlike other project-types generating carbon credits that may encounter issues related to leakage or re-emitting of GHGs, those generated from cattle are permanent.

Residual feed intake is independent of liveweight and growth, the reduction in GHG emission in low RFI cattle is additional to other GHG reduction strategies relating to liveweight or growth. For example, if cattle finished in feedlots get GHG credit relative to pasture finished cattle, this credit should be additional to the low RFI credit. There are currently several research projects worldwide for the development of bio-actives (e.g. drugs, vaccines) for cattle to reduce methane emissions. If some of these R&D become commercialized, there would be the need to examine whether GHG reduction through selection for RFI is additive or negated by these bio-actives.

B.11. Assessment of Baseline Scenarios

Evaluate all possible Baseline Approaches in the list below, and identify which ones are appropriate for the proposed protocol. Justify why each selected Baseline Scenarios is appropriate. Justification should relate to why each appropriate Baseline Scenarios conservatively and accurately represents "business as usual". Also, justify why the other Baseline Scenarios are not appropriate and are excluded from the Protocol.

TABLE 1.2: Assessment of Possible Baseline Scenarios

1. Baseline Options	2. Description	3. Static / Dynamic Baseline	4. Accept or Reject and Justify
Performance Standard	Assessment of baseline scenario based on the assessment of a typical emissions profile for enteric emissions per head of cattle based on best practice guidance.	Static.	Accept as alternate scenario to historical based. Cowbytes or NRC databases can be used to estimate Dry Matter Intake for Base Year Animals of a similar ration and weight class as the Project Condition animals.
Projection Based	Projection of the baseline scenario based on modeling the future reductions of GHG emissions due to low residual feed intake selection within herds.	Dynamic.	Reject. Actual RFI-EBV testing is required for Baseline to Project conditions and efficacy in selecting for low RFI animals.
Normalized Baseline	Assessment of avoided emissions from current practice levels of reduced feed intake from low RFI cattle.	Dynamic	Reject. RFI Selection methods are new and additional – very little market penetration. No normalized baseline approach is required.
Historic Benchmark	Assessment of the baseline scenario based on verifiable records of number of animals and feed intake on farms prior to project implementation.	Static.	Accept. Based on actual farm records of Dry Matter Intake per groups of animals on similar rations and weight classes.
Comparison Based	Assessment of baseline scenario based on the actual measurement of emissions from a control group of animals to be compared with the project group.	Static.	Reject. Emissions measurement impractical on herd sizes contemplated under this protocol. Measurement based on research methods and not commercially available.

B.12. Selection of Baseline Scenario: (For the selected baselines scenario(s) from the above analysis, the Protocol Developer must explain why the Baseline approach is static or dynamic, justify the selection of the most appropriate baseline scenario(s) including references and any assumptions.)

The Historic Benchmark baseline scenario was determined to be most acceptable for this project, based on actual farm records of Dry Matter Intake per groups of animals on similar rations and weight classes. The baseline condition for this protocol is defined as the GHG emissions from a grouping of animals as a result of normal dry matter intake (DMI) of feed prior to the selection for low RFI (i.e. DMI of base year animals of similar weight classes on similar rations). The baseline GHG emissions are quantified based on the business as usual efficiency of the cattle in the baseline year. This is compared to the project condition of known genetic merit for RFI or sires with Estimated Breeding Value (EBV) for RFI and the resultant dry matter intake.

The baseline condition assesses the average feed intake for specific categories of animals on specific diets (e.g., 650-750 lb steers on a backgrounding diet growing at 1.75 lb/day). The average is based on two to three lots or groups of animals for one year prior to the project implementation. Various types of records may be used to develop the baseline including, but not limited to, animal category (e.g., replacement heifer on pasture; yearling steers on a finishing diet), average group weight of animals, approximate age (e.g., 6-7 month old steers calves, 11-12 month old yearling heifers), diet ingredient composition, and dry matter, energy and crude protein content of ration.

B.13. Definition of the Project Condition: (Define the project condition and justification for the scope of the activity considered.)

The project condition is defined as using low (negative) RFI EBV sires or replacement heifers and encompasses pens and/or pastures where the cattle are raised and fed, the facility where manure is stored, and the land where the manure is spread. The project may include a number of sites, and a variety of enterprises, but all project farms will address the activities within the boundary of the Protocol.

Animals in the project condition have EBVs computed using a specified year as the base year or beginning of the project. The mean EBV of a particular trait is set to zero for all the animals born in that year or earlier. This ensures that genetic improvement relative to the animals in the baseline condition can be tracked over several years. This base year can also be used in the protocol to illustrate that practice change since that year has resulted in reductions in GHG emissions. For RFI, it is also essential that the average feed intake (DMI) of animals during the RFI test period for the base year is calculated or estimated.

The necessary elements for implementation of this protocol are:

- The seedstock breeder will be breeding low RFI breeding animals or semen for sale. It is expected that breeding stock/semen for sale will have certified low RFI values and accuracies as part of the sale information;
- The cow-calf operator purchases the certified low RFI breeding stock and uses them in matings to produce progeny. The genetic merit of offspring from such a mating will be equivalent to half the genetic merit of the sire plus half the genetic merit of the heifer. Thus each progeny is assigned an RFI value equal to the average or mean of the parents.
- The majority of the progeny will be sold, with accompanying paperwork to backgrounding operations or feedlots for finishing.

B. 14. Functional Equivalence: (Explain and justify how the project and the baseline are comparable in terms of products and/or activity level. This type of comparison requires a common metric or unit of measurement (such as the mass of beef produced, tonne-kilometers traveled, or energy content of fuel volumes in the case of displacing fossil fuels with biofuels).)

The project and baseline are compared, with the common metric used to demonstrate emission reductions from the selection of low RFI beef cattle being the kg of DMI per day, for specific categories of animals on specific rations. The GHG emissions per kilogram of beef in the project condition is compared to the baseline condition of an inefficient herd of animals – this is the functional equivalence of the protocol.

B.15. Flexibility Mechanisms: (Explain optional approaches for quantifying the reductions to be achieved from the project type.)

Flexibility in applying the quantification protocol is provided to project developers in two ways:

1. Projects that do not have the appropriate data for establishing Dry Matter Intake (DMI) for animals in the baseline year (‘base year animals) may use regional data by animal category, diet composition and dry matter intake (DMI) for establishment of the baseline conditions or DMI can be calculated from IPCC Tier 2, NRC (2001) and/or a ration formulation computer program like CowBytes™ (Alberta Agriculture and Rural Development) within animal category and ration (e.g., 650 to 750 lb steer calves on a backgrounding diet growing at 1.75 lb/day).
2. If one of the parents of a first generation progeny does not have its own certified RFI-EBV, its EBV can be assumed to be zero (meaning the average RFI for the progeny will be 50% of the certified RFI-EBV parent);

Site specific emission factors may be substituted for the generic emission factors indicated in this protocol document. The methodology for generation of these emission factors must ensure reasonable accuracy and verifiability.