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## Mitigation of greenhouse gas emissions by the energy grass *Miscanthus* × *giganteus*

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**Key words:** energy crops, GHG emissions, carbon sequestration, *Miscanthus*

**Introduction** As a result of the increasing demand for biomass energy crops to replace the fossil fuels oil, gas and coal there has been a renewed interest in identifying suitable energy crops which are close to carbon neutral. Biomass crops not only have the capacity to reduce fossil fuel consumption, but can aid in greenhouse gas (GHG) mitigation by acting as carbon sinks. Hence the construction of a full GHG budget for these crops is of vital importance. Reliable budgets depend on validation from long term growth trials but because of the relatively recent interest in dedicated energy crops these trials are few in number. Clifton Brown *et al.* (2007) have recently reported on 16 years of growth trials with the perennial rhizomatous C<sub>4</sub> grass *Miscanthus* × *giganteus*. Life-cycle assessment has been used to synthesise the net environmental impact of energy crop cultivation compared with conventional agricultural land uses, and energy crop combustion compared with fossil fuels, with particular regard to GHG emissions.

**Materials and methods** A field trial of *Miscanthus* × *giganteus* has been established near Cashel, Co. Tipperary, Ireland (52° 39' N, 07° 50' W) since June 1990. From 1991 to 2005, yield was determined in late February or early March (average 9 t dry-matter ha<sup>-1</sup> a<sup>-1</sup>). To determine the amount of carbon sequestered to the soil by 2005, 15 years after planting, one soil core was taken from each of the eight replicate plots and the *Miscanthus* derived organic carbon present in the soil was detected by measuring the change in the <sup>13</sup>C stable isotope signal (average 0.675 t C ha<sup>-1</sup> a<sup>-1</sup>). For details of this procedure see Clifton Brown *et al.* (2007). A life-cycle approach was used to quantify the major GHG emission sources associated with the production of useful heat (kWh<sub>th</sub>) from *Miscanthus* that is harvested and pelleted before combustion (Styles and Jones, 2007 & 2008)-these calculations were updated with Cashel data.

**Results** Life-cycle GHG emission reductions (average per hectare) possible where *Miscanthus* displaces conventional fuels for electricity generation and heat production, and dominant agricultural land-uses.

	Fuel displaced	Fuel GHG-intensity	Useful energy	Energy GHG reduction	Land-use displaced	Displaced LU emis.	Soil CO <sub>2</sub> seq.	LU GHG reduction
		kg CO <sub>2</sub> eq. kWh <sup>-1</sup>	kWh a <sup>-1</sup>	t CO <sub>2</sub> eq. a <sup>-1</sup>			t CO <sub>2</sub> eq. a <sup>-1</sup>	
ENERGY DISPLACEMENT	Peat (elec) <sup>a</sup>	1.15	17,472	19.33	Tillage	3.49	4.25	4.03
	Oil (heat) <sup>b</sup>	0.331	40,961	12.54	Set-aside	0.00	4.25	2.32
	Gas (heat) <sup>b</sup>	0.248	40,961	9.14	Extensif	0.00	2.48	0.54
	Electric (heat) <sup>b</sup>	0.624	40,961	24.54	Sheep	3.75	2.48	4.29
					Cattle	5.24	2.48	5.77
COMBINED ENERGY AND LAND-USE			MIN	9.68	LAND-USE DISPLACEMENT	Dairy	2.48	12.60
GHG REDUCTION (t CO <sub>2</sub> eq. a <sup>-1</sup> )			MAX	37.15				

**Conclusions** Fuel chain GHG emissions attributable to *Miscanthus* are between 70% and 88% lower than those for oil, gas and electric heating fuel chains, and 86% lower than for the peat-electricity fuel chain. However, long-term soil C sequestration when *Miscanthus* is grown on either grassland or tillage land exceed cultivation emissions, and, along with possible displacement of marginal agricultural production, could result electricity and heat production better than C-neutral. With life-cycle GHG reductions of between 9.68 and 37.15 t CO<sub>2</sub> eq. ha<sup>-1</sup> a<sup>-1</sup>, energy crop electricity and heat production represent highly efficient land-use options for GHG mitigation.

### References

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