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# Does the carbon footprint of organic milk production negate its environmental benefits?

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## Abstract

This review aims to highlight the environment, economic and social factors which influence the production of organic milk. In 2006 organic food and drink sales reached £2 billion in the UK, indicating an overall growth of 22% from the previous year (Melchett 2007[b]). However, human health aside, the organic milk market is coming under scrutiny. Its low yields are a crucial factor. Foster et al. (2006) estimates that organic production requires up to 80% more land to produce one unit of milk than conventional production does. And the energy consumption per functional unit in the on-farm process is around 20% higher on an organic model than it is on a conventional one. European farm Life Cycle Assessment models have shown that the actual global warming potential of organic milk is higher than conventional milk. Methane emissions from the organic farm are largely to blame for this. The importing of organic Soya meal for cattle feed from distant continents is a subject that needs recognition, as all the protein requirements for organic dairy cows cannot be grown in temperate/cool climates. The environmental burdens of organic milk production are often subliminal but entirely significant and require further research.

*Key Words: organic, conventional agriculture, carbon footprint, yield, Global Warming Potential, Life Cycle Assessment (LCA), Greenhouse Gases (GHGs)*

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## Introduction

The environmental issues surrounding organic farming are at the best of times confusing. Though it is generally unquestioned that the environmental impact of organic food production is a major benefit to the soil itself, due to the absence of inorganic chemical application, a balanced argument must be established as to whether this benefit comes at a cost elsewhere in the environment. In particular, human health benefits aside, does the process of organic milk production create a larger carbon footprint than conventional milk production? With particular regard to organic milk production there seems to be two clear sides. The debate over organic production of milk is divided between various organic advocating companies such as the Organic Milk Suppliers Cooperative (OMSCo[1]) and the Soil Association[2] and then the various organic sceptics. Organic produce is an extremely fast growing market, with organic food and drink sales

[1] They are the longest and most established supplier of organic milk in the UK.
[2] The largest organic certification organisation in the UK

reaching £2 billion in the UK in 2006 indicating an overall growth of 22% from 2005 (Melchett 2007[b]) . Despite this huge market growth, OMSCo and the Soil Association are facing a backlash. The Government funded Food Standards Agency even released a report showing it supported Genetically Modified foods and 'discouraged the purchase of organically-produced foods' because of a lack of evidence in showing its improved taste and support of local producers. (Dean 2005). The Soil Association inform us that organic farming (including milk production) does benefit the environment, stating that it is 'better for wildlife, causes lower pollution from sprays, produces less $CO_2$ and produces less dangerous wastes' (Soil Association 2007). If this is to be believed then why is there any opposition to its production? Recently, an environmental burden and resource use report compiled by the Department for Environmental Food and Rural Affairs (DEFRA) has suggested that the process of organic milk production may in fact have worse environmental impacts, as far as climate change is concerned, than conventional milk production.

**A definition of organic farming**

While this review focuses on organic milk production alone, a definition of the system of organic farming and its environmental benefits must be accounted for. The most popular definition of organic farming insists on describing what it is not, rather than what it is (Lobley et al. 2005). The Oxford English Dictionary states that an organic food product is one which is 'produced without artificial chemicals, such as fertilizers' (Soanes 2005). Of course, the definition of organic farming is not so simple. Lobley et al. (2005, p.5) elaborate further than that, insisting that there is an absence of 'pesticides, fungicides and herbicides as well as…antibiotics, and more recently Genetically Modified (GM) technologies.' However an advocate of organic farming would not be satisfied with a mere definition of what organic farming does not do. Lampkin (1990, p.2) states that, 'while such a definition has the advantage of being concise and clear, it is unfortunately untrue and misses out on several characteristics which are of fundamental importance'. Gutman (1999, p. 2352) explains this by informing us that the term organic 'refers to a set of philosophical beliefs about our relationship with the environment, not merely to the physical characteristics of [its] product.' Organic farming advertises itself as an agricultural system which improves the quality of soils and wildlife, while maintaining high standards of animal welfare, along with the absence of all chemicals and GM technology mentioned earlier (Lobley et al. 2005). 'It is not seen as a modification of existing conventional practices, but as a restructuring of whole farm systems' (Pretty et al. 2005, p.3).

