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MANY BENEFITS FROM THE PERSPECTIVE OF CYCLE MANAGEMENT

Biogas and Organic Farming

More connections than divisions in agricultural practice

While biogas production has been well established and widespread for almost 10 years, with more than 7,500 plants in German agriculture, only a small number of organic farms has stepped into electricity, heat and fuel production from biomass. However, biogas holds solutions in store for a number of specific challenges of organic farmers.

Biogas is an all-rounder in terms of achieving the energy transition: Energy crops and waste such as manure are transformed into biogas in the fermenters of biogas plants. Methane (CH_4) contained in the biogas can then be flexibly used to produce electricity and heat in a cogeneration process or it can be used as a biofuel in vehicles fitted with gas engines.

For the renewable power supply of the future, biogas is indispensable: Compared to wind and solar energy, which are dependent on the weather, power generation from biogas is more controllable. It pitches in when the sun does not shine or when the wind does not blow. In In the German power and heat sectors, the use of biogas saved 12.4 million tons of greenhouse gas emissions in 2012. This is a considerable amount, given that agriculture is the third largest greenhouse gas emitter after energy production and manufacturing.

The number of biogas plants in Germany has more than quadrupled, from 1,759 in 2003 to 7,720 in 2013. This exponential growth also resulted in changes in land requirements.

In regions with a high density of biogas plants, maize cultivation has augmented. Although only one third of Germany's maize area is used for biogas production, while the bulk of the corn is used for feedingstuffs, it is predominantly biogas that is made responsible for maize fields shaping the landscape in many regions. Based on the energy content, maize constitutes the most important feedingstock for biogas production with a share of 61 percent, followed by other energy crops such as grass, and animal excrements like manure and biowaste.

Just one in three maize fields for biogas

	Total maize area	out of which for biogas
2011	2.5 mil. hectares	0.9 mil. hectares
2012	2.6 mil. hectares	0.9 mil. hectares

Source: DMK, Fachverband Biogas, own calculations

Scepticism and criticism towards biogas from the organic farming and nature conservation communities

Due to high yields per hectare and very high methane yields, maize ranks amongst the most profitable energy crops. This means that only a relatively small area suffices to generate a particularly high amount of electricity, heat and fuel. On the other hand, maize is made responsible for a loss of biodiversity. Especially, repeated cultivation of maize on the same plots of arable land risks exhausting the humus layer of the soil. Besides, generous row spacing of maize plants on the fields favours soil erosion.

For farmers who follow the criteria of organic farming, maize cultivation and biogas production seem to be outruled at first sight. Therefore, biogas production has made only little headway into organic farming so far. Out of a total of 7,720 installed biogas plants in Germany in 2013, only around 180 plants were operated within the framework of organic farming.[1]

[1] Estimate from the University of Kassel, by: Gaul, Thomas: Ökogas aus Ökobetrieben. In: Biogas-Journal 1/2013, pp. 102-105.

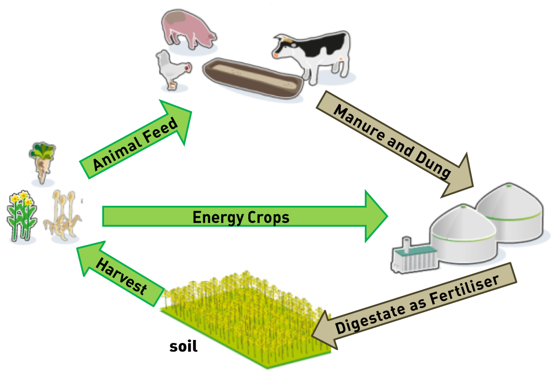
Those 2 percent of the installed assets are becoming increasingly interesting for researchers though, as those plants offer different possibilities for organic farming to expand and optimise nutrient cycles as well as to exert an influence on the problem of humus attrition due to maize monocultures. Organic farmers also achieve an increase in yields by using digestate from the biogas plant as a fertiliser[2].

How can biogas plants then, as an integrative concept, partake in organic farming and what benefits can be reaped from their operation for conventional agriculture?

How biogas supports organic farming

Biogas plants have a long tradition in organic farming. It was especially after the oil crisis in 1973 that they played an essential part among organic farmers, who developed the use of this energy source which had been known since the 18th century.

