QUANTIFICATION PROTOCOL FOR TILLAGE SYSTEM MANAGEMENT

ABRIDGED

Submitted to:

Alberta Environment

and

Albert Agriculture, Food and Rural Development

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Prepared By: Baseline Emissions Management Inc.

Disclaimer

The following document presents an abridged version of the Tillage System Management protocol prepared for Alberta Environment and Alberta Agriculture, Food and Rural Development which has completed an initial round of technical review. This document has been prepared as a means of supporting a broader stakeholder consultation process. As such, this document should not be used as a quantification protocol.

The full-length version of this protocol is largely based on the *Tillage System Default Coefficient Protocol* dated October, 2006. This work was completed under the Soil Management Technical Working Group (SMTWG). Dennis Haak from Agriculture and Agri-Food Canada was the principal author. This work represents the culmination of a multi-stakeholder consultation project and reliance on a number of guidance documents.

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1.0 Project and Methodology Scope and Description

This quantification protocol is applicable to the quantification of direct and indirect reductions of greenhouse gas (GHG) emissions resulting from the implementation of no-till and reduced till systems on agricultural lands. This protocol provides a default methodology that can be applied to all land and all agricultural producers across the country regardless of historical practices associated with the land or a producer. This approach, termed as the adjusted baseline approach, accounts for current practise levels, adjusted with farm census data from Statistics Canada.

FIGURE 1.1 offers a project element life cycle chart for a typical project. **FIGURE 1.2** offers an element life cycle chart for a typical baseline configuration.

In order to make the default approach feasible and credible, it is necessary to create project coefficients and baseline deductions that are regionally aggregated. In other words, in a given region, all project lands doing no-till receive the same emission factor per area regardless of what tillage systems were used in the past. As such this protocol strives to simplify and minimize project administrative costs by not having to collect and analyze historical information for project land parcels.

This protocol is applicable to annual crops grown throughout Canada. Perennial crops are not within the scope of the protocol. While some perennial row crops may involve tillage (e.g. orchards, small fruits, nuts, nurseries, woodlots, etc.), the coefficients used in this protocol are not applicable since the tillage in these scenarios only involves part of the land area (i.e. the inter-row zone).

It is recognized that farming and cropping systems are complex, often with interdependent practices. GHG emissions are potentially impacted by many different specific practices, in addition to the tillage system. However, the reduction coefficients used in this protocol assume that when comparing the project and baseline scenarios for all other aspects of farm operation that there are negligible GHG impacts from the project. This assumption allows for the layering of protocols across a number of project areas.

The baseline condition for projects applying this protocol is considered as a performance based approach. The performance standard for no-till and reduced till farming is set relative to a 1990 baseline and would be subject to revision over time. The uptake of no-till and reduced till farming is considered within the coefficients implicit within the default methodology approach to assessing the relevant performance standard.

The established baseline would be considered as static, where the coefficients remain constant, subject to periodic revision to reflect the evolving performance standard.

To demonstrate that a project meets the requirements under this protocol, the project proponent must supply sufficient evidence to demonstrate that:

