Assessing eco-efficiency of sugarcane production using customised LCA tool

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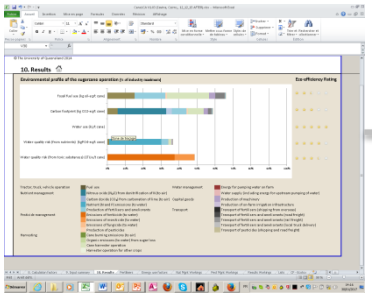
Aim

Making environmental life cycle assessment (LCA)
more accessible and rapid for agriculturalists
so they can evaluate alternative agricultural practices

LCA researchers → **Customised LCA tools for agriculture** → **Transfer to environmental knowledge to agriculturalists** → **Decisions about agricultural practices**

Cane LCA tool



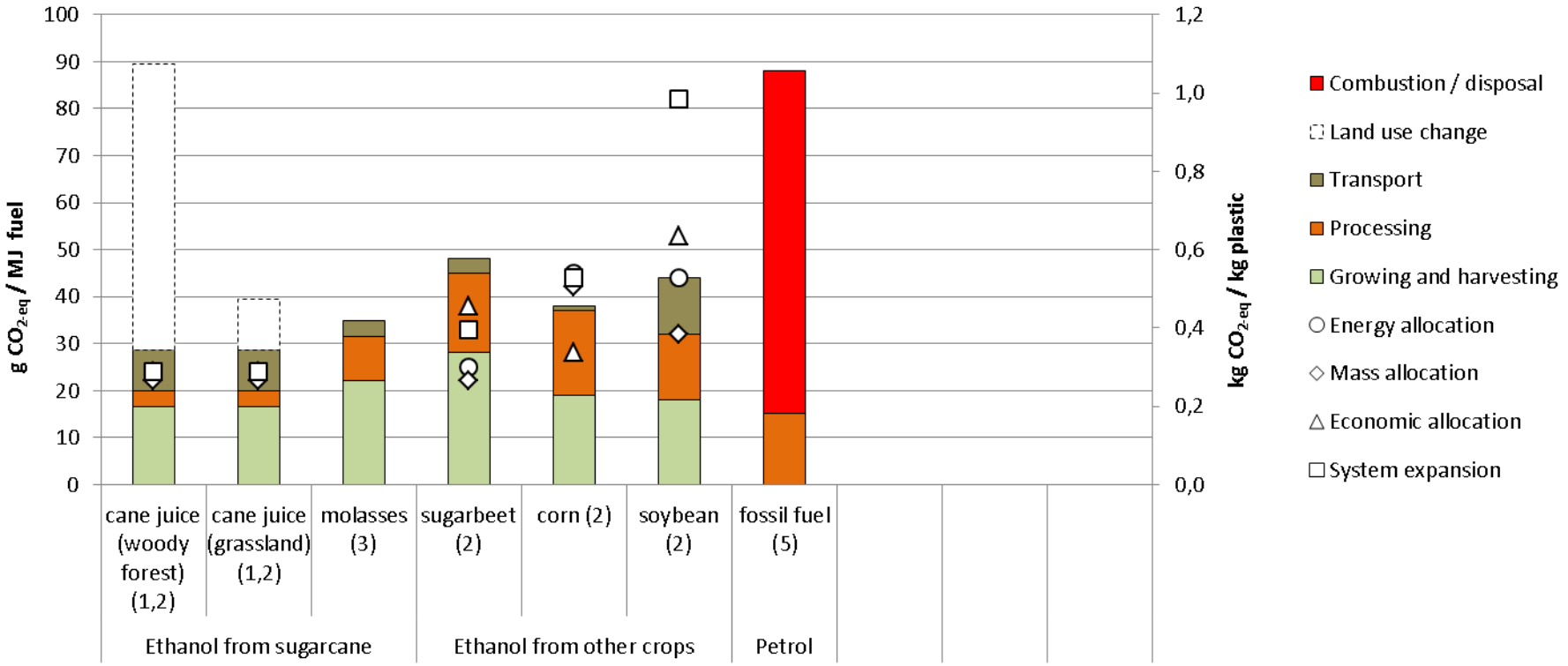
Eco-efficiency

Why is this important for bio-energy?

