NSW GOVERNMENT Primary Industries

FACTSHEET

Life Cycle Assessment of greenhouse gas emissions from agricultural enterprises

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Definition

Life Cycle Assessment (LCA) is an internationally agreed approach which is used to assess environmental impacts from production systems. It was originally developed for manufacturing industries but has been increasingly applied to other sectors of the economy. LCA involves analysis of each stage in the production process of a system or enterprise. Data used to develop LCAs are usually sourced from extensive international Life Cycle Inventory (LCI) databases (RMIT 2005 and Hischier 2009), published papers and direct measurement. International standards ISO 14040 and ISO 14044 apply to the development of LCAs (ISO 2006a and ISO 2006b). Further definition of LCA is available at: http://www.alcas.asn.au/intro-to-LCA/methodology.

When initiating a LCA, it is important to clearly frame the key question that is to be answered, as this clarifies the goal, scope and functional unit of the study. In effect, this establishes the 'system boundary' and defines the associated system inputs (Horne, Grant & Verghese 2009) (Figure 1). The functional unit is the product or service for which all impacts are to be assessed, such as a tonne of wheat or a kilogram of beef. Comparative LCAs can be developed, such as for a tonne of wheat using nitrogen fixed by a legume crop versus a tonne of wheat using only synthetic nitrogen fertiliser.

Scope

The system boundary for LCAs is often cradle-to-grave, covering the full range of environmental impacts (known as Life Cycle Impact Assessment) from the manufacture and transport of raw materials, creation of the product, transport and use of the product and disposal of waste products (Figure 1).

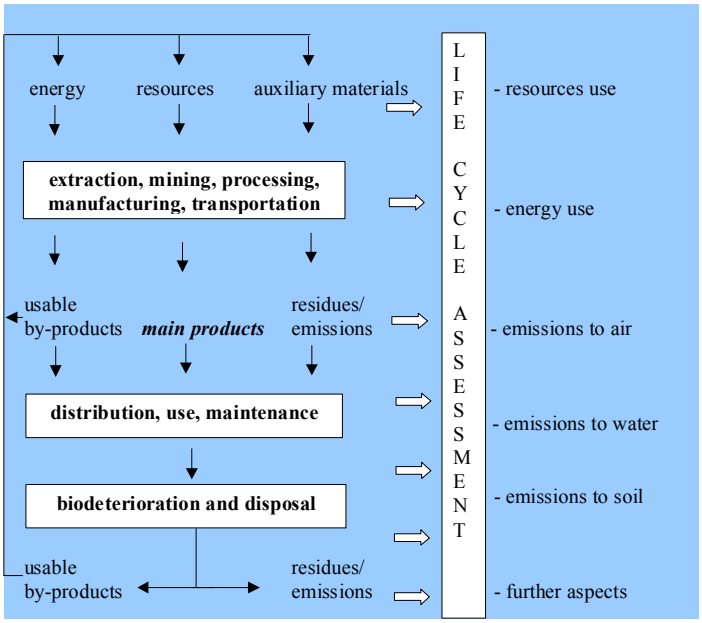

Figure 1. Diagrammatic representation of a generic LCA process

NSW Department of Primary Industries (NSW DPI) has decided to initially focus LCA activities on greenhouse gas emissions, with the option of eventually considering other impacts, such as water use and eutrophication. NSW DPI has also decided to initially develop cradle-to-farm-gate LCAs for agricultural systems, to which post-farm impacts could be added. This means that we will assess both pre-farm and on-farm emissions.

Beyond this agricultural focus, NSW DPI has been developing LCAs for forest products for some time (e.g. Ximenes & Grant 2009; Ximenes 2001) and work has occurred in the biofuels area.

When developing LCAs, we can decide which emissions to consider (as per Attachment 1). In some instances, residues are part of natural cycling and in other instances they substitute for the use of other inputs. Opportunities to reduce

emissions per unit of product often closely align with opportunities to maximise production.

Agricultural LCA can take into account emissions from:

- livestock – enteric fermentation (methane) and animal wastes (methane and nitrous oxide);
- pastures – residue leaching, burning or rotting and nitrogen fixation;
- crops – residue leaching, burning or rotting and nitrous oxide losses;
- fertiliser – through manufacture, transport, application and losses as nitrous oxide;
- on-farm fuel use – for cultivation, sowing, spraying and harvesting;
- transport – inputs to and from farm;
- land clearing, noting that tree planting will reduce emissions.

Context and focus

The Australian Life Cycle Assessment Society (ALCAS) is the peak professional body for LCA practitioners (http://www.alcas.asn.au/). ALCAS provides resources, professional support and collaborative opportunities for people involved in the use and development of LCA. From an Australian perspective, more than a dozen agricultural LCAs have now been developed (such as Narayanaswamy et al. 2004; Biswas, Barton & Carter 2008; Harris & Narayanaswamy 2009; Weidemann et al. 2010; and Renouf, Wegener & Pagan 2010), of which most have been commissioned by agricultural industry funding bodies.