FIGURE 1.1: Project Element Life Cycle Chart

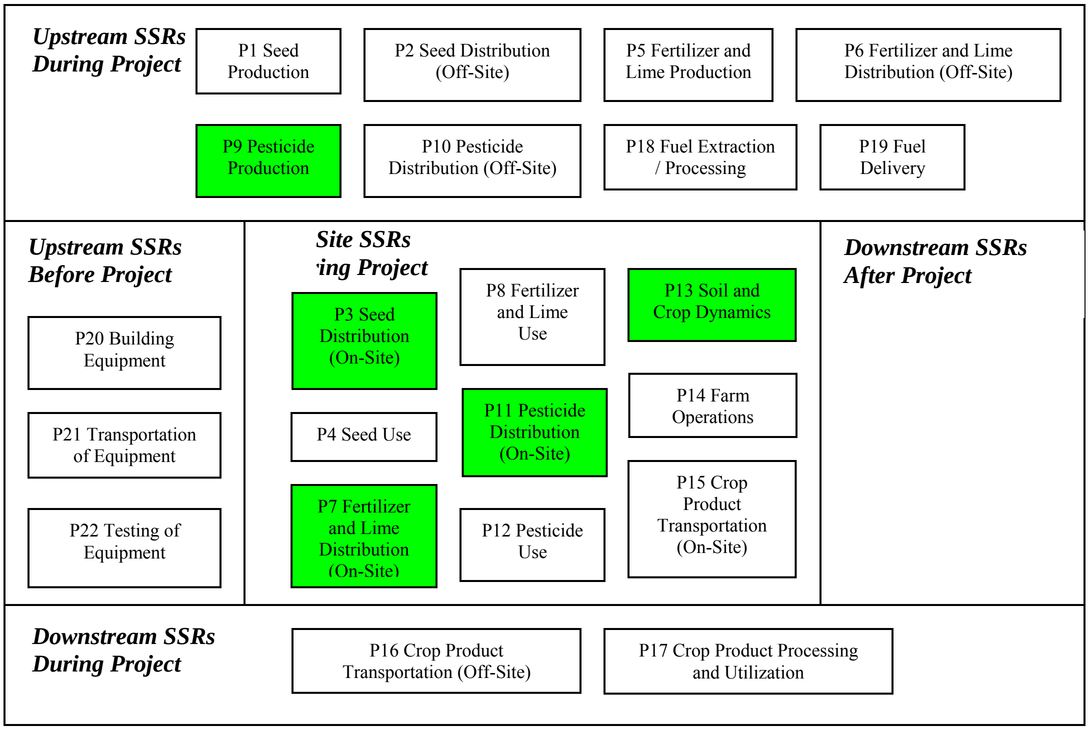
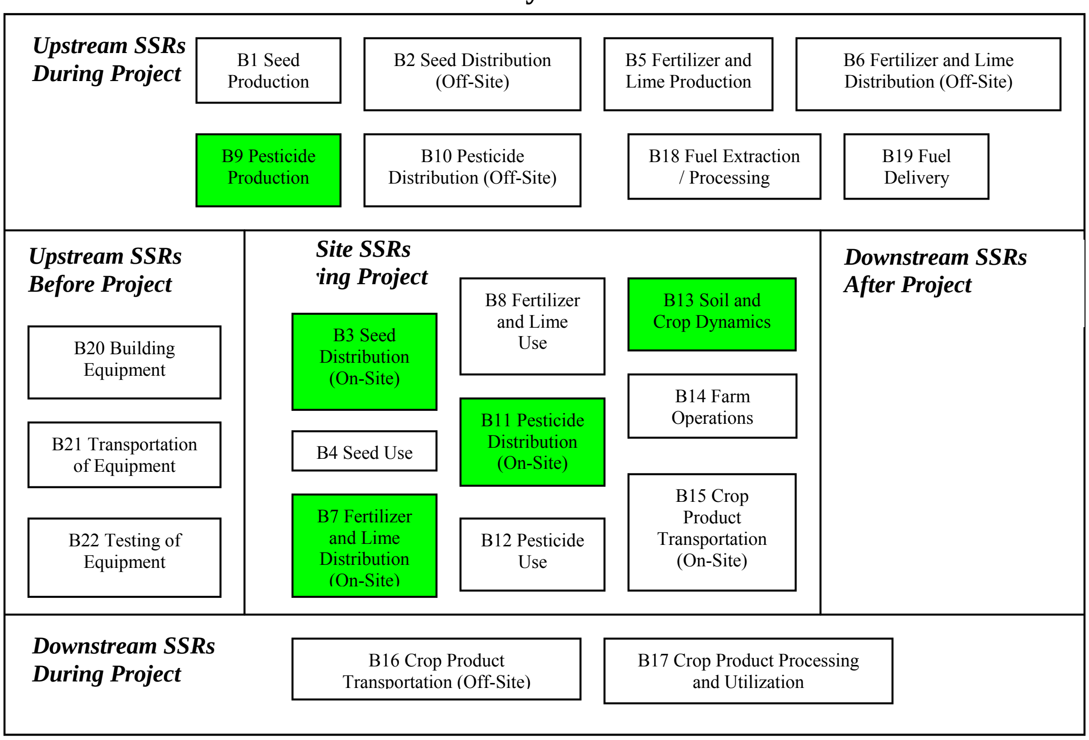


FIGURE 1.2: Baseline Element Life Cycle Chart



* Sources, sinks and reservoirs selected for measurement and monitoring under this protocol are highlighted.

1. All farms must be producing annual crops on the applicable land as confirmed by an attestation from the project proponent and farm records;
2. All farms in the project must operate on the applicable land in a no-till or reduced till system as defined in this protocol as confirmed by an attestation from the project proponent and farm records; and
3. The quantification of reductions achieved by the project is based on actual measurement and monitoring (except where indicated in this protocol) as indicated by the proper application of this protocol.

