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Energy expenditure and costs for animal husbandry systems

Over and above purely economic aspects, material and energy balances have, in the meantime, become standard instruments for characterisation and evaluation of agricultural systems. Not only exact data fundamentals are investigated but, especially, the methods involved are improved and standardised as well as the results correctly evaluated. When not an absolute requirement for such, as in carbon dioxide balancing or for calculations on the effects of different energy-price developments, energy balances are an important addition to material and economic balances.

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World population growth leads to an increasing requirement for food. The available production resources are, however, limited and this means that they have to be used in ways which are as efficient as possible. This is supported through the existing correlation between use of resources and environmental pressures. In this context, energy balances, apart from being utilised to ascertain efficiency in the use of regenerative raw materials and waste materials for energy production, are increasingly also involved in the evaluation of food production systems.

Substantial latitude is available in the energy balancing of agricultural systems. Different methods and the absence of universally-accepted standard values often hamper, not only the comparability of values, but partly also the correct interpretation of such. In the VDI-guideline 4600 „Cumulative Energy Expenditure'' [1] there exists a good methodological basis which nevertheless has to be specified for the system to be balanced.

Methods

The principal method takes place according to the VDI guideline. Should products or systems be balanced with respect to their production, the limits of the system are thus established in principal. Alongside the firm establishment of the inputs and outputs, the subdividing of the system has to be above all decided upon. The system for animal husbandry is readily accessible to calculation when one can subdivide down to the point where feed and young animals are defined as input values and their „manufacture'' seen, on the other hand, as self-contained systems. Decisive is the compatibility of the input and output values of such systems, and a consistent methodology. Such a modular construction allows itself to be applied at farming level.

Reference values can be the product or the area of farmland. The product should be preferred when different production systems are being compared and the fossil energy input is regarded as limiting factor. Where the limiting factor is not fossil energy (which can be substituted), but farmland area, this is then therefore the correct reference value.

Fossil and regenerative energy should be identified separately because the two forms must be evaluated in a different way.

Example pig feeding

The calculations for pig feeding in an insulated, fully-slatted, building show that around three-quarters of the total enterprise costs are represented by the purchase of weaners and feed (*fig. 1*). Third largest expense is building costs with, in this case, a new building with a 20 year life being used. Where an existing building could be efficiently used, building costs could be as little as half.

The sectors weaners and feed offer practical starting points for cost reductions. This applies to the production or purchase of the animals as well as to the efficient use of feed and a very good feed utilisation.

