The Total Resource Use and Greenhouse Gas Emissions of the Lincoln University Dairy Farm - Life Cycle Assessment

This project has determined, based on Life Cycle Assessment methodology, the total resource use and greenhouse gas emissions (GHG) or carbon footprint of milk solids produced by the Lincoln University Dairy Farm (LUDF). The system boundary is to the farm gate. The 2006-07 production year was used for the assessment. LUDF is a high performance dairy farm producing over 1700 kg milksolids per hectare on a pasture based system.

Once the inventory was established two impact categories were chosen, resource use measured as total energy in megajoules (MJ) and GHG emissions measured as kilograms of carbon dioxide equivalents (kgCO2eq).

The functional unit that these two impact categories were measured against was a tonne of milk solids (t MS).

Where there are multiple product outputs from a production system and the inputs can not be attributed to a specific product then the LCA study must either avoid allocation altogether by system boundary expansion or choose a method of allocation, often either economic or biological. Environmental impacts were allocated between the co-products milk and meat according to biological causality at a ratio of 85:15, which is based on the feed requirements to produce milk and meat. Economic allocation would have used a ratio of 93:7.

The LUDF energy and resource inputs per unit of production were found to be almost identical to what this study determined for a “typical” NZ dairy farm, despite being an irrigated property that pumps water from a depth of 90 metres. The LUDF is significantly more intensive than the “typical” NZ farm so consequently resource inputs per hectare were 130% higher.

This study also determined the carbon footprint of a “typical” NZ dairy farm to enable the results to be compared and ensure that this was done using the same methodology and emission factors. Table 1 compares the carbon footprint of the Lincoln University Dairy Farm with a “typical” NZ dairy farm on a production, per hectare and per cow basis.

Table 1 Carbon Footprint of the LUDF vs. a “Typical” NZ Dairy Farm

	Carbon Footprint ($kgCO_2eq$/t MS)		Carbon Footprint ($kgCO_2eq$/ha)		Carbon Footprint ($kgCO_2eq$/cow)	
	Lincoln Uni. Dairy Farm	Typical NZ Dairy Farm	Lincoln Uni. Dairy Farm	Typical NZ Dairy Farm	Lincoln Uni. Dairy Farm	Typical NZ Dairy Farm
Direct Energy	380	360	755	375	185	135
Indirect Energy	730	780	1,455	815	350	290
Capital	50	140	105	145	25	50
Methane	4,770	5,570	9,510	5,805	2,300	2,070
Nitrous Oxide	2,950	3,070	5,875	3,200	1,420	1,140
Total	**8,875**	**9,920**	**17,700**	**10,340**	**4,280**	**3,690**

As shown in Table 2 the LUDF GHG emissions were found to be 11% lower on a production basis than the typical NZ dairy farm. If the use of eco-n™ was also taken into account (assuming it was applied across the whole LUDF as it was in the 2007-08 season and not on the typical NZ farm) then emissions per tonne of milk solids were 21% lower.

When compared to the most recently published AgResearch findings for the "typical" NZ dairy farm (Basset-Mens et al., 2007) LUDF's GHG emissions were 21% lower per unit of production (compared to our estimate of 11%). There is insufficient detail presented in the AgResearch report to determine why their "typical" NZ emissions are so much higher than found in this study despite having very similar production and stocking characteristics. However by comparing this studies estimate of "typical" NZ dairy emissions with the LUDF result, it ensures that the same methodology has been applied to both the LUDF and the "typical" NZ scenario. The estimated 11% lower emissions may then be conservative.

Table 2 Comparison of NZ Dairy and LUDF Energy and GHG Emissions

	MJ / t MS	kgCO_2eq / ha	kgCO_2eq / t MS
Basset-Mens et al.,	18,100	11,320	11,185
Typical NZ Dairy Farm (this study)	21,143	10,340	9,920
LUDF – no eco-n	21,750	17,700	8,875
LUDF – with eco-n	21,885	15,645	7,845

The efficiency of the LUDF emission per unit of output (milksolids) can be attributed in part to achieving higher than average productivity per cow and high grass harvest and conversion. Other management details such as auditing irrigators, tracing soil moisture and closely monitoring the property provide additional efficiencies.

A technical analysis of the NZ Emissions Trading Scheme was conducted. The Agricultural ETS will be applied to the animal and field emissions of methane and nitrous oxide. Total LUDF animal and field emissions that will attract the Agricultural ETS are 2,006 tCO2eq (20% lower than the LCA result). At $25/tCO2 the additional cost in the first year based on 90% of the emissions being allocated for free and assuming there have been no significant changes since the 2005 base year, will be $5,015. By the time the free allocation is phased out this will have increased to $50,160. Any change in carbon emissions either above (e.g. increased stock numbers) or below (e.g. by using a mitigation strategy like eco-n™) the 2005 base year will be charged at the full cost of carbon from the outset of the Agricultural ETS. Table 3 describes the impact of different carbon prices, free allocations and the use of eco-n™.

Table 3 Emissions Trading Scheme Farm Costs

Emission Source	Allocation of 90% of 2005 Emissions			Full Price of Emissions		
Carbon price >	$15	$25	$50	$15	$25	$50
Methane emissions	$1,860	$3,105	$6,205	$18,615	$31,030	$62,055
Field nitrous oxide emissions	$1,150	$1,915	$3,825	$11,480	$19,130	$38,265
Total Farm Carbon Cost	**$3,010**	**$5,015**	**$10,030**	**$30,095**	**$50,160**	**$100,320**
Eco-n Carbon Credit	$4,045	$6,740	$13,480	$4,045	$6,740	$13,480
Total Farm Carbon Cost Using eco-n	**-$1,035**	**-$1,725**	**-$3,450**	**$26,050**	**$43,420**	**$86,840**

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