Flexibility in applying the quantification protocol is provided to project developers in three ways.

1. A project proponent may choose to group together all fuel types across the relevant SSRs where the tracking of the fuel inputs is aggregated as such. Care must be taken to ensure that all fuel sources are included in aggregated data;
2. A project proponent may define and justify site specific SOC sequestration and N_2O coefficients following the methodology from the seed protocol methodology. This would create a site specific baseline and would consider previous practises at the project site;
3. Site or project specific emission factors, adjusted for baseline considerations, may be substituted for the generic emission factors indicated in this protocol document. The methodology for generation of these emission factors must be sufficiently robust as to ensure reasonable accuracy. Further, these emission factors must be assessed to ensure that the project proponent has properly accounted for any material impact on other generic emission factors applied for the project, the assumptions underlying calculations of the generic emission factors, and upon the assurance factor estimate; and
4. This protocol applies to a single component of farm operations. As such, this protocol can be combined with other protocols where multiple projects are undertaken to lower overall greenhouse gas emission reductions.

If applicable, the proponent must indicate and justify why flexibility provisions have been used.

2.0 Quantification of Identified Sources, Sinks and Reservoirs

Quantification of the reductions, removals and reversals for the sources, sinks and reservoirs selected for measurement and monitoring under this protocol will be completed using the methodologies outlined in **TABLE 2.1**, below. These calculation methodologies serve to complete the following three equations for calculating the emission reductions from the comparison of the baseline and project conditions.

$$\text{Emission Reduction} = \text{Emissions}_{\text{Baseline}} - \text{Emissions}_{\text{Project}}$$

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Energy Use}} + \text{Emissions}_{\text{Carbon Sequestration}} * \text{Assurance Factor} + \text{Emissions}_{\text{Nitrogen}}$$

$$\text{Emissions}_{\text{Project}} = 0$$

TABLE 2.1: Quantification Procedures

1. Project/Baseline SSR	2. Parameter / Variable	3. Unit
Project SSRs		
P9 Pesticide Production	Captured in Baseline Adjusted Factors	
P3 Seed Distribution (On-Site)	Captured in Baseline Adjusted Factors	
P7 Fertilizer and Lime Distribution (On-Site)	Captured in Baseline Adjusted Factors	
P11 Pesticide Distribution (On-Site)	Captured in Baseline Adjusted Factors	
P13 Soil and Crop Dynamics	Captured in Baseline Adjusted Factors	
Baseline SSRs		
B9 Pesticide Production; B3 Seed Distribution (On-Site); B7 Fertilizer and Lime Distribution (On-Site); B11 Pesticide Distribution (On-Site)	$Emissions_{Energy\ Use} = \sum Area_{Till\ Practice\ y} * EF_{Energy\ Use}$	
	Emission Reductions from Carbon Sequestration / $Emissions_{Energy\ Use}$	kg CO_{2E} / yr
	Area of Field under Each Till Practice / $Area_{Till\ Practice\ Y}$	ha
	Reduction Factor For Relevant Till Practice in Relevant Area and Geographic Zone / $EF_{N2O\ Coefficient}$	kg CO_{2E} / ha / yr
B13 Soil and Crop Dynamics	$Emissions_{Carbon\ Sequestration} = \sum Area_{Till\ Practice\ y} * EF_{20\ yr\ Linear\ SOC\ Coefficient}$	
	Emission Reductions from Carbon Sequestration / $Emissions_{Carbon\ Sequestration}$	kg CO_{2E} / yr
	Area of Field under Each Till Practice / $Area_{Till\ Practice\ Y}$	ha
	Sequestration Factor For Relevant Till Practice in Relevant Area and Geographic Zone / $EF_{20\ yr\ Linear\ SOC\ Coefficient}$	kg CO_{2E} / ha / yr
	$Emissions_{Nitrogen} = \sum Area_{Till\ Practice\ y} * EF_{d\ N2O\ Coefficient}$	
	Emission Reductions from Nitrogen Oxide Reduction / $Emissions_{Nitrogen}$	kg CO_{2E} / yr
	Area of Field under Each Till Practice / $Area_{Till\ Practice\ Y}$	ha
	Reduction Factor For Relevant Till Practice in Relevant Area and Geographic Zone / $EF_{N2O\ Coefficient}$	kg CO_{2E} / ha / yr

APPENDIX A: Glossary of New Terms

Assurance Factor: The assurance factor accounts for the risk and magnitude of carbon sequestration reversal due to tilling events occurring in fields that would otherwise be reduced and no-till practices. This factor accounts for the average number of tillage events anticipated over a 20 year period. Reversals are contemplated as linear, in keeping with the model for sequestration under reduced and no-till practises. The assurance factor accounts for the reversal event across the years that the field is credited for the sequestration from reduced and no-till practises. This prevents a liability accruing on the field in years where tillage events occur, as the fields would receive neither a credit nor reversal of a credit in years where the tillage events occurred.

