# On the economics of organic grassland and alternative bio-energy systems – A risk modelling approach

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## Abstract

*Organic farming enterprises manage their grasslands mostly extensively, often participating in nature preservation schemes. On extensive or semi-natural grassland sites, the profitability of grassland utilisation with customary processing procedures like dairy or suckler cow farming is often realized insufficiently, however. As the global demand for sustainable energy supplies increases, the newly developed IFBB-technique (Integrated Generation of Solid Fuel and Biogas from Biomass) could exhibit an alternative grassland utilisation by using plant cover from extensive grasslands for the generation of renewable energies whilst preserving valuable grassland habitats, without competing against land for food production. A survey amongst farmers in the low mountain range of Vogelsberg, Germany, identified general frameworks of extensive grassland management as well as incentives and objections for an implementation of the IFBB technology at single farm level. Calculations of processing values of grassland in different procedures of animal husbandry, landscape maintenance and bio-energy production indicate that the utilisation of extensively managed grassland in alternative bio-energy systems could exhibit the most favourable land use option for organic semi-natural grassland management. These results are verified by a risk modelling approach.*

## Introduction and objectives

Organic grassland management in various forms of utilisation is currently often struggling to achieve economic profitability. Therefore on the one hand an estimated middle-term decrease of grassland utilisation for feed of up to 25 % is anticipated e.g. in Germany (Rösch *et al.* 2009). On the other hand the demand for the provision of sustainable and ecologically consistent energy from renewable energy resources increases (Wachendorf *et al.* 2009). The Integrated Generation of Solid Fuel and Biogas from Biomass (IFBB), a bio-energy procedure newly developed at Kassel University, Germany, may offer promising prospects regarding the utilisation of biomasses from semi-natural grassland sites for the generation of biogas (power and heat) and grass pellets for combustion purposes. Unlike the fermentation of biomasses with low digestibility in conventional biogas plants the IFBB procedure is especially suitable for the application of extensive grassland material. Global potentials for the production of biomasses from semi-natural LIHD (low-input high-diversity) grasslands grown on poor soils or areas less favourable for agricultural production that neither compete with food production nor cause ecosystem destruction have roughly been estimated e.g. by Field *et al.* (2008) and Tilman *et al.* (2006) to account for 386 million ha and 500 million ha, respectively, providing a biomass potential of more than 5 % (Field *et al.* 2008) of the global energy consumption in

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2005. In Asia alone an estimated 100 million ha tropical lands, formerly forested but currently out of agricultural production (Houghton *et al.* 1991), in China more than 50 million ha currently unused so called “waste grassland” (Yan et al. 2008) could be mobilized for semi-natural grassland utilisation. This paper´s aim therefore is to identify field procedures with a profitable use of organic semi-natural grassland as well as incentives and objections of the implementation of the IFBB procedure at single farm level to begin with in Germany. Modelling the respective risk potential shall support the decision process, what kind of grassland processing is to be preferred.

## Materials and methods

The calculation of full costs and processing values of semi-natural grassland management and its utilisation in subsequent procedures is based on the results of expert interviews of 12 organically and conventionally operating farmers interested in sustainable energy issues, located in the grassland based Vogelsberg region, Germany. The conducted survey is the beginning of a series of farm surveys and expert interviews in three European partner regions, Vogelsberg/Germany, Ceredigion/Wales and Tartu/Estonia in order to compile generally valid criteria for the suitability of an implementation process of the IFBB procedure – applicable for any grassland region in agriculturally disadvantaged areas or extensive grassland regions. The data were complemented and operationalized with standard data (KTBL 2010). The calculation of costs was conducted in accordance with the standards of full cost accounting. Returns and single farm and compensatory payments for animal husbandry and landscape maintenance procedures (335 €/ha), bioenergy returns and subsidies (returns on electricity including subsidies: 20,67 ct./kWh; returns on grass pellets, no subsidies: 3,66 ct./kWh) as well as transport costs for bio-energy substrate (grassland) were considered in the calculations. Factor costs were assessed with a wage rate of 15 €/h and costs for land with 75 €/ha $a^{-1}$, buildings for animal husbandry were charged with half of the costs for new buildings. Risk modelling was performed with a Monte Carlo-simulation *(@risk 5.5)* by allocating triangular distributions to the parameters grassland yields (t/ha), grassland production costs (€/t dry matter) and market prices for meat (€/kg) and grass pellets (€/t). Yields were adapted to current yield ranges on Vogelsberg semi-natural grasslands, variation in production costs are due to modified mechanisation, market prices vary due to different marketing strategies for meat and the market price fluctuation of wood pellets in 2010. The probability simulation was carried out with 10000 iterations.

