A comparison of different conversion techniques for the production of energy from permanent grasslands

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Background

- Ensuring the **conservation of species-rich permanent grassland** → utilization of the biomass for **energy production**
- **Conventional techniques:**
  - Whole-crop digestion (**WCD**) → low digestibility (ligno-cellulose)
  - Combustion of hay (**CH**) → emissions, corrosion, ash-melting (elements)
- **Novel technique:**
  IFBB (Fig.1): - Press fluid (PF) for **biogas** production (high digestibility)
  - Press cake (PC) as **solid fuel** (low element concentration)

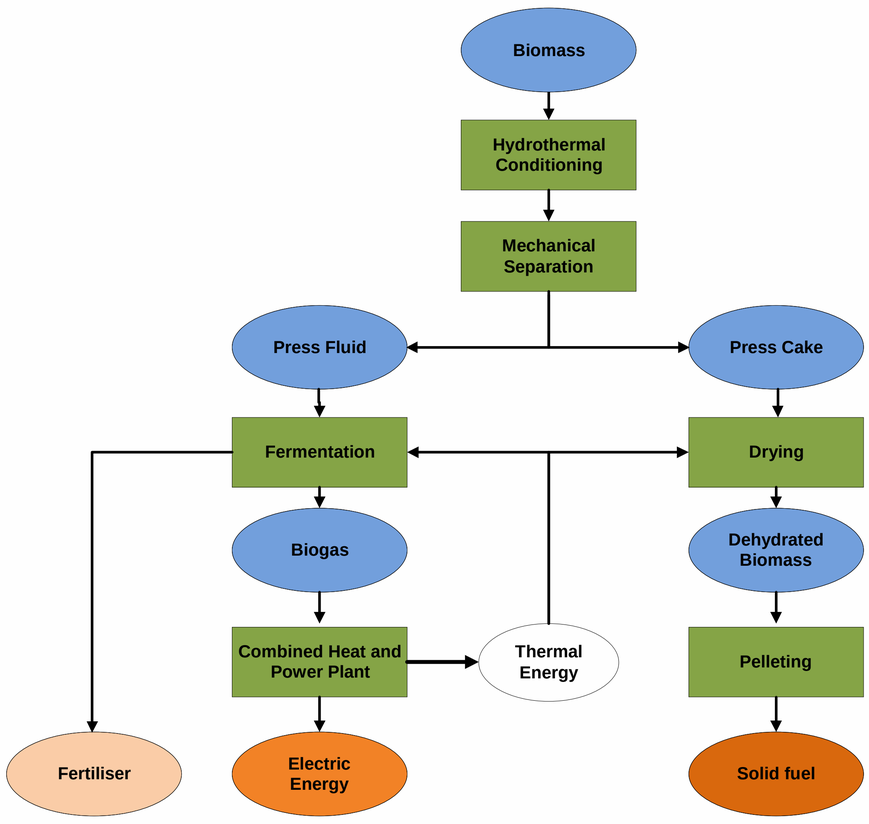

Figure 1: Integrated Generation of Solid Fuel and Biogas from Biomass (IFBB)

Materials and Methods

- **9 permanent grasslands**: 5 montane hay meadows, 4 lowland swards
- **Hydrothermal conditioning**: Temperature treatments: **10°C, 60°C**
- **Mechanical dehydration** with a screw press
- **Chemical composition** of press cakes and hay → fuel quality
- **Anaerobic digestion** of press fluids and silage in batch experiments
- **Energy balance:** - Output → Biogas (electricity & heat), Solid fuel (heat)
  - Input → Diesel, Electricity, Heat

Table 1: Comparison of quality parameters between conventional biomass energy sources (hay and silage) and IFBB energy sources (press cake and press fluid) as means of nine different grassland swards.

