NEW ZEALAND
LIFECYCLE
MANAGEMENT CENTRE

1st New Zealand Student Symposium on Life Cycle Management

Symposium Proceedings

16 October 2012

Table of Contents

Accounting for Soil Carbon Stock Changes in LCA: Importance, Issues and Potential Solutions

Edouard Périé[1,2,3*], Sarah J McLaren[1,3] and Brent E Clothier[2,3]
[1] Massey University, Palmerston North, New Zealand,
Edouard.perie@plantandfood.co.nz, S.McLaren@massey.ac.nz,
brent.clothier@plantandfood.co.nz
[2] New Zealand Institute for Plant & Food Research Ltd, Palmerston North, New Zealand,
Edouard.perie@plantandfood.co.nz, brent.clothier@plantandfood.co.nz
[3]New Zealand Life Cycle Management Centre, Palmerston North, New Zealand,
Edouard.perie@plantandfood.co.nz, S.McLaren@massey.ac.nz,
brent.clothier@plantandfood.co.nz

Soil carbon is excluded from carbon footprint and Life Cycle Assessment methodologies although its contribution could dominate the cultivation stage of the carbon footprint for some agricultural products. Moreover, soil carbon is, in many ways, essential for the sustainability of our food production systems. Soil carbon stocks are highly spatially variable which advocates using site specific estimates. In proposed methodologies, the reference situation used to calculate the impact may not reflect field reality, and instead could be based on soil characteristics. The capacity of the soil to store carbon is limited and this limit varies for different soils. These characteristics impact the potential storage capacity of management practices for different soils and the difficulty to store and maintain stocks. These aspects should be taken into account when calculating the impact. The timeframe to measure changes is important as changes may not be linear with time.

In this presentation, we describe how important soil carbon is in general, present some issues related to its accounting in LCA, and highlight potential solutions.

The Carbon Footprint of Biochar Systems: a Relative Contribution to Climate-Change Mitigation

R.K. Anaya de la Rosa[1]
[1]Massey University, Wellington, New Zealand, r.anayadelarosa@massey.ac.nz

Abstract

Biochar is charcoal used for application into soils to store carbon and to improve soil functions. Since the carbon in biochar can take hundreds or thousands of years to decompose, the incorporation of biochar into soils is being promoted as a climate-change mitigation strategy. Furthermore, the recovery of by-products, syngas and bio-oil, for fossil fuel substitution offers additional opportunities to reduce greenhouse gas emissions. Since biomass resources are limited, the trade-offs associated with alternative end uses of biomass need to be explored using a system expansion perspective, particularly when considering policy options to encourage or discourage the production and use of biochar.

The goals of this carbon footprint study are: 1) to compare future alternative management scenarios for three biomass feedstocks selected as case studies (prunings from apple orchards, logging residues, and cereal straw); and 2) to inform policymakers on the best use of biomass to mitigate climate change. The functional unit is 'the management of one tonne of fresh biomass'. The alternative scenarios considered in each case study, however, deliver additional functions (e.g. energy production and soil quality). Therefore, system boundaries have been expanded for each scenario to include background processes required to achieve the same functions.

The results of the carbon footprint of three biochar systems will be presented in relation to alternative biomass management options. This comparative assessment is different from the approach taken in existing carbon footprint studies of biochar as the climate-change mitigation potential of biochar is recognised as one alternative use amongst others, and with consequences for other activities in the economy.

The Water Footprint of New Zealand Wine: Evaluation of Different Water Footprinting Protocols

Indika Herath[1,2,3], Brent Clothier[1,3], Steve Green[1], David Horne[2], Ranvir Singh[2,3] and Carlo van den Dijssel[1]

[1] New Zealand Institute for Plant and Food Research, Palmerston North, New Zealand, Indika.Herath@plantandfood.co.nz, brent.clothier@plantandfood.co.nz, steve.green@plantandfood.co.nz, Carlo.vandenDijssel@plantandfood.co.nz

[2] Institute of Natural Resources, Massey University, Palmerston North, New Zealand, I.K.Herath@massey.ac.nz, D.J.Horne@massey.ac.nz, R.Singh@massey.ac.nz

[3] New Zealand Life Cycle Management Centre, Massey University, Palmerston North, New Zealand, Indika.Herath@plantandfood.co.nz, brent.clothier@plantandfood.co.nz, R.Singh@massey.ac.nz