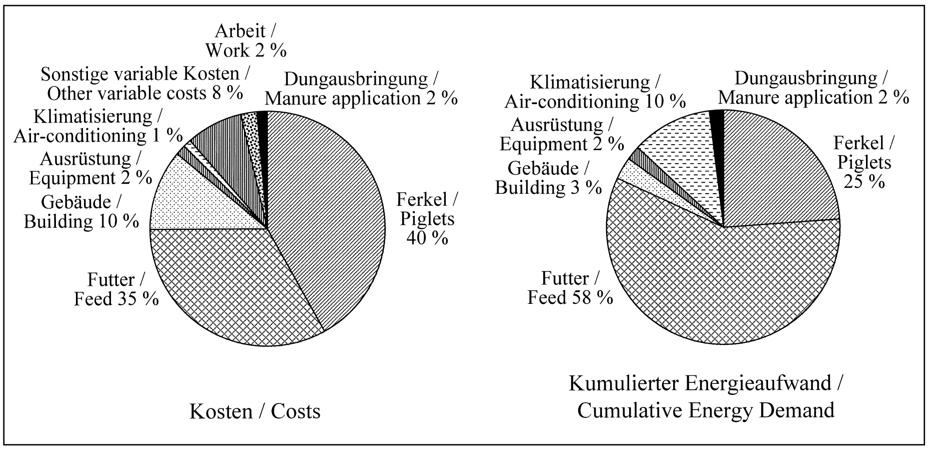

Fig. 1: Costs and cumulated energy demand per place and year in pig finishing

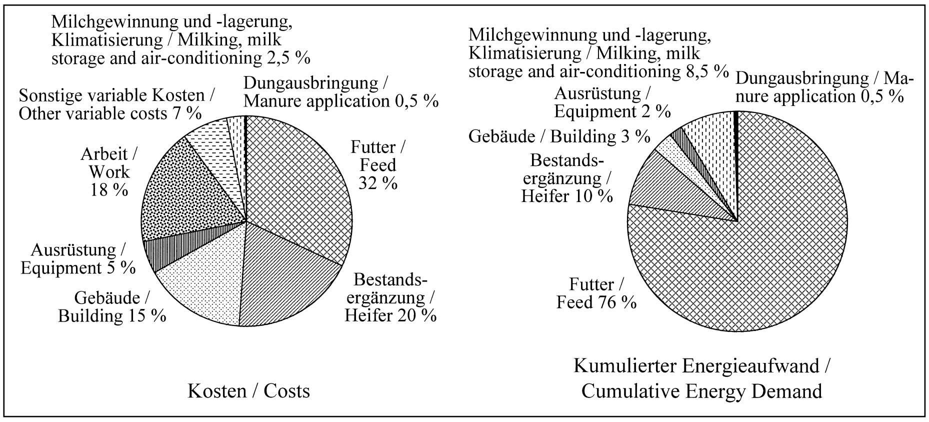

Fig. 2: Costs and cumulated energy demand per place and year in dairy husbandry

Feed and young pigs or weaners also represent the sectors within slaughterpig production with the greatest energy requirement, whereby very clearly dominating in this aspect is the feed sector with nearly 60% of cumulative energy expenditure (KEA) (fig. 1).

It is hard to estimate to what extent savings made through using natural ambient housing instead of heated/ventilated units compensates for the increased feed intake which the animals do not transfer into higher feeding performance. From a purely arithmetical stand point, an extra average feed consumption calculated over the year of 0.4 kg per animal and day would cancel out the energy saving through the omission of heating and ventilation as well as through a less complicated building design. For heating oil, one can take costs of around 0.01 DM/MJ KEA, for slaughterpig feed the sum is around 0.10 DM/MJ KEA. From the point of view of cost neutrality, this should mean that extra feed used should amount to only a tenth of this, i.e. 0.04 kg per animal and day.

In the first line, an important reduction of the energy expenditure is possible through efficient production and utilisation of feed and this applies to the quality of the weaners too. In weaner production, the feed represents 80% of the cumulative energy expenditure.

If one analyses the energy expenditure in the feed production, it’s clear that in this context a substantial share of 40% represents the fertilising of the crop.

Reducing fertiliser application can be seen differentially. Such reduction, as a rule, is associated with yield decreases. With regard to the factors of site and weather conditions different optimal values result from the different reference values (energy expenditure per kg grain or per ha farmland).

The reduction of the energy expenditure in the manufacture of the fertiliser, about from 50 to 30 MJ/kg nitrogen fertiliser, has, also in the case of a further decreased application of fertiliser, substantial influences on the cumulative energy expenditure of the cereal production.

Example dairy cow husbandry

With dairy cow keeping in unbedded cubicles with herringbone parlour we are involved in a completely different costs and energy distribution (*fig. 2*). Also used for these calculations is a new building with 20 years’ lifetime. The halving of building costs through the utilisation of a renovated older building is only possible in individual cases in that, usually, former byres are converted for this purpose and the expenditure involved in this in part lies around the level of that for a new building.

Labour cost reductions can be achieved through good management and technical developments, independently from the influence of the size of the unit. Around 60% of working time is required for milking. According to experience up until now, the introduction of automatic milking can reduce labour requirements by one third, even where input in herd control and management as well as a quasi „round the clock availability” for the solving of possible problems is taken into account [2, 3].

Three years in the milking string is calculated for herd replacements. If this could be increased to four of five years, the share of replacement supply in total costs sinks to 16 or 13% respectively.

Dominating energy expenditure in dairy cow production is the sector feed (fig. 2). Worthy of mention outwith this are only the sectors herd replacement, milking and milk storage including temperature control. In this latter area, along with certain saving potentials, there are especially possibilities for replacing fossil energy carriers with regenerative ones.

The proportion of energy expenditure involved in herd replacement production reduces to around 7 to 6% when the working life in the milking herd of the animals is increased to four to five years. Further reductions are possible through savings in heifer rearing, especially in the feed sector.

In dairy cattle husbandry too, efficient feed production and utilisation is the best method of reducing energy expenditure. In feed production, it can be established that the proportion of fertiliser in silage production – at 50% of the cumulative energy expenditure, is higher than that for cereal feed. Here, the observations already made regarding fertiliser use for grain are at least just as applicable for silage crops.

The cumulative energy expenditure regarding energy content of feed is in the case of maize silage less than half that of grass silage or cereal feeds. Regarding costs based on energy content, maize silage comes out as more efficient than grass silage which is itself better than cereal feed in this context. The planning of the feed ration depends, of course, on site-dependent factors and, above all, on nutritional-physiological points of view. Nevertheless, observation of the associations here also offers possibilities for reducing costs and energy expenditure.

Conclusion

Energy expenditure and costs involved in livestock products indicate substantial differences. This the production costs of 1 kg of pigmeat run from 2.50 to 3.00 DM (full costs), the cumulative energy expenditure at around 15 MJ. The costs involved in the production of 1 kg milk lie between 0.50 and 0.60 DM, the cumulative energy expenditure at around 3 MJ. The separation of energy expenditure and costs is, in the individual livestock husbandry systems, also quite different. For both of the factors mentioned here, however, the feed sector has a quite substantial influence in both the slaughterpig and dairy cow husbandry. An efficient feed production and utilisation with regard to site-specific and nutritional-physiological factors is of especial importance, not only from the production-technological point of view.

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