NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Corn Grain Land Preparation, Operation

Reference Flow: 1 kg of Biomass Operation

Brief Description: This unit process includes operations for land preparation for corn grain including an input of combusted diesel, emissions, and a calculation of required land area.

Section I: Meta Data

Geographical Coverage: US **Region:** Midwest

Year Data Best Represents: 2008

Process Type: Installation Process (IP)

Process Scope: Cradle-to-Gate Process (CG)

Allocation Applied: No

Completeness: All Relevant Flows Recorded

Flows Aggregated in Data Set:

☒ Process ☒ Energy Use ☐ Energy P&D ☐ Material P&D

Relevant Output Flows Included in Data Set:

Releases to Air:	☐ Greenhouse Gases	☒ Criteria Air Pollutants	☐ Other
Releases to Water:	☐ Inorganic Emissions	☐ Organic Emissions	☐ Other
Water Usage:	☐ Water Consumption	☐ Water Demand (throughput)	
Releases to Soil:	☐ Inorganic Releases	☐ Organic Releases	☐ Other

Adjustable Process Parameters:

Corn yield (Corn_yield_y)	*Represents the weight of corn grain acre per year.*
Horizon time (Horizon_time)	*Represents the study horizon time used to calculate required land use.*

Tracked Input Flows:

Diesel Combustion, Mobile Sources, Truck [Refinery products]	*Amount of diesel combusted within the mobile source.*
Equipment Assembly per kg Biomass [Valuable substances]	*Amount of farm equipment required for 1 kg of biomass.*

Tracked Output Flows:

Biomass Operation [Installation]	*This unit process is assembled with the biomass cultivation operation unit process in series, therefore the reference flow is assumed to be 1 kg biomass operation.*

Section II: Process Description

Associated Documentation

This unit process is comprised of this document, as well as the data sheet (DS) *DS_Stage1_O_CG_Land_Preparation_2011.03.xlsx*, which provides additional details regarding calculations, data quality, and references as relevant.

Goal and Scope

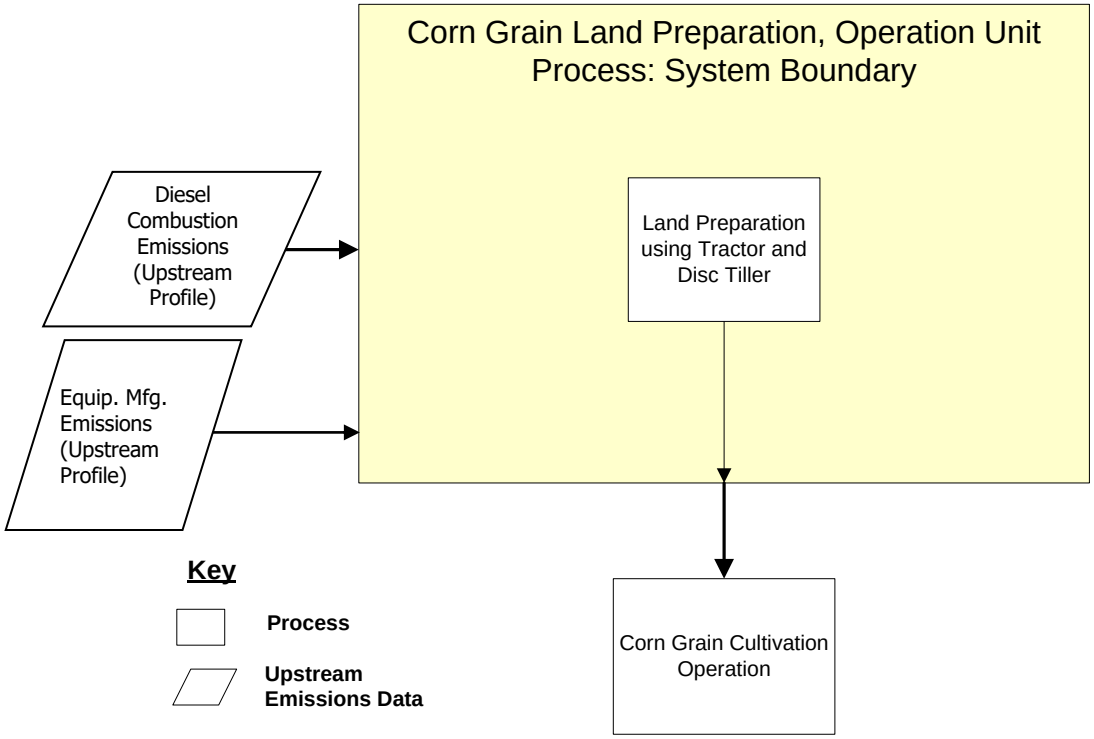
The scope of this unit process covers the operation of farming activities used for land area preparation for corn grain biomass in life cycle (LC) Stage #1. This unit process is based on the reference flow of 1 kg of biomass operation to prepare land, as described below, and in **Figure 1.** The operation activities are assumed to occur once when the land is transformed into a corn field. The inputs to the unit process include diesel combustion (technosphere) and land use (resource). Diesel is used as fuel for the land preparation equipment (a tractor); the energy and material flows for the upstream production and delivery of diesel as well as life cycle emissions of diesel production are not included in the boundary of this process. Emissions from diesel combustion are handled in a linked upstream unit process. Land use, expressed in terms of acres per unit production of corn grain, is considered a resource that involves no upstream operating or construction activities. Fugitive dust from the use of land preparation equipment is included in the unit process boundary. Fugitive dust is categorized as particulate matter (PM) emissions to air. Water use and emissions to water are not characterized in this process, because they are assumed to comprise a negligible contribution to the direct operations of land preparation.