Abstract

Globally, the food industries are confronting serious challenges associated with freshwater use. The water footprint (WF) has been proposed as an indicator of the impacts of food-production systems on freshwater resources. A number of methods for water footprinting have been proposed. The WF of a bottle of wine was assessed for the Marlborough and Gisborne regions using the hydrological water-balance method. Our results were compared with the Water Footprint Network's (WFN) method and two LCA-based methods: those of Ridoutt and Pfister (2010) and Canals et al. (2009). The water-balance method shows a large variation in the local impacts since the hydrology is driven by the great variability in rainfall and the wide differences in soil properties. On average, in both regions, the groundwater resources are recharged under viticulture, which is reflected in a negative blue-water footprint. The impact on water quality was assessed by the average nitrate concentration and the load of nutrients reaching groundwater. The WFN method for the blue-green footprint lacks correspondence to the impacts on the local water resources, and the comparisons of impacts between products of different regions are therefore limited. The two LCA-based methods enable comparison between products from different locations. However, their ability to indicate the localised impacts is limited due to the spatial constraints of the characterization factors that are used. The hydrological water-balance method can indicate local impact on water resources in a way that it can be understood by the non-technical community. This provides useful information to both growers and resource regulators so that they can set measurable targets to reduce the WF. The robustness of current WF protocols for quantifying the impact of the product life cycle on water quality is dubious. It needs further improvements so that water footprinting can provide metrics for the sustainable use of our water resources.

Development of an Approach for the Systematic Comparison of Ecologic Assessment Methods in the Aviation Sector

K.Bauch[1]
[1]University of Stuttgart, Stuttgart, Germany, k.bauch@pe-international.com

Introduction

The starting point of this study was the question of an international aircraft manufacturer on which method should be used for the determination of product-related environmental impacts. The aim of this study was therefore to inform the in-house selection with the development of an approach to provide a systematic support.

Methodology

Two suitable methods were identified: the top-down oriented input-output-based Life Cycle Assessment (LCA) and the bottom-up oriented process-based LCA. For both strengths and weaknesses were elaborated. Based on this analysis, the significant aspects for this decision were determined, grouped and transformed into a set of criteria. To link the required objectivity of the decision to the individual requirements of users, the selection process was divided into two parts: the objective method evaluation and the criteria weighting. As part of the method evaluation, the two accounting alternatives for each criterion were compared and rated. The requirements and conditions in different departments have been integrated into the decision making process through the weighting of the main criteria. The assessments were calculated separately then brought together and evaluated. For a practical review of the results, both methods were applied and compared by assessing a vertical tail.

Results

With the analysis of the criteria weighting which was filled out by three departments of the aircraft manufacturer, it was demonstrated that the situational requirements, arising from the different activities of the areas considered, influence the subjective relevance of the criteria and thus the selection of method. However, it was also shown that in addition to the separate evaluation of each area of activity through a coherent view, the synergy and learning effects must be included in the final decision.

Finally, the practical application of both methods performed on the vertical tail has shown that the input-output-based LCA is well suited to identify dependencies between economic sectors, while the process-based LCA is more suitable to optimise processes within a company.

After LCA – Life Cycle Management and Ongoing Product Development of Bloodmeal Based Thermoplastics

J.M. Bier[1], C.J.R Verbeek[2] and M.C. Lay[3]
[1]University of Waikato, Hamilton, New Zealand, jmb101@waikato.ac.nz
[2] University of Waikato, Hamilton, New Zealand, jverbeek@waikato.ac.nz
[3] University of Waikato, Hamilton, New Zealand, mclay@waikato.ac.nz

Abstract

Concerns regarding fossil fuel depletion and the build up of wastes in the environment have motivated the development of biobased and compostable alternatives to conventional plastics. One such alternative is Novatein Thermoplastic Protein (NTP), produced from bloodmeal, a low value, inedible by-product of the meat processing industry. The purpose of this work is to discuss implications and experiences of performing life cycle assessment (LCA) early in the product development cycle, using NTP as an example.

Any product developed in response to sustainability and environmental concerns should be evaluated using techniques such as life cycle assessment A difficulty with this is determining when during the product development cycle such an assessment should be conducted. Too early, and the product system may be insufficiently defined for a suitably thorough analysis of a realistic situation. Too late, and much time and many resources may get spend on developing ideas that are more expensive and less marketable than existing technologies with little potential for true environmental benefits.

In the case of NTP, after successful laboratory trials the thermoplastic formulation was patented [1] and a commercial feasibility study conducted. Following this, a cradle to gate partial LCA was conducted to identify hot spots in the production of NTP and make a comparison with other plastics that may be functionally equivalent for some applications [2-3].

Since that study was completed, ongoing product development in the laboratory environment has suggested several changes to the proposed commercial process. Although the changes mean specific numbers from the partial LCA are no longer accurate, several key themes and issues were identified that remain relevant for commercialisation. These include issues regarding allocation approaches, identification of major hot spots and fundamental differences in the technology used to produce different classes of bio-based plastics. The continued relevance of these issues in ongoing product development demonstrates the usefulness of performing LCA at an early stage in the product development life cycle.