An alternative way to define organic farming would be understand its aims. Organic farming's primary aim, according to Pretty (2002, p.114), is to 'grow food in harmony with nature'. Lampkin and Padel (*see Pretty 2002*) go further to state that organic farming treats the farm as an organism, incorporating the 'soil, minerals, organic-matter, micro-organisms, insects, plants, animals and humans ... to create a coherent and stable whole'.

Reaching a widely accepted definition is certainly not a simple undertaking. However, broken down, Nicolas Lampkin (1990, p.5) sees the definition in three separate parts: firstly, 'what organic farmers do not do, [secondly,] what positive things they do instead, [and finally, viewing] the soil as a living system that the farmer, in harmony with nature, should seek to develop.' To summarise, organic farming opposes the industrialised process of conventional (non-organic) farming by banning artificial chemical inputs and GM substitutes for an agricultural system which works *with* nature to reach an optimum condition for soil, animals, humans, the environment and society.

**The knock-on effect of low yields**

DEFRA's report by Williams et al. (2006) studied the various environmental burdens of specific organic products. The report highlighted that whilst energy was saved by the avoidance of synthetic fertiliser applications, this was actually being offset by the significantly lower yields and greater mechanical field inputs (Williams et al. 2006). The low yields mean that organic milk production is can require up to 80% more grazing pasture to produce one unit of milk than conventional production does (Foster et al. 2006). These low yields create a negative environmental knock-on effect because an organic dairy farm needs a larger area to produce less milk than a conventional farm.

One method that can be used to determine a products carbon footprint is an analysis of its *life cycle*. The process, known as a Life Cycle Assessment (LCA), is a method for integrated[3] environmental impact assessment of organic milk throughout its entire life (De Boer 2003). The Finnish Environment Institute used functional units[4] (FU) in an LCA, comparing conventional and organic milk (Grönroos et al. 2006). According to Grönroos et al. (2006) the energy consumption per functional unit of the on-farm organic milk process is around 20% higher than the conventional process. As a result, organic systems require approximately a third more man hours than conventional systems (Ziesemer 2007). The longer man hours include machinery hours and therefore creating a greater consumption of fossil fuels, in the form of diesel and electricity, increasing organic milk's carbon footprint. The report's final calculations showed that the total on-farm primary energy use in the organic system is 15.8%[5] higher than the conventional system, while organic milk required 33.9%[6] more fuel per thousand litres of milk (Grönroos et al. 2006).

The low yields have a clear impact on nitrate leaching. A DEFRA report indicates that around 50%[7] more ammonia ($NH_3$) is lost on an organic farm compared to a conventional one (Williams et al. 2006). These vital inputs must be balanced by organic fertiliser application. In the organic system this can require the spreading of up to 20 tonnes/ha of manure in order to reach a sustainable fertility level on grazing and cropping land needed for milk production (Hart 2007). Despite conventional cows producing a similar amount of manure as a by-product, conventional farms can easily dispose of this with slurry irrigators, whereas organic farms need solid muck (for easy storage and transport to the required land) obtained through slurry separators[8]. Consider this in the knowledge that the average conventional farm applies around 1100 kg/ha of synthetic fertiliser (McCombe 2007). That is around 20 times the weight difference in transport and management

[3] The several environmental aspects assessed e.g. Global warming, manufacturing energy use and waste disposal (De Boer 2003)
[4] "*The total environmental impact of milk production*", but generally, depending on the aim of the investigation is defined as "*the mass of the product leaving the farm gate*." In this case it is measured as 1000 litres of milk. (Cederberg, C. and Mattsson, B. 2000)
[5] A difference of 1.12 (Conventional) to 1.33 (Organic) GJ per 1000 litres of milk.
[6] A difference of 0.39 (Conventional) to 0.59 (Organic) GJ per 1000 litres of milk.
[7] 63kg of ammonia per 10,000 litres of milk produced, compared to 40kg of $NH_3$ in the conventional system (Williams et al. 2006)
[8] A device used to separate the solid manure from the liquid muck collected. The solid muck is then stored separately for easier handling.

