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ENPOS – Energy positive farm

J. Ahokas[1,*], H. Mikkola[1], T. Jokiniemi[1], M. Rajaniemi[1], W. Schäfer[2]
H. Rossner[3], V. Poikalainen[4], J. Praks[4], I. Veermäe[4], J. Frorip[5] and E. Kokin[5]

[1]University of Helsinki Department of Agricultural Sciences, PL 28 (Koetilantie 5), 00014 Helsingin Yliopisto, Finland;
[*]Correspondence: jukka.ahokas@helsinki.fi
[2]Agrifood Research Finland MTT, MTT, Kotieläintuotannon tutkimus, Jokioinen Vakolantie 55, 03400 Vihti, Finland
[3]Estonian University of Life Sciences, Institute of Agricultural and Environmental Sciences, Kreutzwaldi 1, Tartu EE51014, Estonia
[4]Estonian University of Life Sciences, Institute of Veterinary Medicine and Animal Sciences, Kreutzwaldi 62, EE51014 Tartu, Estonia
[5]Estonian University of Life Sciences, Institute of Technology, Kreutzwaldi 56, EE51014 Tartu, Estonia

Abstract. In ENPOS (Energy Positive Farm) project possibilities to save energy on Estoni an and Finnish farms was studied. Energy can be saved easily and without large financial costs 10 –30%. The most important thing is to increase the energy knowledge of the farmers. This means advisory work and energy education.
Energy bookkeeping and energy analysis are important things in energy consumption follow-up. The farm energy consumption should be followed and with this acquired knowledge farmers can notice where they consume more energy than on average and also where they are better than others.
Energy consumption is not easy to follow because this would mean in most cases energy meter assemblies and this is costly. New agricultural machinery could be designed so that they include energy consumptions meters.

Key words: energy, agriculture.

INTRODUCTION

Energy consumption in agriculture is low compared to the national consumption. The share of agriculture is in many developed countries 1–5% of the total energy consumption (OECD 2008). This means that the agricultural energy consumption does not have much influence on energy consumption of the whole nation. However agriculture is responsible for 20% of all anthropogenic greenhouse gas (GHG) emissions (Woods et al., 2010). For single farm or farmer, however, the energy efficiency is also an economical matter. With lower energy use also the financial costs are lower.

The energy consumption can be divided into two parts, direct and indirect consumption. Direct consumption means energy directly bought to the farm (fuel, electricity). Indirect energy means energy, which is embedded in the product. For instance machines and fertilizers are manufactured in factories and this consumes energy. Fig. 1 shows an example of energy use in barley production. Half of the energy is indirect energy and in this case agrochemicals form the indirect energy. For plant production it is normal that indirect energy part is more than half of the total energy use.

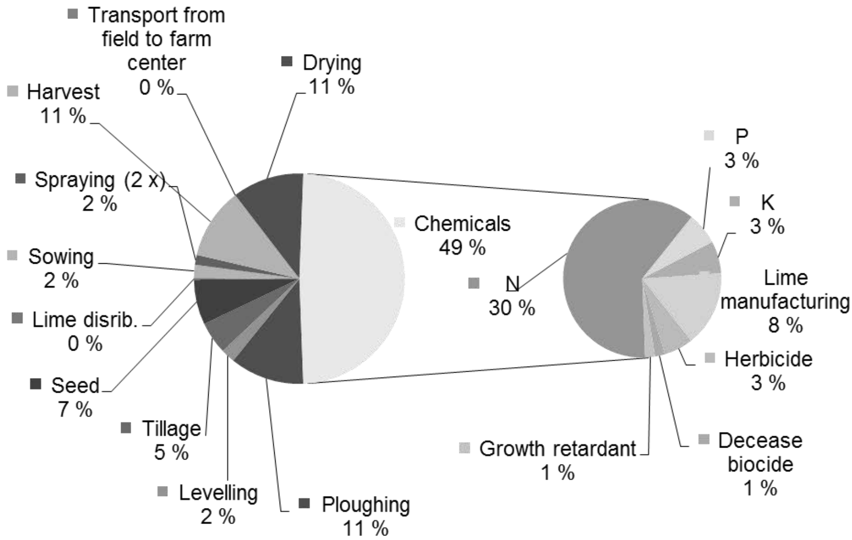

Figure 2. Energy consumption in barley production (14 GJ ha^{-1}).

In livestock production the most energy consumption part is the feed material of the animals. Fig. 2 shows an example of energy consumption share in dairy production. In livestock production feed material share is normally 70–80% of the total energy use. Feed material is considered indirect energy in livestock production although it may come from the farm fields.

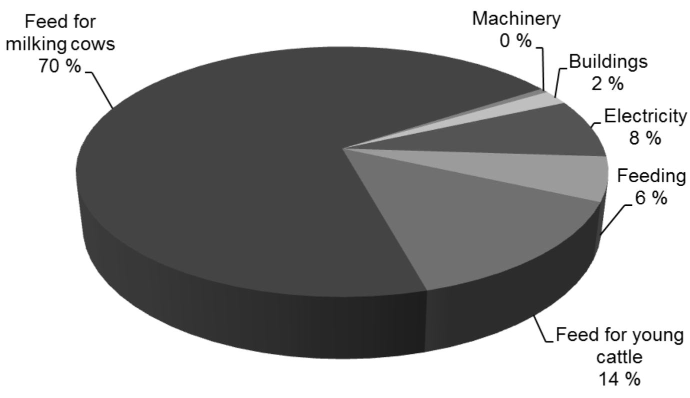

Figure 3. Energy consumption in dairy production.