Boundary and Description

The LC boundary of this unit process starts with farming activities to prepare land for seeding and ends with a unit of land area ready to seed. Operations for the preparation of land for corn grain production are based on the estimated diesel consumption of farming equipment, fugitive dust emissions caused by surface dust that is disturbed by land preparation equipment, and the annual yield rate of corn grain. **Figure 1** provides an overview of the boundary of this unit process including a schematic of operations considered within the boundary of this unit process. Rectangular boxes represent relevant sub-processes, while trapezoidal boxes indicate upstream data that are outside of the boundary of this unit process. As shown, upstream emissions associated with

the production and delivery of diesel fuel are accounted for outside of the boundary of this unit process. The methods for calculating these operating activities are described below.

Figure 1: Unit Process Scope and Boundary



There are two adjustable parameters in this unit process: the annual yield of corn grain and time horizon of the study. These adjustable parameters are designed to allow modeling flexibility to enable the modeler to update the unit process to meet specific assumptions and study criteria, as relevant. Additionally, these values may be updated as needed to incorporate newer or revised data sources. Corn grain yield per year indicates the annual yield of corn grain per acre and is used to translate the values for diesel consumption, diesel combustion, and fugitive dust emissions from a basis of quantity per acre to a basis of quantity per kilogram of biomass production NETL currently recommends a default value of 3,829 kg/acre-yr for this parameter based on a survey of national data from 2004 to 2009 (Iowa State 2009, USDA 2010). The horizon time indicates the study period such that the initial conversion of the land into a corn field is allocated over every kilogram of corn which is produced. This conversion only occurs once during the study period.

Diesel is consumed by the tractor as it pulls the disc tiller. The diesel consumption of equipment used in farming cultivation activities was calculated based on specifications of a 1953 rpm tractor consuming 10.26 gal/hour diesel fuel and a disc tiller of 4.78 m (188 inches) width (John 2009a, John 2009b).

Assuming that tractor operates at 5.8 miles per hour (mph), an average operating speed, and by multiplying the width of the disk tiller by the operating speed of the tractor, the land coverage rate is estimated at 11 acres per hour (Caterpillar 2010). Multiplying this land coverage rate by the fuel consumption rate, the estimated diesel consumption is 0.93 gal/acre prepared. This calculation assumes that the tractor makes two passes over the site; the total diesel consumption is 1.86 gal/acre.

The emissions for the required amount of diesel combusted for this process are accounted for in an upstream diesel combustion process. That process is pulled as an input to this process. The impacts associated with the manufacturing of the tractor and disc tiller are accounted for in a separate unit process. This process scales the manufacturing processes based on the amount of biomass demanded.