every year. This figure is staggering when you consider the difference in power and machinery hours needed to load, transport and spread up to 20 t/ha of manure compared to a meagre 1.1 t/ha of synthetic fertiliser, having implications on fossil fuel consumption and the carbon footprint. This difference in fuel usage was not even highlighted in DEFRA's sceptical environmental burden report, where the fuel quantity was displayed as a constant in their LCA model (Williams et al. 2006). In many cases when an organic farm has insufficient solid manure from its own cows it is actually forced to import organic manure from other organic farms (Hart 2007). The lower yields, occupying a larger acreage, create a carbon loading on every litre of milk, by virtue of the machinery hours used to cover this increase.

## Global Warming Potential (GWP)

Global Warming Potential is universally recognised[9] calculation of the influence of a greenhouse gas on the greenhouse effect, essentially the amount of heat the gas' molecule can hold onto as well as the duration (CARA 2005). Essentially, the higher the GWP value is, the greater its ability to influence the greenhouse effect. Since the principal gases that create the carbon footprint of organic milk (Carbon Dioxide, Methane and Nitrous Oxide) are harmful greenhouse gases, it is essential that the different gaseous outputs from a conventional farm and an organic farm must be compared. Similar studies by Williams et al. 2006 and de Boer 2003 shown in Table 1 show the Global Warming Potential of organic milk production, compared to Conventional, in three different European case studies. After the formulation of an LCA model, different $CO_2$ equivalent factors[10] were used to create the GWP of milk on a 100 year time horizon.

| Case Study | *Global warming potential (100 year $CO_2$ -equivalents(g)/FU)* | |
|---|---|---|
| | **Conventional (g/FU)** | **Organic (g/FU)** |
| **UK** | 1060 | 1230 |
| **Holland** | 888 | 922 |

***Table 1: GWP for different European case studies***
(*Data from Williams et al. 2006 and De Boer 2003*)

Table one shows the higher total GWP values of organic milk's GHGs in comparison to conventional. The Dutch organic system differs slightly to the British system as they use a high content (22%) of dried grass in cattle feed and the drying process is an energy consuming process contributing to a high GWP (De Boer 2003). However, 'the reduction in GWP due to reduced

[9] Currently used as a standard greenhouse gas measurement in the Kyoto Protocol (United Nations 1998)
[10] GWP values: 1 for $CO_2$ (Carbon Dioxide), 21 for $CH_4$ (Methane) and 310 for $N_2O$ (Nitrous Oxide) (Audsley et al. 1997)

emissions of $CO_2$ and $N_2O$ in organic production is nullified by its inherent increase of methane emission' (ibid. p.74). Of the three greenhouse gases concerned[11], methane is the highest contributor to the GWP of milk. Three separate case studies[12] (Sweden, Holland and Germany) show that organic milk's methane contribution (out of the three GHGs) is higher than conventional milk in each case study (ibid.) and a later case study in the UK showed the figure to be 70% methane in the organic system, compared to 52% on the conventional system (McCombe 2007). In terms of GWP, methane gas is twenty three times more potent than carbon dioxide (ibid.). It is estimated that cows in the UK alone produce up to 500 litres, per cow, of methane every day, a figure so high that they account for 3% of the UK's total greenhouse gas emissions (Crawford 2006). Research by the Food and Agriculture Organisation (FAO) of the UN have also recently stated that methane emissions from livestock make them worse polluters than transport (ORC 2007). The reasoning behind the higher methane emissions amongst organic dairy cows is the lower milk production level per cow and the increased use of roughage (De Boer 2003; Takahashi and Young 2001).

According to Kite agricultural consultants, the easiest way to decrease your carbon footprint (GHG emissions), is to increase your milk yields (FWi 2007). The move from a conventional to an organic system is instantly reducing yields, increasing your acreage and therefore increasing the total carbon footprint. The significantly lower yields of organic milk production mean more greenhouse gas emissions per ton of production, a fact even accepted by Peter Melchett, Policy Director of the Soil Association (Melchett 2007[a]).

