

Energy Accounting on Farms

J.A.M. van Bergen

Centre for Agriculture and Environment, P.O. Box 10015, 3505 AA Utrecht, the Netherlands

Abstract

This article describes the development of an energy accounting. This is a management tool to give farmers a clear understanding of their energy use and of the emission of greenhouse gases on their farm. Results are given of one year accounting on dairy farms and on pig farms. The results show large differences in energy use and in emissions of greenhouse gases between individual farms. These differences indicate that a substantial reduction of emission of greenhouse gasses is possible.

1. INTRODUCTION

The Dutch Centre for Agriculture and Environment (CLM) has figured that agriculture in the Netherlands contributes 12 percent to the national emission of greenhouse gases (1). These emissions of carbon dioxide, methane and nitrous oxide in Dutch agriculture have also been calculated per sector. Dairy farming has the major contribution with a total emission of 57 percent. Intensive livestock farming contributes 20 percent, greenhouse cultivation contributes 16 percent and field cultivation 7 percent (1).

The high score of dairy farming and intensive livestock farming is partly caused by the high use of indirect energy. The importance of the use of indirect energy in animal production has been pointed out in literature earlier (for example 2,3). The CH₄-emission by ruminant digestion of feed and the N₂O-emission by soil processes are the other causes of the high score of dairy farming.

So far, no management tool is available to monitor the emissions at farm level. CLM has started a project to develop an accounting system to calculate the use of energy and the emission of greenhouse gases at individual farms. It should give farmers a clear understanding of their energy use and of the emission of greenhouse gases on their farm. The instrument is simply denominated as the Energy accounting. Because of the important contribution of dairy and intensive livestock farming to the greenhouse effect, the energy accounting is first being developed for these sectors.

2. FRAMEWORK OF AN ENERGY ACCOUNTING SYSTEM

Setting up an energy accounting system includes developing a registration form, a methodology to calculate emissions and a way to present farmers the results. In addition the project deals with advice on possible strategies and measures to reduce emissions of greenhouse gases. In this article we describe only the framework of the energy accounting.

The energy accounting is based on administrative management data of farms, for example meter readings on energy use or energy bills, data on use of fertilizers and feed concentrates. These farm data are combined with standard factors on energy values and emissions of greenhouse gases. The calculations take place in six modules:

- direct energy use and CO₂-emission for both dairy and intensive livestock production;
- indirect energy use and CO₂-emission for both dairy and intensive livestock production;
- CO₂-emission by mineralization of peat for dairy production;
- CH₄-emission by feed fermentation for dairy production;
- CH₄-emission by slurry storage for intensive livestock production; under Dutch conditions the CH₄-emission by storage of slurry from cows is neglectable;
- N₂O-emission by soil processes for dairy production.

Table 1
Framework of the energy accounting

| Module | Basic data per farm | Calculations with standard factors | Results MJ | Results CO ₂ -emission |
|--|--|------------------------------------|------------|-----------------------------------|
| 1. Direct energy use fuel/electricity | meter readings | MJ/l diesel, kWh | MJ | kg CO ₂ |
| 2. Indirect energy use | use of fertilizers, feed concentrates, tools and buildings | MJ/kg N, kg concentrate etc. | MJ | kg CO ₂ |
| 3. CO ₂ -emission by mineralization of peat | area peat soil, drainage | CO ₂ -emission/ha | | kg CO ₂ |
| 4. CH ₄ -emission by feed fermentation | number of cattle, feed ration and level | CH ₄ -emission/cow | | kg CO ₂ -equi. |
| 5. CH ₄ -emission by slurry storage | slurry quantity storage days | CH ₄ -emission/ton | | kg CO ₂ -equi. |
| 6. N ₂ O-emission by soil processes | area, soil type, fertilization, grazing, drainage | N ₂ O-emission/ha | | kg CO ₂ -equi. |
| Totals | | | | |
| per farm | | | MJ | kg CO ₂ -equi. |
| per product | | | MJ | kg CO ₂ -equi. |

Table 1 gives a schematic view of the framework of the energy accounting. The emissions of CH₄ and N₂O are converted to an emission of CO₂-equivalents. Summation of the emission of the six modules results in a total emission per farm. For comparison of individual farms, this total is expressed in the form of an efficiency-figure, for example kg CO₂-equivalent per 100 kg milk. The same applies to the total energy use, for dairy expressed as MJ per 100 kg milk.