- GHG mitigation from eco-efficient agriculture can be significant compared to GHG abatement from bio-energy production

- Eco-efficient agriculture mitigates other environmental trade-offs from bio-energy production

Implications of eco-efficient agriculture for bio-fuels



Source: Renouf, M.A., 2016. Greenhouse gas abatement from sugarcane bio-energy, bio-fuels and bio-materials, in: O'Hara, I.M., Mundree, S.G. (Eds.), Sugarcane Based Biofuels and Bioproducts. John Wiley & Sons

Consequential LCA results of sugarcane bio-production compared with eco-efficient sugarcane production (per 100t cane processed)

Environmental impact categories		**Utilisation of mill co-products from processing of existing sugarcane**			**Dedicated bio-production resulting in expanded cane production**		**Eco-efficient cane growing**
	Unit	Electricity. from bagasse	Ethanol from molasses	Ethanol from bagasse	Ethanol from cane juice	Plastic (PLA) from cane juice	
Energy use	GJ	-45.3	-51.1	-75.2	-315.2	-738.7	**-14.2**
GHG emissions	t $CO_{2(eq)}$	-4.1	-4.3	-5.7	-21.6	-20.1	**-3.6**
Eutrophication	kg $PO_{4(eq)}$	-2.0	1.4	-1.3	32.6	21.3	**-11.7**
Acidification	kg $SO_{2(eq)}$	-148	-74	-102	182	-368	**-44.9**
Water use	kL	0.0	-1.7	0.0	3,751	3,767	**-1,235**
Land use	ha	0.0	0.5	0.0	1.2	1.2	**0.0**

-ve results= decreased impact

+ve result = increased impact

Red values are environmental trade-offs

Source: Renouf, M., Pagan, R.J., Wegener, M.K. (2013) Bio-production from Australian sugarcane: an environmental investigation of product diversification in an agro-industry.Journal of Cleaner Production, 39, 87-96

CaneLCA

BSES Sugarcane for the future

The University Of Queensland AUSTRALIA

Australian Government
Sugar Research and Development Corporation

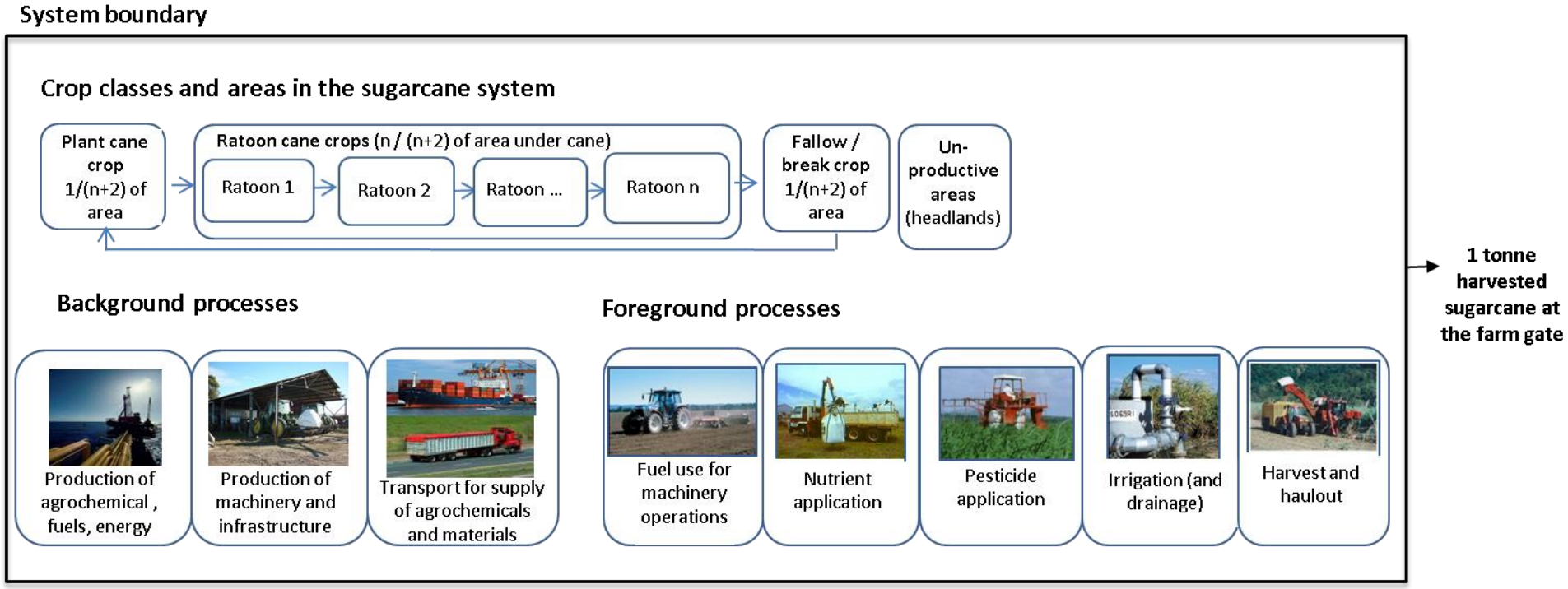
CaneLCA Eco-Efficiency Calculator
for Australian sugarcane growing
(Version 1.03)