Nutrient cycles in organic farming are complemented by biogas



The supply of artificial mineral fertiliser is taboo in organic farming. The requirement of organic agriculture to offer a complete nutrient cycle can be secured by integrating a biogas plant into the farming concept. It is common knowledge that the substances left in the fermenter after fermentation, the so-called digestate, can substitute mineral fertilizers and might even be able to outperform it. For nitrogen fixation in the soil, organic farmers usually use catch crops, which are grown between two main crops. For soil enhancement, they also return organic substances into the soil in the form of compost or manure. The digestate from biogas plants therefore significantly widens the range of fertilisers for organic farmers. They have experienced an increase in yields and also a quality improvement of their products.[3] Clover, in particular, has great significance for organic farming because of its nitrogen-fixing effect. In conventional agriculture, a lot of energy is needed to enrich mineral fertiliser with nitrogen. 1 kg of nitrogen requires 1 litre of oil equivalent. Clover grass, by contrast, is able to produce 300 kg of nitrogen per hectare per year. Clover grass is normally used in organic farms to feed livestock. However, if an organic farm has a small number or no livestock, grown clover grass is often mulched, left to remain on the land and would, therefore, produce laughing gas, which is harmful to the climate. This is why clover grass is an ideal feedstock for biogas plants. Instead of livestock (which is not reared on those farms) the biogas fermenter is, "fed" with surplus clover grass. High methane yields of up to 4,000 m3/ha also make clover grass an attractive part for the feedstock mix.[4]

New crop rotations in Wendland

The farm of Martin Schulz, an anti-nuclear activist, is located In Wendland, a region in Lower Saxony. It is his intention to protect the environment and bring the energy transition forward. His biogas plant is located just outside the forest edge. Apart from manure and grass silage, this plant is currently supplied with a high proportion of conventional maize. However, Martin Schulz wants to reduce this share of conventional maize more and more in the years to come. This is why he experiments with crop rotation and fields framed with flower strips for wild plants. Martin Schulz' biogas plant produces electricity for 1,000 households. Besides, he has built a heat network which supplies heat to 70 connected households at a rate, which is 20 percent below the local natural gas tariff.

www.bioenergie-wendland-elbetal.de

Organic farming as a source of ideas for conventional biogas production

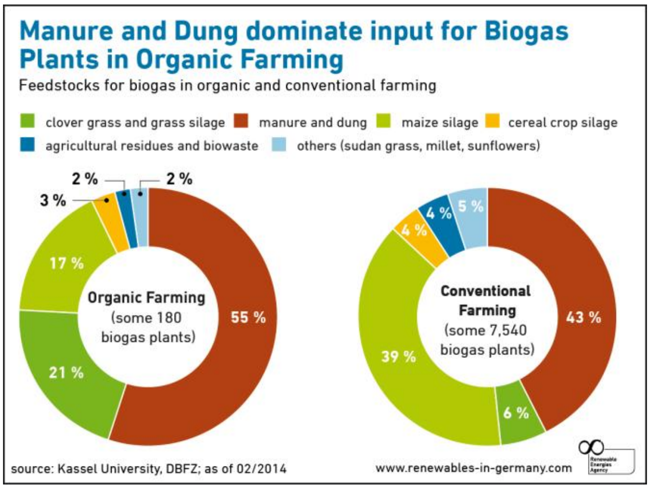
Organic farming abstains from monocultural cultivation, whose drawbacks have been discussed within the context of maize cultivation for biogas production. Energy crops are

[2] Räder, Eberhard: Bioenergie vom Ökohof. In: Renewable Energies Agency: Den Boden bereiten für die Energiewende). Berlin, February 2013, pp. 66-69.

[3] Danner, Walter/Kilian, David: Biogas und Ökolandbau. Die perfekte Kombination). Snow Leopard Projects, Reisbach 2012.

[4] Zerger, Uli: Sustainable for Plate and Tank (Nachhaltig für Teller und Tank): How biogas in organic farming brings the energy transition forward (Wie Biogas im Ökolandbau die Energiewende voranbringt). In. AEE: Preparing the ground for the energy transition (Den Boden bereiten für die Energiewende). Berlin, February 2013, P. 70-73.

always a part of multiple crop rotation rather than sole crop. Of course, conventional operators of biogas plants also practice crop rotations for energy crop cultivation, but, in principle, harmful monocultures are not banned. On the other hand, the cultivation practice of organic farming aims at avoiding a loss of biodiversity and soil quality. Organic farmers, who operate a biogas plant, mainly use residues such as manure and dung, which are obtained from farming and animal husbandry. With these feedstocks, biogas production could be increased. So far, conventional farmers as well as organic farmers use only around 20 to 25 percent of the available manure and dung to produce biogas. This means that around three quarters of animal excrements available for biogas production remain unused. However, compared to biogas production from energy crops, this potential still remains negligible.[5]

