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Organic farming, greenhouse gas emissions and energy use

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Agricultural components of climate change

Agriculture contributes to greenhouse gas increases through:

- Carbon dioxide releases linked to fossil energy use, decomposition of organic matter and deforestation
- Methane releases from paddy rice cultivation, enteric fermentation in ruminant livestock and manures
- Nitrous oxide releases from fertiliser manufacture/use and manure applications
- Methane 23x and nitrous oxides 297x more potent than carbon dioxide: $C0_2$ equivalence

Significance of agricultural emissions

- These agricultural components account for more than 50% of methane, 80% of nitrous oxide and 95% of CO_2 emissions linked to land use
- Livestock related emissions may account for 18% of total human-derived emissions (10% of CO_2, 35% of CH_4, 60% of NO_x), but big differences between species and systems
- Whole food systems, including inputs, distribution, processing, retailing and domestic, account for >35% of total emissions

Assessing the evidence on organic farming

- Needs careful assessment of evidence, but real world data is highly variable
- Organic farms are not homogeneous; can be significant differences in:
  - Land use, from hill farms to market gardens
  - Soil types and locations/climatic conditions
  - Production methods/intensity
  - Reliance on fossil/renewable energy
  - Skills, training and priorities of producers
- Carbon footprint calculators and organic v. conv. comparisons too simplistic

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Greenhouse gas emissions from milk production

	Conv. average	*Conv. top 25%*	*Org. average*	*Org. top 25%*
g CO_2 equiv. per litre milk	907	745	828	705
% from CO_2	23	25	21	22
% from CH_4	52	55	69	68
% from N_2O	25	20	10	10

Source: Allen et al., 2007

Fossil energy use

- Carbon dioxide emissions (other than those arising from organic matter breakdown) are closely linked to fossil energy use
- In general, organic farming uses less fossil energy than intensive, conventional farming systems
  - per hectare and per unit food produced
  - but some crops, e.g. potatoes, more problematic

Some examples of organic energy use as % of conventional

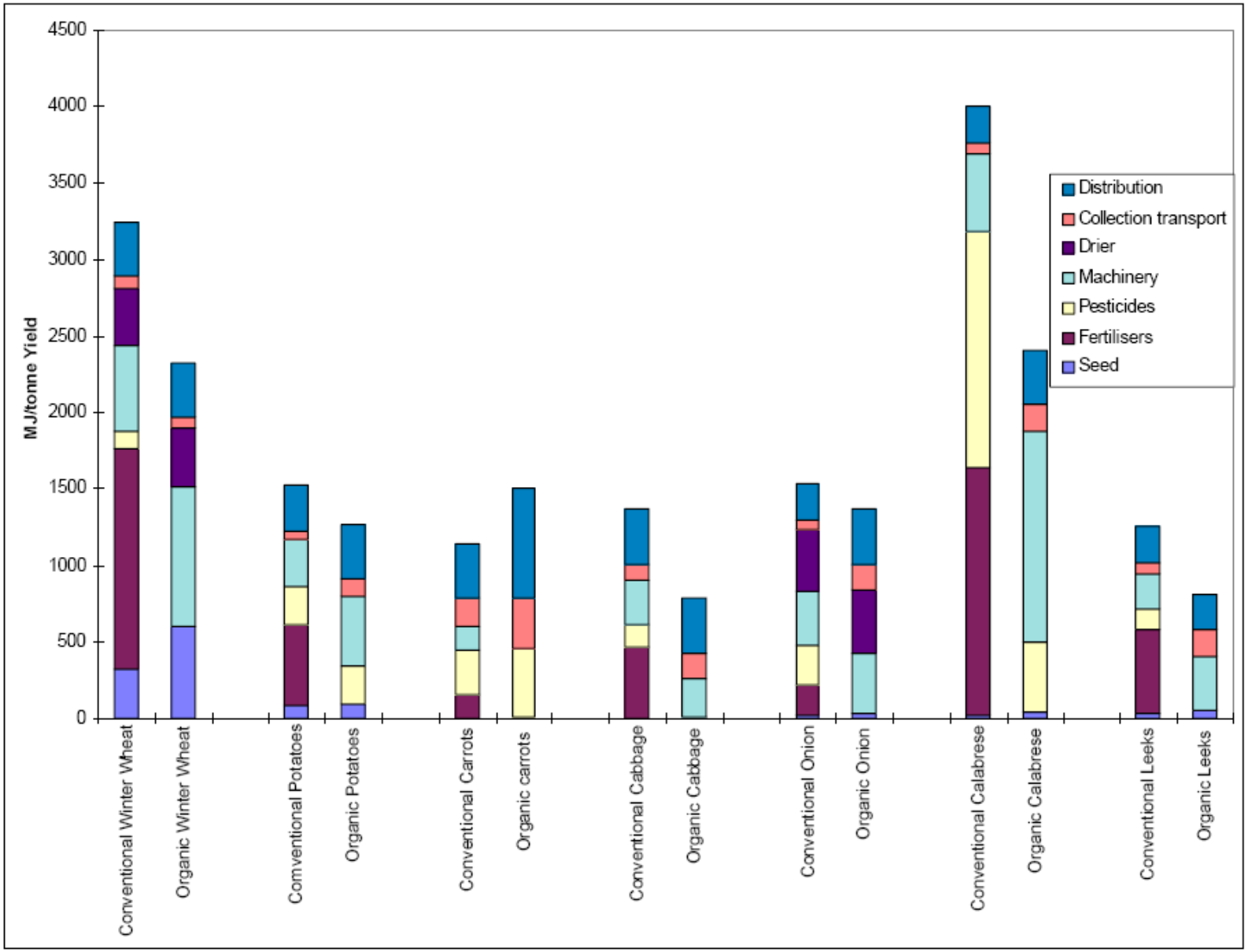
Study	*Country*	*Product*	*per ha*	*per kg*
Edwards-Jones & Howells (1997)	Scotland	Potatoes Wheat Barley	29 51 48	24 70 65
Refsgaard et al. (1998)	Denmark	Cereals Forage Milk		87 32 84
Cormack & Metcalfe (2000)	England	Wheat Potatoes Carrots Cabbage Onion Calabrese Leeks	40 55 41 53 69 30 40	70 86 127 65 93 60 -
Williams et al. (2006)	England	Wheat Potatoes Sheep Milk Poultry		71 102 80 62 132