	Unit†	Fresh biomass/hay	Press cake 10°C	Press cake 60°C
Crude ash (XA)	g kg^{-1} DM	72.38	53.53	52.39
Potassium (K)	g kg^{-1} DM	12.70	2.46	1.11
Magnesium (Mg)	g kg^{-1} DM	2.11	1.11	0.86
Chloride (Cl)	g kg^{-1} DM	3.33	0.55	0.27
Nitrogen (N)	g kg^{-1} DM	14.28	12.21	11.33
Sulfur (S)	g kg^{-1} DM	1.53	1.00	0.85
Higher heating value (HHV)	MJ kg^{-1} DM	18.82	19.35	19.32
Ash softening temperature (AST)	°C	1158	1203	1224
	Unit†	Silage	Press fluid 10°C	Press fluid 60°C
Methane yield	L_N kg^{-1} VS	244.01	453.06	452.62
Degree of degradation		0.56	0.84	0.87

† VS, volatile solids

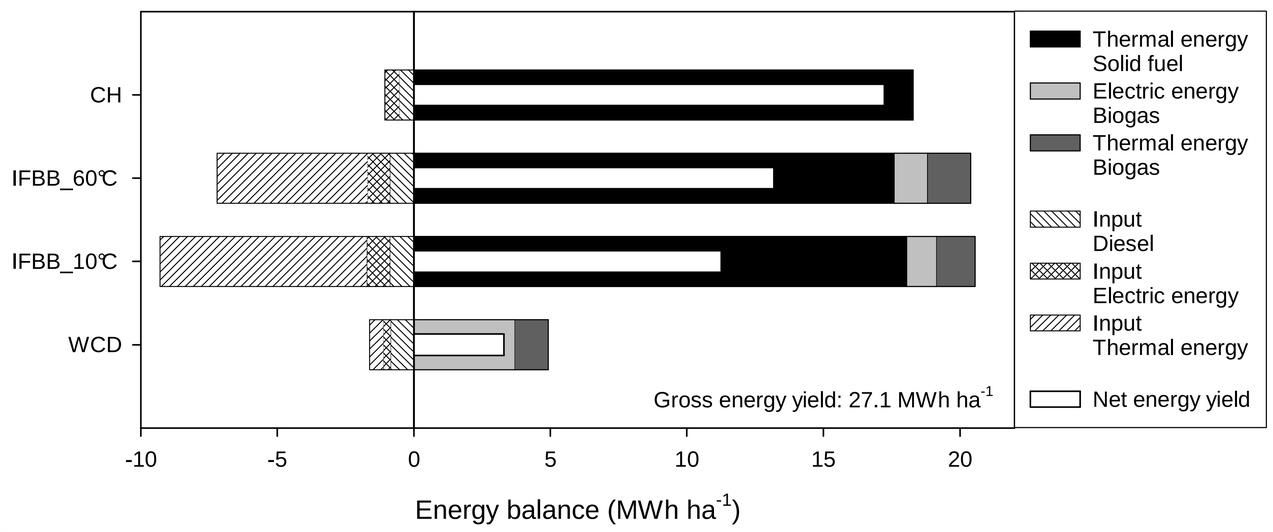

Figure 2: Net energy yields as balance of energy input and energy production of combustion of hay (CH), IFBB at two conditioning temperatures (10°C and 60°C) and anaerobic whole-crop digestion (WCD) as means of nine different grassland swards.

Results

- **Concentrations of elements** significantly (P<0.05) **reduced** in press cake compared to hay (Tab.1)
- **Specific CH_4 yield** and **degree of degradation** of organic matter of press fluids significantly (P<0.05) **higher** compared to silage (Tab.1)
- **60°C treatment** performed **better** compared to 10°C treatment (Tab.1)
- **Highest net energy yield** obtained by **CH** (17.23 MWh ha^{-1}), but only thermal energy
- **Net energy yield** of **IFBB 60°C treatment:** 13.2 MWh ha^{-1}, as thermal and electric energy

Conclusions

- IFBB as management option for the conservation of species-rich grasslands
- IFBB's energy sources (press fluid for biogas production, press cake for combustion) with higher quality than conventional sources (WCD, CH)
- IFBB with lower net energy yield compared to CH

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