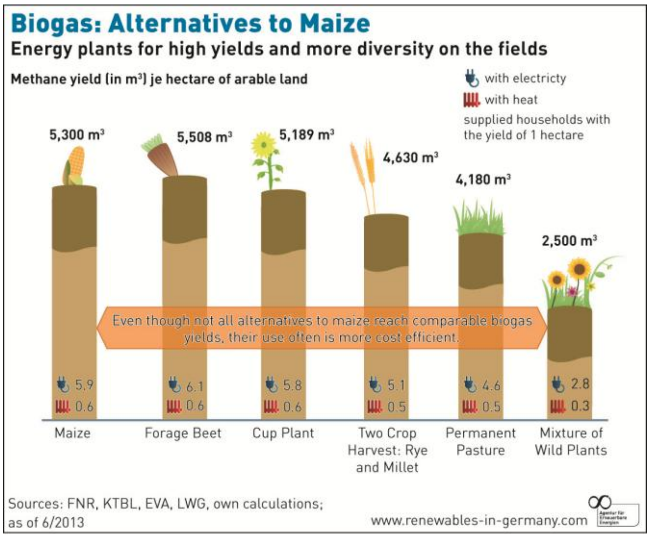


In 2012, 6.2 percent of Germany's farming area was used for organic farming. The aim of the national Strategy for Sustainable Development of the Federal Government is, however, to increase this percentage to 20 percent by 2020 in order to be able to meet the large demand for products from organic farming as well as to make agriculture and energy production more sustainable.

Eco friendly alternatives to Energy Maize

Numerous crops are available to replace maize as part of a nitrogen rich crop rotation cycle that is high in biogas yields. These crops include nurse crops such as legumes, catch crops such as clover grass, new crops such as cup plant (silphium perfoliatum) and wild plants. Depending on the yield of each crop, the gas extracted from 1 ha of conventional energy maize could be substituted by 4 to 6 ha of catch crops or 1.5 to 2 ha of clover grass.[6]

Opportunities for more diversity on the field have arisen from the use of perennial wild plants for biogas production. Their optimal growing conditions are currently being examined by a research project of the Federal Ministry of Food and Agriculture under the lead of the Bavarian State Institute for Viticulture and Horticulture. Since 2008, a total of 214 wild plant species has been tested and combined to yield rich mixtures. The mixtures with the currently highest biomass yield reached as much as 50 to 60 percent of the methane yields of maize.



Research is still in an early stage. It can therefore be expected that additional alternatives are to be developed in the coming years and that these, ideally, might be able to achieve the same yield as maize. At this stage, an enormous advantage of all wild plants currently in cultivation has already been observed: They are very easy to look after, require only small amounts of fertiliser and have to be sown for cultivation only every five years. Due to this, the substrate costs amount to only 750 Euro, as compared to 1,573 Euro for maize, which must be sown every year in the field. This makes cultivation of wild plants economically quite attractive for farmers: Although the yields are significantly lower than those of conventionally grown maize, biogas can also be produced at a lower cost. Wild plants are increasingly being chosen to expand the diversity of fields and crop rotations. This offers various animal species, such as wild animals or

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[5] AEE: Residues for Bioenergy Use (Reststoffe für Bioenergie nutzen). Potential, Mobilisation and Environmental Balance (Potenziale, Mobilisieurng und Umweltbilanz). Renews Spezial 64, April 2013.

[6] Office of Technology Assessment at the German Bundestag (TAB): Ecological farming and Bioenergy Production. Trade-offs and Solutions. Berlin, August 2012.

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bees, a new habitat. This supports biodiversity, enriches the landscape, and, therefore, usually leads to an improved public image of farmers as well as energy crop cultivation.[7]

Nature Conservation thanks to biogas

The "Wendbüdel" farm of the Association for the Environment and Nature Conservation (BUND), is situated near Oldenburg. The farm with its attached biogas plant has been built next to the Delme River to maintain the surrounding wet grassland area. The diversity of these marsh lands, which is under Nature Conservation, can only be maintained, if they are continuously managed, meaning they need to be mowed regularly, though yields are too low from the agricultural point of view. This is where biogas comes in: The mown grass is used as silage in the two fermenters of the biogas plant. In order to guarantee a constant supply of biogas, the two fermenters are alternately filled with the material and additionally with dung every other week. Under the EEG 2009, biogas plants, that utilise more than 50% of landscape conservation material, for example, from nature conservation areas, are eligible to receive additional support of 2 cent per kilowatthour (kWh) of electricity that is generated. At a daily production rate of 500 m^3 biogas, the farm is quite viable. The digestate, in turn, is used as fertiliser.

www.wendbuedel.de

Due to dense ground coverage throughout the year, wild plants and clover grass prevent soil erosion and nutrients in the ground from being washed out. Since the harvest period for wild plants does not overlap with the breeding and nurturing season of many wild animals, fields may team with them during this time of year. In all wild plant test areas, higher number of species and individual animals compared to the neighbouring maize fields could be observed.