## Results and discussion

### Expert interviews

The expert interviews helped to identify parameters that indicate the suitability of semi-natural grassland regions for the IFBB approach. In the Vogelsberg region farms often display large amounts of surplus grassland, whereas capital and labour are limited production factors. Full time farmers would like to utilise their surplus grassland in an IFBB plant, but are partially restricted by path dependencies, not willing to give up their current farming branches immediately. Moreover, a higher willingness to invest and to carry risks than for the polled part time farmers could be detected. Full time farmers therefore rather imagine operating an IFBB plant than just supplying it with substrate. Part time farmers are more open to reduce their existing farming branches significantly or even abolish them in order to provide additional grassland for the supply of an IFBB plant.

**Processing values**

The calculation of processing values indicates that grass from organically managed semi-natural grassland sites by trend is used particularly efficiently in the bio-energy procedures IFBB or Dry fermentation (Table 1). This is especially true when considering the results of the expert interviews, that the availability of labour and capital is limited, whereas the factor land is not limited, which is typical for agricultural production in low mountain ranges.

**Table 1: Characterisation of extensive grassland utilization in different organic processing procedures (€/t DM)***

| | Suckler cows | Dairy | IFBB | Dry ferment a-tion | Mulchin g | Com-posting |
|---|---|---|---|---|---|---|
| **DM needs from grassland, t DM $a^{-1}$** | **696** | **480** | **3747** | **3420** | **-** | **-** |
| **Calculatory farming branch result, € $a^{-1}$** | **23565** | **15748** | **326016** | **175598** | **180** | **-112** |
| **Processing value, €/t DM** | **34** | **33** | **87** | **51** | **45** | **-28** |

*Netto yields 40 dt DM/ha; one bio-energy unit each, suckler cow stock size 116, dairy stock size 120

However, for animal husbandry systems approximations of processing values to bio-energy values can be achieved with suitable marketing strategies and low fixed costs e.g. for buildings. Influencing factors on the profitability of composting are the distance of composting facilities and the disposal costs of „green waste". Mulching is often prohibited under agro-environmental schemes. The profitability of the IFBB procedure considerably depends on the varying rates of future price increases of solid fules and distance of grassland sites (affecting transportation costs). The influence of subsidies for bio-energy production on profitability is rather small, since only 15 % of the IFBB earnings come from subsidized power sales and 85 % from unsubsidized solid fuel sales. Since investment needs for bio-energy procedures can be higher than for animal husbandry systems, one solution for farms based on forage production could be the collaborative operation of an IFBB plant, which would drastically reduce the provision of capital assets for each associate. Premium grassland sites could still be used in the existing animal husbandry procedures, whereas extensive surplus grassland could be used as substrate for a collaborative bio-energy plant.

**Risk modelling**

Risk modelling of suckler cow husbandry and the IFBB procedure in comparison shows that processing values of grassland utilisation in suckler cow husbandry can be similar to its utilisation in the IFBB procedure, however only 4.3 % of probable results lie within 90 % of the probable results of the IFBB procedure (Figure 1). Furthermore the cumulative probabilities are distributed much more broadly than for the IFBB procedure. Therefore with the IFBB procedure not only a more profitable grassland utilisation is achieved, but the considerably lower distribution of probable results implies an also considerably lower risk in using extensive grassland within IFBB.

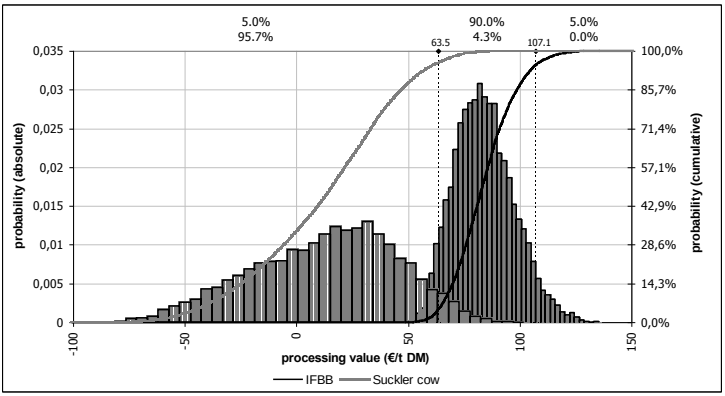


**Figure 1: Probability (p) calculations of the processing value (€/t DM) of grassland used in suckler cow husbandry and IFBB procedure in comparison**

## Conclusions

Model calculations and risk assessment presented in this paper indicate that a comprehensive land use is associated with economic difficulties in the middle term future, even for organic agricultural production. Especially for organic farms with surplus extensive grassland, the IFBB procedure could exhibit an alternative to customary processing procedures, since it represents a new opportunity to produce renewable energy even in areas less favourable for agricultural production without having to rely on intensively produced biogas substrates of conventional biogas technologies. One solution of preserving valuable grassland habitats *and* agricultural practice in low mountain ranges by creating new income possibilities is therefore a combination of organic management of semi-natural grassland and its utilisation in alternative bio-energy systems.

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