NSW DPI already has expertise in emissions accounting for agriculture and staff members have published papers about emissions from both livestock and cropping systems (Alcock & Hegarty, in press; and Schwenke et al. 2010). FarmGAS (http://farmgas.farminstitute.org.au/) has also been developed by NSW DPI as an emissions calculation tool for extension and accounting purposes. LCAs have been drafted by NSW DPI for products such as wheat (Attachment 1), wool and beef. However, these LCAs require further refinement prior to publication and therefore Attachment 1 has been provided as sample output only.

Future directions

The intention is to build LCAs for specific enterprises, which will then be used to create LCAs for agricultural systems. System-based LCAs will be important in developing understanding of how enterprises and practices can influence emissions profiles, including those in subsequent enterprises.

NSW DPI has chosen to use the internationally recognised software Simapro (2011) to develop our LCAs. We have built many of the formulas and emissions factors from the National Greenhouse Gas Inventory (Commonwealth of Australia 2007) into Simapro. However, because LCA will be used for assessing emissions for specific enterprise structures, rather than as a national emissions accounting tool, we are able to alter assumptions and emissions factors. We also have direct access to research findings that are specific to NSW.

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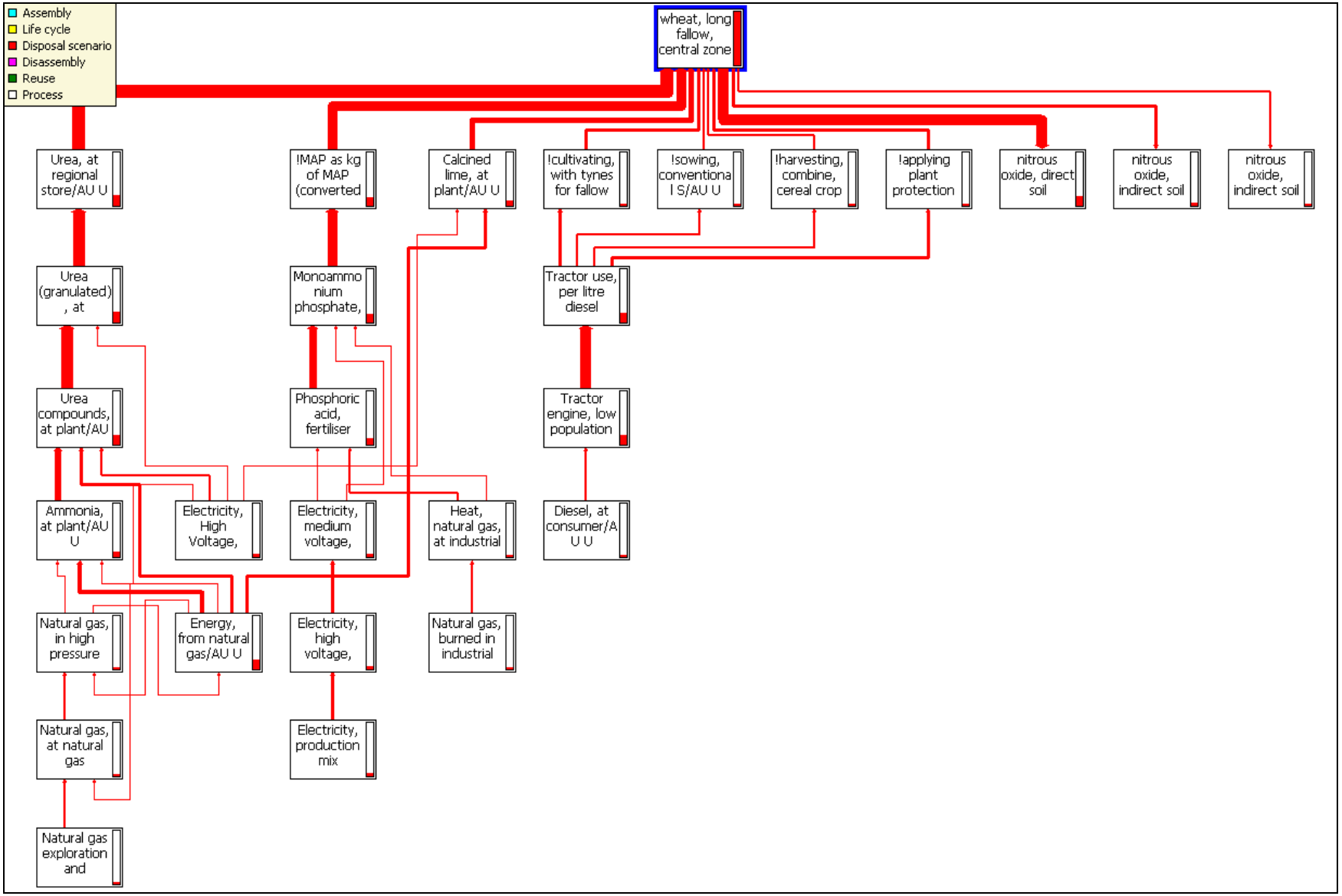
Attachment 1. Greenhouse Gas emissions from 1kg wheat grown in central zone east NSW, long fallow*



* Not all emissions are visible, nor are all of the 2273 processes that comprise this LCA, as the cut-off has been set at 3.1% to simplify the diagram. The width of the branches represents the contribution from each process to the total emissions.