Biogas as a challenge for organic farming

The main challenges organic farmers have to confront when thinking about establishing a biogas plant are financial issues. Especially on farms without their own livestock and without significant quantities of liquid and solid manure, the limited productivity of clover grass or catch crops may be a problem. From a nutrient cycle perspective it may seem obvious that organic farms should have their clover grass processed in a biogas plant. However, such an operation might not be profitable with only small amounts of clover grass. In order to operate their biogas plant economically and efficiently, 50 percent of organic farms also utilise conventional substrates, especially maize. Thus, most biogas plants are often not operated exclusively with energy crops and waste from organic farming. It is estimated that 80 percent of the electricity generated in biogas plants operated by organic farmers comes from conventional substrates. In order to supply the biogas plants operated by organic farmers solely with feedingstocks from organic agriculture, the area needs of those plants would increase by 40 percent on aggregate, according to calculations.[8]

The reason for this can be found in the lower yields of organic farming per hectare. In order to provide a comparable amount of biomass from one hectare of conventionally grown maize, organic farming requires a larger area of land. Although the umbrella organisations of organic farming have significant concerns regarding the expansion of biogas plants, they accept the use of mixed conventional-organic substrates. However, the three largest organic farming associations, namely Demeter, Naturland and Bioland require their members that at least 70 percent of the substrates used have to come from organic agriculture. By 2020, the remaining share of conventional materials is to go down to zero.

"In my work as a farmer, I am guided by the combination of natural cycles. This applies to the production of food as well as to the generation of eco-friendly, renewable energy from the field and the stable."[9]

Eberhard Räder, organic farmer from Bastheim in the Rhön region.

Lower harvest and low methane yield of the substrates used are not the only financial challenges that organic farmers have to face. The Renewable Energy Sources Act (EEG) also puts them in a difficult position as clover grass, commonly used as a mainstay of biogas production in organic farming, is not recognised and supported as a main crop in the EEG as amended in 2012. Specifically, this means that in terms of the

[7] Degenbeck, Martin: Energy from wild plants - an ecological and economic initiative for the production of biogas (Energie aus Wildpflanzen - eine ökologische und wirtschaftliche Initiative bei der Biogasproduktion). lecture, Berlin, 3rd Bioenergy Project Day (3. Projekttag Bioenergie), 11th June 2013.

[8] Christopher Brock et.al. (Ed.): It is about all: Researching through the Dialogue on Science and Practice (Es geht ums Ganze: Forschen im Dialog von Wissenschaft und Praxis). Result of the Dialogue Workshop in the 11th Conference of Organic Farming. Giessen, June 2011.

[9] AEE: Preparing the ground for the energy transition (Den Boden bereiten für die Energiewende)

feed-in tariffs for biogas, clover grass is categorised in the Feedstock Remuneration Class I instead of Class II and thus receives 2 Euro cents/kWh less in support – despite the fact that the high environmental benefits of clover grass could have made it eligible for Remuneration Class II. At the end of the year, a 500 kW-biogas plant is recorded with a shortfall in revenue of 60,000 Euros on average when compared to conventional biogas plants.[10]

The de facto difference in support between conventional and organic biogas plants has an influence on the development of land rates in the regions. Through the guaranteed payment of electricity generated from biogas under the EEG, farmers planning to operate biogas plants receive necessary investment security. If there is no significant cost increase on agricultural markets, viable farming of energy crops is secured via the EEG and its feed-in tariffs over the long-term. Small biogas plants that are tailored to low biomass yields from organic farming are often not able to operate profitably under the EEG as amended in 2012, though.

And yet another cost-pusher prevents more farmers from deciding to build a biogas plant: Feedstocks such as clover grass, wild plants and legumes have a strong high-fiber structure, which means high processing costs. The pump and mixer of the fermenter of biogas plants in organic farming must be exceptionally strong. They also need to be inspected frequently in order to be able to use the substrate efficiently. Besides, for clover with its several cuttings, more work is needed than for harvesting maize.