No-Till and Reduced Till: These terms are defined regionally as per **TABLE A.1**, below.

TABLE A.1: Definitions of No-Till and Reduced Till

Region	Tillage System	Description
East	Reduced Till	One fall tillage with HD Cultivator, or < tillage
	No Till [2]	Up to two passes with low-disturbance openers (up to 33%) or 1 pass with a slightly higher disturbance opener (up to 40%) [3], discretionary tillage of up to 10% [4], no fall tillage
East-Central	Reduced Till	One fall tillage With HD Cultivator, or < tillage
	No Till [2]	Up to two passes with low-disturbance openers (up to 33%) or 1 pass with a slightly higher disturbance opener (up to 40%) [3], discretionary tillage of up to 10% [4], no fall tillage
Parkland	Reduced Till	Fall tillage limited to injection of manure or fertilizer with <40% [3] soil disturbance, 1 to 2 cultivations on summerfallow.
	No Till [2]	Up to two passes with low-disturbance openers (up to 33%) or 1 pass with a slightly higher disturbance opener (up to 40%)[3], discretionary tillage of up to 10%[4] , no cultivations on summerfallow, no fall tillage.
Dry Prairie	Reduced Till	Fall tillage limited to injection of manure or fertilizer with < 40% [3] soil disturbance, 1 to 2 cultivations on summerfallow.
	No Till [2]	Up to two passes with low-disturbance openers (up to 33%) or 1 pass with a slightly higher disturbance opener (up to 40%)[3], discretionary tillage of up to 10%[4] , no cultivations on summerfallow, no fall tillage.
West [1]	Reduced Till	One fall tillage With HD Cultivator or < tillage.
	No Till [2]	Up to two passes with low-disturbance openers (up to 33%) or 1 pass with a slightly higher disturbance opener (up to 40%) [3], discretionary tillage of up to 10% [4], no fall tillage.

Notes:

1 The Peace River Lowland ecoregion is contained within the Parkland zone.

2 Additional operations with harrows, packers, or similar non soil disturbing implements are accepted. Where a second low soil disturbance operation is performed it is normally for injection of fertilizer or manure.

3 Percentage values associated with openers are based on average opener width (below ground) divided by row or shank spacing of the implement.

4 Discretionary tillage of up to 10% means that up to 10% of the surface area of a single agricultural field may be cultivated to address specific management issues. These areas are determined on an annual basis, meaning that specific areas may change from year to year.

APPENDIX B: Development of Relevant Assurance Factors

The assurance factor accounts for the average risk of reversal across all farms within a given region. Technical experts (6 contributing sources) were consulted to assess both the range of values and to explore the relationships across regions and across practises. The range of data reported for the number of reversals anticipated over a 20 year tillage period is provided. Where the range was slim, a simplified analysis was facilitated. Where the range was broader, a review of the ranges was completed to assess whether outliers were robust. Based on this analysis, a chosen average number of reversals were selected. As the sequestration of carbon over time is linearized, reversals are assumed to be equivalent in magnitude. As such, the assurance factor could then be estimated using the following formula:

Assurance Factor = (1 - (# of Reversal Events / 20 year period)) * 100%

Table B.1: Assurance Factors by Region and Practise Type

Region	Factor	Reduced Till	No Till
East	Assurance Factor	85.0%	80.0%
	Chosen Number of Reversals	3	4
	Range of Values	Range: 2-4	Range: 1-6
East-Central	Assurance Factor	87.5%	85.0%
	Chosen Number of Reversals	2.5	3
	Range of Values	Range: 2-3	Range: 1-5
Parkland	Assurance Factor	87.5%	87.5%
	Chosen Number of Reversals	2.5	2.5
	Range of Values	Range: 2-3	Range: 1-4
Dry Prairie	Assurance Factor	90.0%	92.5%
	Chosen Number of Reversals	2	1.5
	Range of Values	0 - 3	1 - 2
West	Assurance Factor	87.5%	92.5%
	Chosen Number of Reversals	2.5	1.5
	Range of Values	2 - 3	1 - 2