Available online at www.sciencedirect.com
ScienceDirect
Agriculture, Ecosystems and Environment 119 (2007) 135–144
Agriculture Ecosystems & Environment
www.elsevier.com/locate/agee

Energy use efficiency of specialised dairy, arable and pig farms in Flanders

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Received 3 February 2006; received in revised form 27 June 2006; accepted 3 July 2006
Available online 7 September 2006

Abstract

In this study, we determined the energy use and energy use efficiency of a representative set (Flemish Farm Accountancy Data Network, FADN) of specialised dairy, arable and pig farms in Flanders. Total energy use comprised direct energy, based on the consumed amounts of diesel, lubricants, electricity and other energy sources (p.e. natural gas); and indirect energy, consumed during the production of farm inputs such as mineral fertilisers, seeds, pesticides, concentrates, forages and field machinery. We studied the changes in energy use and energy use efficiency between 1989–1990 and 2000–2001 for dairy and arable farms and between 1989–1990 and 1997–1998 for pig farms. The results showed that the use of mineral fertilisers and animal feed accounted for a high share of the total energy use on the farms. Diesel use took the major part of direct energy use. For dairy and arable farms, total energy use per ha has decreased significantly over the considered time period; on pig farms, energy use per fattening pig equivalent (FPE) in 1997–1998 was comparable to that in 1989–1990. The most energy efficient dairy and pig farms were intensive farms, which combined a high production with a low energy use and which possessed a gross value added per production unit comparable to, or even higher than the average. Based on the energy productivity of the top 5% farms, target values were set of 35 l milk 100 MJ^{-1} and 7.5 kg carcass 100 MJ^{-1} for energy use on Flemish dairy and pig fattening farms, respectively. On arable farms, the energy use efficiency was highly dependent on the crop rotation. For that reason, it is recommended to calculate energy balances on field level, for each separate crop.

Keywords: Arable farming; Dairy farming; Energy use efficiency; Flanders; Pig farming

1. Introduction

Efficient use of resources is one of the major assets of eco-efficient and sustainable production, also in agriculture. Eco-efficiency is a management approach that was acknowledged at the 1992 Rio Earth Summit as a way for companies and businesses to contribute to sustainable development (de Jonge, 2004). Eco-efficient production has been given many definitions, all of them however adding up to the one principle 'produce more from less'; adding maximum value with minimum use of resources and with minimum environmental impact (WBCSD, 2000; Jollands et al., 2004). In this study we focus on one aspect of eco-efficiency in agricultural production systems: energy use efficiency.

Inefficient energy use can result in severe environmental impacts. The emission of greenhouse gasses by combustion of fossil fuels contributes to climate change. As a consequence, the global mean temperature has increased during the past 100 years and raised concerns over global warming and uncertainty over future impacts on the climate (a.o. Pimentel et al., 1996). The reduction of greenhouse gas emissions requires a decreased use of fossil fuels. Partly this can be achieved by using more sustainable sources of 'green energy', such as wind, bio energy and solar energy; or by a substantial increase of the energy use efficiency (Corré et al., 2003), where the same amount of output is produced with

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0167-8809/$ – see front matter
doi:10.1016/j.agee.2006.07.002

less energy. The development of energy efficient agricultural systems – with a low input of energy compared to the output of products – should therefore help to reduce agricultural emissions of greenhouse gasses (Dalgaard et al., 2001). To achieve this, knowledge about energy use in different agricultural systems is needed.

On farms, energy – whether fossil or renewable – is consumed in a 'direct' and an 'indirect' way (Hülsbergen et al., 2001; Pervanchon et al., 2002; Corré et al., 2003). Direct energy is used on farm for agricultural activities, the use is directly measurable and it comprises mainly diesel fuel, electricity and natural gas. The energy that is used to produce farm inputs such as mineral fertilisers, seeds, pesticides, concentrates, forages and machines is indirect energy.

Energy use efficiency is often expressed by the 'energy price' (EP) of agricultural products (a.o. Refsgaard et al., 1998; Corré et al., 2003). This is the amount of energy (in MJ) needed for the production of one unit of product (e.g. 1 kg wheat, 1 l milk). The energy use involves all energy used directly and indirectly up to the moment that the products leave the farm ('farm gate approach'). In our study, we prefer to express energy use efficiency as the reverse of the EP (i.e. the amount of product produced with one unit of energy), since this better fits the above definition of eco-efficiency: produce more (output) from less (input).

In this paper we study energy use efficiency, comparing energy input to production output, of three major agricultural systems in Flanders. Our major aims are:

- to determine the total (direct + indirect) energy use of a representative set of specialised dairy, arable and pig farms in Flanders and calculate their energy use efficiencies;
- to study the changes in energy use and energy use efficiency on farm level between 1989 and 2001;
- to set achievable targets for energy use efficiency on farms in Flanders.

2. Materials and methods

2.1. Data and farm characteristics

The Flemish Farm Accountancy Data Network (FADN) is a database of technical and economic data from a representative set of Flemish farms. From this dataset we used the data of the specialised dairy and arable farms in 1989, 1990, 2000 and 2001. For the specialised pig farms, we used the data of 1989, 1990, 1997 and 1998; data of 2000 and 2001 were considered unreliable, due to a food safety hazard in the sector in Flanders (dioxin in the production chain).

We considered dairy farms as 'specialised' when at least 95% of the farm income originated from dairy activity. On specialised arable farms and specialised pig farms, at least 66% of the standard gross margin (SGM) originated from arable or pig production, respectively; SGM being the average monetary value of gross production minus specific costs for a given region (Commission of the European Communities, 1985).

A selection of average characteristics of the farms is presented in Table 1.

2.2. System boundaries

Jones (1989) presented a hierarchy of methods for energy use analysis in agro-ecosystems, based on the applied system boundaries. The method used in our study corresponds to 'process analysis', where all energy inputs (direct and indirect) to an agricultural system are considered, based on physical material flows. Human labour and solar energy are not considered in this method. We only included the indirect energy use one step backwards from the farm. This means that we included e.g. the energy used to produce fertilisers, but not the energy used to manufacture the equipment to produce the fertilisers. According to Refsgaard et al. (1998), by applying these boundaries, over 90% of the

Table 1
Average characteristics of the specialised dairy, arable and pig farms in the dataset extracted from the Flemish Farm Accountancy Data Network

	Unit	1989	1990	2000	2001
Dairy farms	#	169	165	78	69
Utilised area	ha	28	28	32	32
Stocking rate	cows ha^{-1}	1.73	1.73	1.64	1.62
Milk production	l cow^{-1} year^{-1}	5319	5365	6017	5827
	l ha^{-1} year^{-1}	9607	9567	10043	9643
Arable farms	#	64	57	55	50
Cultivated area[a]	ha	50	52	63	65
No. of crops		7	7	7	7
	Unit	**1989**	**1990**	**1997**	**1998**
Pig farms	#	85	98	97	98
No. of pigs	FPE[b]	675	792	1207	1249

[a] The cultivated area is the sum of the areas of all cultivated crops during 1 year. Since a parcel of land can be used to grow more than one crop during 1 year, this area can be larger than the utilised area.

[b] FPE = fattening pig equivalent: 1 fattening pig = 1 young sow = 1 FPE; 1 sow = 2 FPE; 1 boar = 1.5 FPE.