However, in estimating economic efficiency of a biogas plant in organic farming, it is not enough just to compare the costs and benefits of each substrate and the required processing technology with those of conventional biogas plants. The increase in yields at harvesting time, which could be obtained by means of using high-quality digestate, might be able to contribute considerably to the economic efficiency of the farm. Therefore, the biogas plant should be seen as an integral part of the farm, rather than as a separate cost risk.

In this context, the use of heat from the biogas plant, either on the farm and/or for feeding heat into a local network to create an additional source of income for the owner, also has an important role to play.

[10] Neue Osnabrücker Newspaper: Organic sector feels extremely disadvantaged when it comes to biogas (Biobranche fühlt sich bei Biogas extrem benachteiligt). 27th March 2012.

Biogas as a driver to switch to organic farming

In Northern Swabia, where “Bioenergie Reimling“ is located, biogas is produced from 15 organic farms. The plant was originally founded by 5 organic farmers. Afterwards 10 other farms, that were conventionally run, switched to organic rules, seeing that the change could promise better economic prospects. Together the farms now use clover grass and field grass as well as conventional maize and whole crop silage from 300 ha, producing electricity for approximately 4,000 households. With the generated heat from the process the nearby hospital can be completely supplied - thereby saving 300,000 litres of crude oil per year. The “Reimling” biogas plant is a good example for the financial benefits which organic farmers can reap from biogas production too. Additionally, it shows that farmers may even be encouraged to change to organic farming in this way.

Conclusion

Organic farming as a pioneer of biogas production in Germany enriches its nutrient cycle with digestate from biogas plants in a meaningful way. Clover grass is an ideal feedstock. However, the EEG has not taken this fact into account sufficiently so far to heed the specific challenges which organic farmers are confronted with, when they consider entering biogas production. Considering the problem of (energy) maize monocultural cultivation, conventional farmers could take an example from the sophisticated cultivation concepts in organic farming with its lower input of energy and mineral fertilizers, while yields per hectare are significantly lower though. A consistent use of biogas and digestate, however, could lead to a significant yield increase as confirmed both in practice and by science.

The increased use of residues such as manure and dung as well as alternatives to maize such as perennial wild plants or clover grass holds in store an expansion of biogas production both in conventional and organic agriculture.

Biogas can be interesting particularly for organic farmers, who do not engage in dairy farming, as clover grass, which is part of the crop rotation on organic farms, is used to feed cattle. On organic operations that are only active in arable farming or pig farming, such feed use is absent. Therefore, by having clover grass or alfalfa fermented in a biogas plant, the digestate from the process can be valuable for the farms as fertiliser in the fields.

Biogas in Organic Farming at a Glance

Strengths

- Flexible, controllable electricity production
- Reduction of greenhouse gas emissions
- Production of high-quality fertilisers

Weaknesses

- Lack of feedstocks
- Low remuneration for clover grass in the EEG
- Relatively high specific costs for feedstocks

Opportunities

- Meaningful use of clover grass
- Closing of nutrient cycles
- Additional economic mainstay for electricity and heat

Challenges

- Competition to conventional farming
- Skepticism from nature conservation and organic associations
- Financial risk

In the EEG, there are currently two remuneration classes for the use of energy plants, according to which the biogas base remuneration increases by 6 Eurocents/kWh or by 8 Eurocents/kWh. The Remuneration Class II only includes clover grass and alfalfa, which are particularly widespread in organic farming, when they are grown as catch crops, not as main crops. This stipulation has met with incomprehension amongstorganic farming representatives. However, current plans envisage to completely do away with the energy crop remuneration. This would not only fundamentally question biogas production from conventional energy crops, but also from alternative substrates such as clover grass from organic farms, as far as new installations are concerned.

In view of the synergies described here, it would be unfortunate if biogas and organic farming would see themselves as opponents struggling for presumably scarce land and promotion. A discontinuation of conventional biogas production would not resolve the structural obstacles, with which the organic farming sector in Germany is confronted. Joining biogas production and/or organic farming deserves adequate political support -after all, both are important for climate protection in agriculture.

Biogas plants in organic farming have to face up to a multitude of challenges, including the issue of cost-effectiveness. New cultivation systems, alternative energy plants and the advancement of the required technology could open up new avenues for biogas production, also in economic terms. Irrespective of the mentioned issues, it should be noted that the fermentation of organic material for regenerative energy production rests on the basic principle of cycle management which organic farming has embraced in a special way.

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