**Contradictions: a 'closed' system?**

The utopian dream of both farming in total self-sufficiency (the closed system) and a truly 'organic' product is obstructed by UK milk producers' inability to grow certain (mostly quality protein) feeds in our temperate climate (Hart 2007). These proteins are vital to the nutrition of the organic dairy cow. Though it is without benefit to the environment, Genetically Modified Organisms (GMOs) used in conventional farming hold a further advantage over organic. The United Kingdom Register of Organic Food Standards (UKROFS, the regulatory authority governing all regulations in organic farming), outlaw the use of GMOs. Therefore the ability of the British organic farmer to grow vital proteins is dramatically hindered as a result of their own climate. This creates a sourcing problem in diets for the dairy cow. Where recently, 'food miles' have featured heavily in arguments put forward to support 'close to market producers' and their environmental benefits, it is ironic and a barely reported fact that organic milk, which brands itself as a local perishable produce, is hamstrung by it's own sector body's ruling. In order to achieve a balanced diet, certain feeds including certified non-GMO straights (feeds in raw material form, in other words not compounded) can only be sourced from elsewhere in the EU or worse, from South America. According to Hi-Peak Feed, a large UK organic and conventional cattle feed supplier: many of their organic ingredients are sourced locally. What is often overlooked is that Soya meal, a key protein rich ingredient is sourced from farms in Asia, South America and the US. These imports are fuelling slash and burn techniques and further deforestation in areas of South America

[11] $CO_2$ (Carbon Dioxide), $CH_4$ (Methane) and $N_2O$ (Nitrous Oxide)

[12] Williams et al. have not provided a UK methane contribution percentage, however McCombe suggests a figure of around 70% (McCombe 2007)

(Cummins 2007). This shatters the food mile argument from much further down the supply chain, before the manufacturing process of feeds begins and even before feed is synthesised into milk. Whilst Soya meal is not present in all cattle feeds, the environmental impact of long distance goods importation must not be underestimated when carrying out an LCA.

**Discussion and Conclusions**

It is accepted that organic farming needs more hectares because of lower stocking rates; however this does not come without cost. Conventional farming achieves efficiency through larger, cleaner (weed content), and easier to harvest crops to feed the dairy herd. Further to this, total crop failure is not uncommon in modern organic farming. Obviously pesticides and fungicides avoid this in conventional farming. But in the organic system, losses due to weed burden in the seed establishment phase, or later by fungus or pests, cannot be avoided.

The principles of organic farming are clear and as Ziesmer (2007) points out, it holds a great potential for pioneering energy reducing practices, such as the elimination of energy intensive synthetic fertiliser production. Studies by Williams et al. (2006) have shown that despite organic milk production having a higher GWP, around half the giga-joules of primary energy[13] per thousand litres of milk is used in the organic system compared to the conventional. However there are several pitfalls that must be addressed and researched without the constraints of politics or bias. It seems absurd to say that organic farming is still a relatively new practice because it has been a way of life since the first civilisations. It is essential that more independent research must be conducted to not only provide valuable data but also to reduce the environmental burden of organic agriculture as a whole. The organic principles are of self sufficiency and minimal primary energy use, and much of the evidence points to this; however the subliminal factors investigated here are a potential spanner in the works. Additionally, organic dairy farms must reduce their carbon dioxide emissions further to nullify its increased[14] production of methane (De Boer 2003).

This review aimed to build a picture of the carbon footprint of organic milk production highlighting its differences with the conventional system. What is clear is that the system of organic milk production is a complicated process which ties in many environmental, social and economic issues. Whilst a LCA of milk production may highlight various contrasts between the two systems of agriculture, various other factors must be considered that are often overlooked, like the protein requirements for organic dairy herds in areas like the UK. The key issue that organic farmers cannot deny, and forms the basis of organic milks' carbon footprint, is its massive land requirements and subsequent low yields when compared to the conventional system. As a result, organic milk consumers may believe that paying the premium price makes them stake holders in the environment,

[13] Principally electricity and diesel usage
[14] In comparison to conventional dairy farms

but their holding is a tenuous one. At present, it seems that organic milk production demonstrates a balance of environmental offsets rather than clear green gains.

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