Energy output/input ratios

(tropical subsistence = 10-40, UK agriculture overall < 0.5)

Source	*Product*	*Conv.*	*Org.*
Leach (1976)	Wheat	3.5	-
	Maize	2.8	-
	Potatoes	2.6	-
	Milk	0.4	-
	Poultry	0.1	-
Pimentel (2006)	Wheat	2.1	-
	Maize	5.1	7.7
	Soya	3.2	3.8

Energy use per tonne for UK crops



Source: Cormack & Metcalfe, 2000

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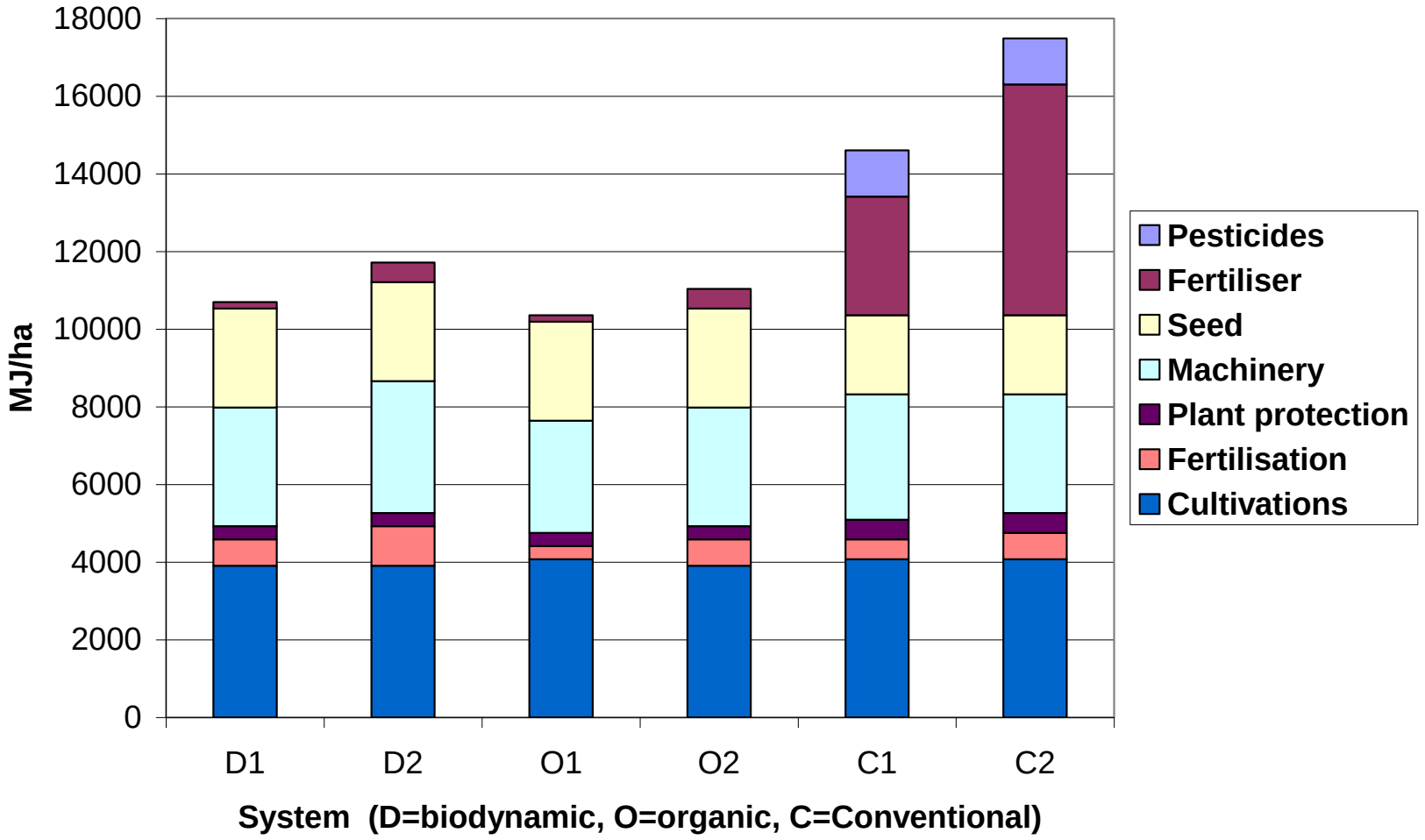
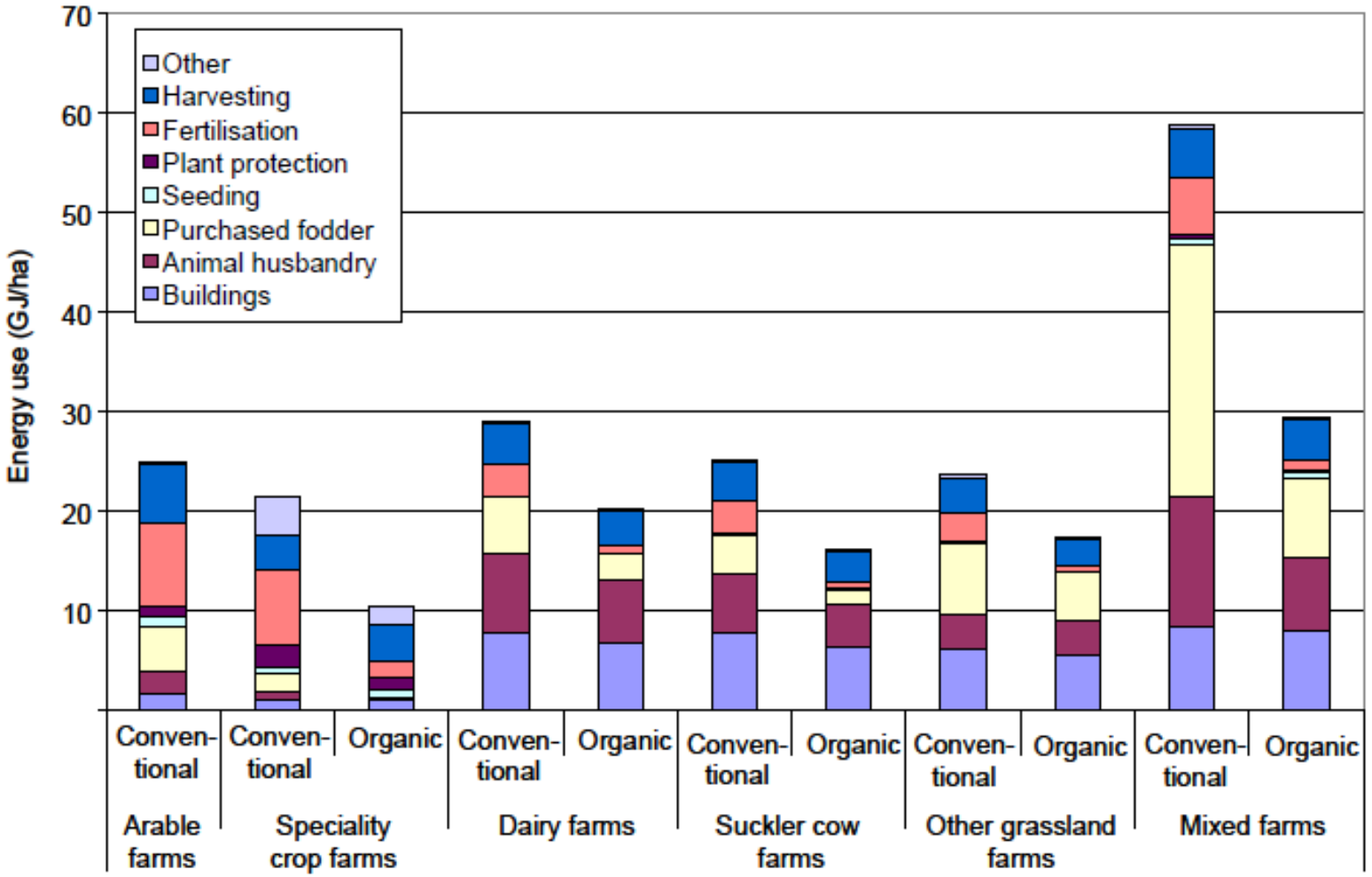
Role of fertilisers and pesticides



Source: Alfoeldi et al., 1995

Comparison of energy use per hectare between farm types (Switzerland)



Source: Schader, 2010, unpublished PhD thesis

Not just a production issue

- Need to consider whole food system
- Localisation of food production not sufficient (or even most important issue?)
- Should diet change to reduce meat content?
- Does urbanisation of population require radical change in production patterns?