Customises the LCA process for the sugarcane sector by:

- focusing on 'cradle to farm gate' processes
- focusing on relevent environmental impact categories
- parameterising practice variables
- presenting results in a way that facilitates interpretation by agriculturalists

Available from: UniQuest web site (http://eshop.uniquest.com.au/)

CaneLCA system scope



Mid-point impact indicators assessed:

Non –renewable energy use

Climate change

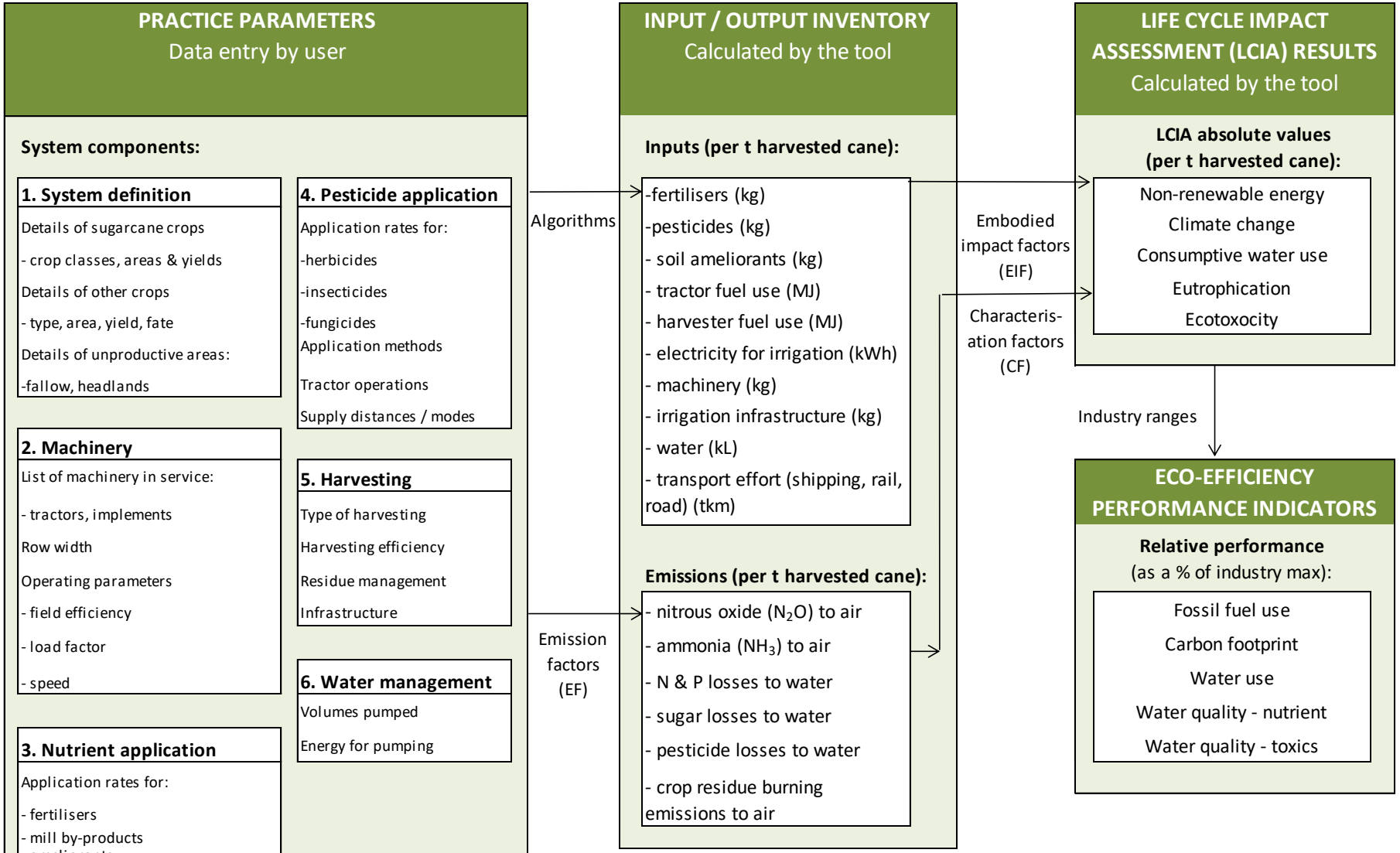
Consumptive water use

Eutrophication

Freshwater ecotoxicity

Source: Renouf, M.A., Poggio, M., Collier, A., Price, N., Schroeder, B. and Allsopp, P. (2018) Customised life cycle assessment tool for sugarcane (CaneLCA): a development in the evaluation of alternative agricultural practices. International Journal of Life Cycle Assessment (10.1007/s11367-018-1442-z).

Components of CaneLCA



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Applications to date

Development of CaneLCA (V1,01) by Australian sugar industry and pilot testing - 2011

Renouf, M.A., Price, N., Allsopp, P.G., Schroeder, B., 2011. Streamlined LCA tool for cane growing - project outline. Prepared by University of Queensland and BSES for the Sugar Research and Development Corporation

Example application of CaneLCA (V1,02) to hypothetical practice change scenarios - 2014

Renouf, M.A., Schroeder, B.L., Price, N., Allsopp, P.G., 2014. Assessing the environmental benefits of practice change using the CaneLCA Eco-efficiency Calculator. International Sugar Journal 116, 755-765.