References

[1] Verbeek, C.J.R., Viljoen, C., Pickering, K., van den Berg, L., inventors; Waikatolink Limited, assignee. (2007) "NZ551531: Plastics material," *New Zealand patent,* No. 551531.

[2] Bier, J., Verbeek, C., Lay, M. (2012). "An eco-profile of thermoplastic protein derived from blood meal Part 1: allocation issues," *The International Journal of Life Cycle Assessment,* Vol. 17, No. 2, pp. 208-219

[3] Bier, J., Verbeek, C., Lay, M. (2012). "An ecoprofile of thermoplastic protein derived from blood meal Part 2: thermoplastic processing," *The International Journal of Life Cycle Assessment,* Vol. 17, No. 3, pp. 313-324.

A Framework of Barriers and Enablers to Successful LCM Uptake in Primary Industry Sectors

Helene Sterzik[1,2,3], Sarah J McLaren[1,2], Anthony Hume[2,3], Elena Garnevska[1] and James E McDevitt[2,4]
[1] Massey University, Palmerston North, New Zealand, H.Sterzik@massey.ac.nz, S.McLaren@massey.ac.nz, E.V.Garnevska@massey.ac.nz
[2]New Zealand Life Cycle Management Centre, H.Sterzik@massey.ac.nz, S.McLaren@massey.ac.nz, HumeA@landcareresearch.co.nz, James.McDevitt@scionresearch.com
[3]Landcare Research, Wellington, New Zealand, H.Sterzik@massey.ac.nz, HumeA@landcareresearch.co.nz
[4]Scion, Wellington, New Zealand, James.McDevitt@scionresearch.com

Abstract

There is a rising awareness of environmental problems and wider sustainability issues amongst governments, industries and consumers [1, 2]. Environmental considerations are particularly important for the New Zealand primary industry sectors since they rely heavily on natural resources and provide about 70% of the export products.

Proactive integration of sustainability into business practices reinforces the country's 'clean and green' image. At the same time, New Zealand companies can strengthen their competitiveness in the global market place [3]. However, many organisations, particularly small and medium sized enterprises (SMEs), face major difficulties implementing sustainability practices and are therefore lagging behind [4, 5].

One approach to incorporate sustainability into company operations, management and strategies is the implementation of Life Cycle Management (LCM) initiatives. In this PhD project, a framework has been developed to facilitate the identification of specific barriers to successful, sector-wide uptake of LCM in a particular industry sector. The barriers have been identified from the bodies of literature on SMEs, supply chain management and technology transfer.

The barriers to sector-wide uptake of LCM include structures that impede knowledge sharing, limited resources (financial, human, technical), cultures that do not support sustainability initiatives, limited knowledge and recognition of environmental issues, lack of future orientation, perceived conflicts between environmentally friendly practices and other business objectives, lack of market requirements, geographical separation of production and consumption, communication barriers and lack of networks.

The framework has been verified through a pilot study in the New Zealand kiwifruit industry. The pilot study involved semi-structured, face-to-face interviews with growers (conventional and organic), packhouses and Zespri. It has shown that the main enablers for the kiwifruit sector are its monopoly structure, the culture that supports open communication, the knowledge of - and recognition of - environmental issues, and the future orientation and awareness of market requirements. The barriers are lack of resources, and subsequently trade-offs between business objectives as well as separation from consumers and lack of effective collaboration. The findings suggest that future industry specific tools and practices should focus on improved collaboration so that findings on how to improve the environmental performance of the different stakeholders can be used across the industry, and not only by individual companies.

The next phase of the project includes identification of the specific barriers (using the generic framework) to LCM implementation faced by growers, processors and other associated organisations in the New Zealand-based part of the supply chains for two specific industry sectors. This will be carried out through large scale internet surveys. Based on the results from the surveys, it may be possible to identify sector-specific barriers and enablers for LCM implementation. Focus group sessions will be conducted to identify and investigate effective improvement projects for the organisations in the supply chains. This may involve initiatives by individual organisations; however,

it is hypothesised that a sector-based approach is a more effective way of implementing LCM in the primary industry sectors.

References

[1] Green Growth Advisory Group. (2011). Greening New Zealand's Growth.
[2] McLaren, S.J. (2008). Defining a role for sustainable consumption initiatives in New Zealand.
[3] Pure Advantage. (2012) New Zealand's Position in the Green Race, pp. 58.
[4] Seidel, M., et al., (2009). Overcoming Barriers to Implementing Environmentally Benign Manufacturing Practices: Strategic Tools for SMEs. Environmental Quality Management, pp. 37-55.
[5] Hillary, R., (2000). Small and medium-sized enterprises and the environment: business imperatives: Greenleaf Publishing.