Fugitive dust emissions are generated by the disturbance of surface soil during land preparation. Fugitive dust emissions from land preparation are estimated using an emission factor specified by Western Regional Air Program (WRAP) (Countess Environmental 2004), which conducted air sampling studies on ripping and sub-soiling practices used for breaking up soil compaction. The emission factor for fugitive dust is 1.2 lb PM10/acre-pass. The tractor makes two passes of the site and thus has a fugitive dust emission factor of 2.4 lbs PM10/acre. The total emissions of fugitive dust are 0.036 kg PM/acre-year. The ratio of PM2.5 to PM10 utilized for this study is 0.15 kg PM2.5/kg PM10.

Properties of corn grain biomass land preparation operation activities relevant to this unit process are illustrated in **Table 1**. **Table 2** provides a summary of modeled input and output flows. Additional details regarding input and output flows, including calculation methods, are contained in the associated DS sheet.

Table 1: Properties of Land Preparation Operation Activities

Property	Value	Units
Corn grain yield	3829	kg/acre-year
HHV corn grain	6970	Btu/lb
LHV corn grain	6545	Btu/lb

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)	DQI
Inputs			
Diesel Combustion, Mobile Sources, Truck [Refinery products]	**5.18E-05**	**kg**	**2,3**
Equipment Assembly per kg Biomass [Valuable substances]	**1.00E+00**	**Pieces**	**2,2**
Area of Production Land	8.71E-06	acres	2,3
Outputs			
Biomass Operation [Installation]	1	kg	2,3
Dust (PM10) [Particles to air]	9.48E-06	kg	2,3
Dust (PM2.5) [Particles to air]	1.42E-06	kg	2,3

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows.

Inventory items not included are assumed to be zero based on best engineering judgment or assumed to be zero because no data was available to categorize them for this unit process at the time of its creation.

Embedded Unit Processes

None.

References

Countess Environmental 2004 — Countess Environmental, 2004. *WRAP Fugitive Dust Handbook.* WGA Contract No. 30204-83. Western Regional Air Partnership.

Federal Register 2004 — Federal Register. 2004. *Part II: Environmental Protection Agency: 40 CFR Parts 9, 69, et al. Control of Emissions of Air Pollution from Nonroad Diesel Engines and Fuel; Final Rule*. National Archives and Records Administration.

Iowa State 2009 — Iowa State. 2009. *Iowa Farm Outlook Chartbook.* Iowa State University. http://www2.econ.iastate.edu/outreach/agriculture/periodicals/chartbook/Chartbook2/Tables/Table10.pdf (Accessed June 13, 2012)

John 2009a — John Deere. 2009. *John Deere Model 7830 165 PTO hp (Manufacturer Specifications)*. Deere & Company.

John 2009b — John Deere. 2009. *John Deere Model 425 Disk Harrow Wheel Type Offset (Manufacturer Specifications)*. Deere & Company.

PSU 2009	PSU. 2009. *Coping with High Energy Prices: Heat Energy Content of Shelled Corn*. Penn State College of Agricultural Sciences. http://energy.cas.psu.edu/energycontent.html (Accessed February 15, 2010).
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Tillage 2009	Tillage Answers. 2009. *Tillage Calculators*.www.tillageanswers.com/tandem_calculator.cfm (Accessed Feb 15, 2010).
USDA 2009	USDA. 2009. *Fact Sheet: Management and Lifecycle Assessment of Bio-energy Crop Production*. U.S. Department of Agriculture.
USDA 2010	USDA. 2010. *2009 Crop Year is One for the Record Books, USDA Reports.* U.S. Department of Agriculture. Washington D.C. http://www.nass.usda.gov/Newsroom/2010/01_12_2201.asp (Accessed June 13, 2012).

Section III: Document Control Information

Date Created: May 26, 2011

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Revision History:

13JUNE2012	Updated to revised parameter values.
26DECEMBER2014	Updated to reflect diesel combustion removal. Combustion is now an input to this process. Added inventory item level DQI data. Speciated fugitive dust emissions by size.

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