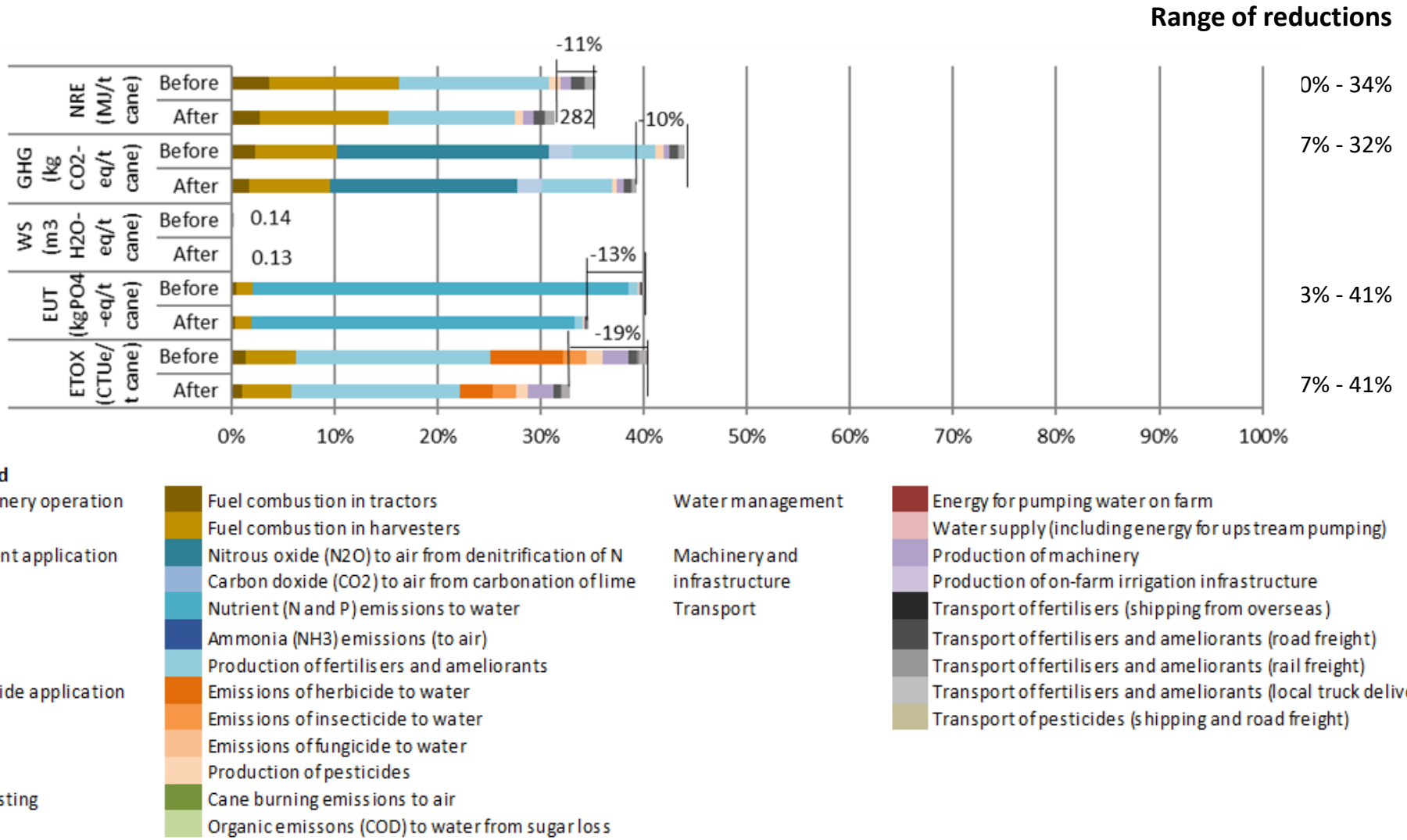
Detailed method description of CaneLCA (V1,03) and application to actual practice changes - 2017

Renouf, M.A., Poggio, M., Collier, A., Price, N., Schroeder, B. and Allsopp, P. (2018) Customised life cycle assessment tool for sugarcane (CaneLCA): a development in the evaluation of alternative agricultural practices. International Journal of Life Cycle Assessment (10.1007/s11367-018-1442-z)

Example evaluation of practice change at 6 case study farms in Australia

- Practice changes
  - increased row spacing to reduce traffic areas and reduce soil compaction
  - reduced tillage intensity and number of machinery operations, also to reduce soil compaction
  - GPS guidance on tractors and harvesters, for controlled traffic measures, and precision application of fertilisers and pesticides
  - changes to machinery and implements, to enable the above
  - reduced N application rates
  - legume break crop, to reduce synthetic urea-N use and surpress weed pressure and herbicide use
  - mill-mud application (a by-product from the sugar mill) to utilise its residual nutrients (N,P,K)
  - changed herbicides with reduced toxicity, and reduced application rates through more precise application methods
  - sub-surface application of N to to avoid NH_4 volatilisation

Example results



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