Life Cycle Sustainability Assessment to Analyse Alternative Forestry Value Chains with Māori Land Owners

S. Pizzirani
Scion, Rotorua, New Zealand, stefania.pizzirani@scionresearch.com

Forestry in New Zealand is a major industry providing jobs and revenue to the national economy. Natural and planted forests exist throughout the country yet they are primarily managed in only two ways: the natural forests as nature reserves and the planted forests as intensive timber production.

Shifts in consumer demands and environmental policy are leading to a widespread interest in forest management diversification. Furthermore, New Zealand is committed to several initiatives which support sustainable forest management such as the Conservation Act and the Resource Management Act. There is a great need therefore to evaluate the potential impacts of expanding New Zealand forestry to include other management styles, and to diversify the associated forest products and services.

To do this, work has begun to perform a life cycle sustainability assessment (LCSA) on these new management approaches. LCSA assesses a product's environmental, social, cultural, and economic impacts from raw material extraction and product development through to the product's final disposal (i.e. from the 'cradle to the grave'). LCSA is commonly used within a variety of sectors to demonstrate the impacts of activities.

The research will focus on Māori-owned forestry enterprises. Māori are fast becoming the largest forest land owners in New Zealand, and have demonstrated their interest in utilising less intensive management – although some Māori may be more interested in long-term profit and economic stability. The Māori community therefore has diverse needs and is an ideal stakeholder with which to investigate alternate forest management regimes.

This research presentation will review the issues of utilising alternative management regimes (particularly in New Zealand), and Māori interests regarding forest management. The presentation will highlight the progress that has been made in these areas, the challenges that remain, and potential solutions to promote the holistic advancement of forest management in New Zealand.

Complementing Hoofprint Studies with Water Footprinting - An Integrated LCA Approach to Ensuring Long Term Sustainability

N. A. Bortsie-Aryee[1]
[1]Otago University, Dunedin, New Zealand, nanabo.aryee@yahoo.com

Water is considered one of the most essential commodities for the sustenance of all forms of life in the world. However, despite its importance, millions of people around the world do not have access to safe drinking water, face water shortages and sometimes lack basic sanitation components associated with water supply and use. These issues concerning fresh water supply has led to the development of tools and concepts needed to improve water use domestically and in industrial settings including agriculture and various agro related processing industries. One of these relatively new concepts is water footprinting.

Water footprinting like hoofprint studies (which focuses on measuring greenhouse gas emissions like methane and carbon dioxide from the production and processing of meat and dairy animals and products) measures the impact of human activities and processes on water quality and quantity within a certain scope or boundary. The use of this tool within a scope and a boundary makes it applicable to supply chains of products and services. Hoofprint studies, developed by experts in the agribusiness industry, have been on the rise lately. This is due to the advantages it offers in terms of competitive advantage in the growing green business sectors and the option of reducing costs whilst also being profitable in the medium to long term.

Coupling the two footprint concepts starts from ensuring that the same functional unit is used in both. However, more can be achieved by integrating other concepts such as geographical information system, system dynamics and agent based modeling into the coupled footprint study. This study presents a framework for an integrated footprinting model that consists of hoofprinting and waterfootprinting and can serve as a basis for environmental management in New Zealand agribusinesses.

.

Contribution of Milk and Feed Wastes Disposal to the Carbon Footprint of a Dairy Farm

Matthew L. Chung[1], Andrew N. Shilton[2], Benoit J. Guieysse[2], Chris Pratt[2]
[1,2]School of Engineering and Advanced Technology, Massey University, Palmerston North, New Zealand, m.s.l.chung@massey.ac.nz, a.n.shilton@massey.ac.nz, b.j.guieysse@massey.ac.nz, c.pratt1@massey.ac.nz

Abstract

The carbon footprint of dairy farming is mainly caused by enteric emissions, manure management and N_2O emissions from agricultural soil. Within the 'manure' subset, most greenhouse gas emissions are attributed to the release of methane during the treatment of the manure collected from farm operation (e.g. milking) in effluent treatment systems (e.g. anaerobic ponds). However, manure is not the only waste with bio-methane potential that enters anaerobic ponds in dairy farms. Waste milk (e.g. milk residuals in piping and contaminated milk) and feed wastes (e.g. feed residues from spillage) are also discharged into the anaerobic ponds along with wash-down manure. The contribution of milk and feed waste disposal to the carbon footprint of a dairy farm are currently unaccounted for. Using a dairy research farm in New Zealand as a case study, we show that methane emissions from milk and feed wastes could potentially increase the total methane emissions from the anaerobic ponds by 30 – 60%. Our estimates can be considered as conservative given the increasing trend in feed-pad usage in New Zealand, which will mean that more feed wastes, in addition to more manure, will enter anaerobic ponds on dairy farms in the near-future. It is therefore concluded that further research into accurately establishing the full extent of emissions from this sector, which has been previously overlooked, is warranted.