3. FIRST RESULTS

The system mentioned above is now being tested in three study groups of dairy farmers, and four study groups of intensive livestock farmers. Table 2 shows the results of the first testing year of three dairy farms and two pig farms. The farms presented here are selected for the differences in their CO₂-equivalent emissions.

Table 2
CO₂-equivalent emissions (kg CO₂/100 kg milk, kg CO₂/100 kg growth)

| | Direct energy | Indirect energy | CO ₂ -min. | CH ₄ | N ₂ O | Total |
|--------------|---------------|-----------------|-----------------------|-----------------|------------------|-------|
| dairy farm 1 | 6 | 28 | 201 | 27 | 100 | 362 |
| dairy farm 2 | 4 | 14 | - | 25 | 17 | 60 |
| dairy farm 3 | 6 | 27 | - | 22 | 7 | 62 |
| pig farm 1 | 21 | 204 | - | 81 | - | 306 |
| pig farm 2 | 12 | 179 | - | 38 | - | 229 |

The first results give a good insight in the significance of the emissions and in the differences that were found between individual farms. Concerning the dairy farms, the following results were the most striking:

- for peat soils, CO₂-emission from mineralization as well as N₂O-emission from soil processes (farm 1) have a large influence on total CO₂-emission, compared to total CO₂-emission from clay (farm 2) and sandy soils (farm 3);
- the differences in indirect energy related CO₂-emission are of much more importance than the differences in direct energy related CO₂-emission;
- on farms with clay and sandy soils, the CO₂-emissions caused by the use of direct and indirect energy, the CH₄-emission and the N₂O-emission are each of the same importance.

The emissions per module vary not only between farms on different soils but also between farms on the same soil. In the study group with sandy soils the extreme values in total CO₂-emission were 62 and 86 kg CO₂ per 100 kg milk. The results indicate that farmers can reduce the emissions of greenhouse gases by improving their efficiency of energy use, of fertilizer use and of concentrate and feed use.

The results of the two pig farms show clearly that :

- the use of indirect energy in pig breeding is very important;
- the variation in CO₂-equivalent emission between the two farms caused by use of direct and indirect energy is of the same magnitude than the variation caused by storage of slurry.

The differences indicate that on pig farms there are possibilities to improve use of direct and indirect energy. Farmers can either make energy-saving investments in climate control or improve their general and feeding management. The calculated difference in methane emission is mainly caused by a difference in storage time: technical measures to reduce this emission are developed.

4. DISCUSSION

The results have a provisional character. Changes in the methodology to calculate emissions are possible during the testing years. The purpose of this project is to create a management instrument for farmers. It is in discussion to which extend emissions should be part of this instrument that hardly can be influenced by farmers. Most discussion is about the mineralization of peat (4). Possible changes also depend on the availability of relevant farm management data and on changes in knowledge of emissions. An important source of new knowledge is the NRP research on emission of nitrous oxide from grassland.

The variation in the results from individual farms show that farmers do have possibilities to reduce their energy use and emissions of greenhouse gases. These possibilities can lead to a substantial reduction of emission of greenhouse gases. In the second year of the project more research will be done on the contribution of advice on energy-saving investments and on better management practices to reduce the emission of greenhouse gases on farms.

5. REFERENCES

- 1 Bergen J.A.M. van and E.E. Biewinga (1992). *Agriculture and Greenhouse effect, Survey to reduce the Emissions of Agriculture and Horticulture*. (In Dutch with English summary), Centre for Agriculture and Environment, Utrecht.
- 2 Leach, G.A. (1976), *Energy and Food Production*. IPC Science and technology Press Limited, Guilford.
- 3 Pimentel, D. (1980) *Handbook of Energy Utilization in Agriculture*, CRC Press, Boca Raton.
- 4 Hanegraaf M.C. and E.E. Biewinga (1994). 'Use of Energy and Emission of Greenhouse Gases at individual dairy Farms'. In : *Meststoffen 1994*, p. 59-67.