Farmers can do their own energy analysis in two different ways, bottom-up or top-down. In the Bottom-up analysis, energy consumption in every machine is recorded and summing these, the whole farm energy consumption can be calculated. In top-down analysis only the energy bought to the farm and the material sold from the farm are included. From energy analysis figures consumption per hectare or animal place are calculated. This is compared to the figures of other farms and if much different from average figures, then reason for this should be clarified. If the production type of the farm is different from other farms (for example organic versus conventional farming) then energy used per produced product must be used in calculations and analysis.

Top-down analyses is easier to do but it does not show the details of the consumption. Bottom-up analysis needs good bookkeeping and it is laborious to do but it reveals the consumption hotspots.

MATERIALS AND METHODS

The aim of ENPOS project was to analyse Estonian and Finnish farm energy use and find ways to reduce energy consumption. Fig. 3 shows an example of energy consumption in a dairy farm.

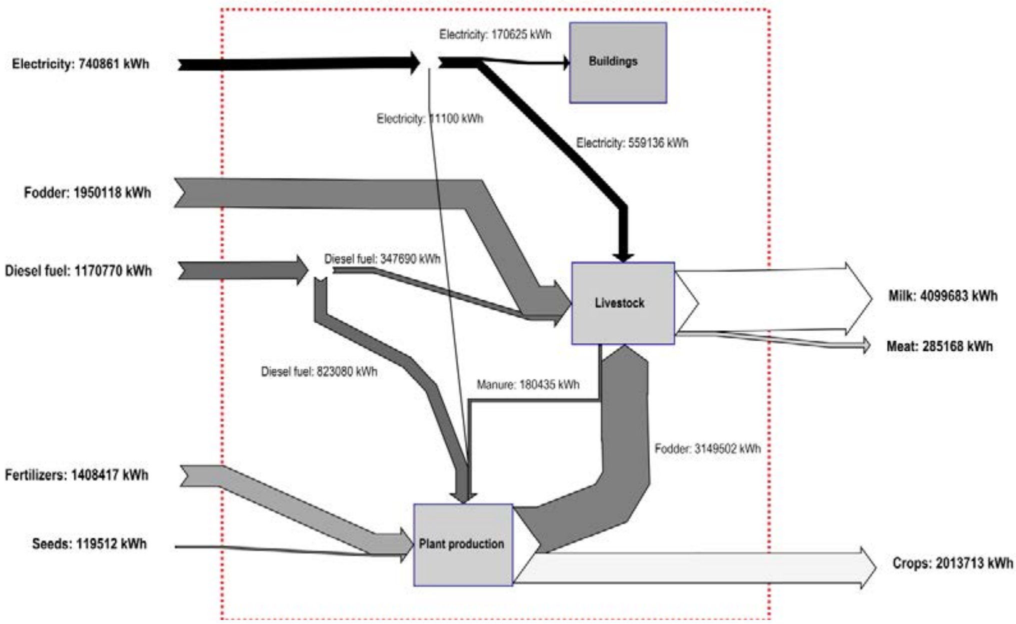

Figure 4. Energy flows in a dairy farm.

The farm consumes 5.4 GWh of energy and in the products, which the farm produces, is embedded 6.4 GWh of energy. The energy ratio (output/input) is 1.2, which means that the farm produces more energy than it uses in the production.

This kind of analysis was done for six Estonian farms and four Finnish farms. The farms had plant production but they had also livestock production: milk, pork or broiler. From the case farm data and also from the agricultural process analysis the ways to save energy were obtained.

RESULTS AND DISCUSSION

Numerous energy saving possibilities were found based on the farm energy analysis. The results can be found in the books published by the project (Ahokas, 2013).

In plant production the following items were found to be the most important and economical:

- More advisory information for the farmers. For instance, with proper tractor driving habits and implement adjustment 10–20% energy can be saved in field work energy consumption.
- With grain dryer insulation 10–20% energy can be saved. If crop is used as feed material and used on the same farm during winter season, then the moisture content can be higher than what is used for long time preservation. For instance 16–17% moisture content is suitable instead of 13–14%. Also drying temperature can be increased; this will increase dryer capacity and decrease energy consumption. These measures will decrease energy consumption 10–20%.
- Fertilizer use can be decreased by better nutrient circulation especially on cattle farms. Nitrogen fixing plants can be used to decrease fertilizer use and the yield level can be kept as high as with artificial fertilizers.

In livestock production the following energy saving possibilities are available.

- In livestock production most energy is used for feed material production. By decreasing energy use in feed (plant) production livestock production energy use decreases also.
- In dairy production the shorter the cow's lifetime is, the more energy is needed for replacement animals.
- Waste heat of milk cooling and exhaust air of pork and broiler housing can be utilised more effectively.
- Biofuel use for heating does not decrease energy consumption but makes the fuel CO_2 neutral.
- Livestock technology has also energy saving possibilities. For instance energy efficient lights and light programs can be used. In milking facilities vacuum pump speed control reduces energy consumption.

CONCLUSIONS

Energy can be saved easily and without large financial costs by 10–30%. The most important thing is to increase the energy knowledge of the farmers. This needs advisory work and energy education.

Energy bookkeeping and energy analysis are important measures for energy consumption follow-up. The farm energy consumption should be followed and with acquired knowledge the farmers can compare where they consume more energy than an average farm does and also where they are better than others.

Energy consumption is not easy to follow because this would mean in most cases energy meter or logger assemblies and this is costly. New agricultural machinery could be designed so that they include energy consumptions meters. For fuel consumption optimization the new tractor models have already fuel consumption measurement system. Tractors with stepless transmissions (CVT-transmission) can be programmed to drive in fuel efficient way automatically. The same kind of equipment should be introduced also to other agricultural machinery. For instance livestock machinery and equipment energy consumption is easier to follow if the machine already has readiness for this. Embedded measurement system would not increase costs as much as the installation of additional equipment later on.

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