

## **Available unused substrate potentials and obstacles to their energetic use in German biogas plants - Survey of livestock farmers without biogas plant**

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In Germany, considerable potential for agricultural by-products currently remains untapped. In particular, large quantities of manure (liquid and solid), which could be used to generate energy in biogas plants, are still available. A survey of livestock farmers, who do not operate their own biogas plants, was conducted to determine the reasons why the available substrates remain unused for energy generation.

The survey intended to provide information on available manure quantities, existing manure removal techniques and manure storage, as well as information on key reasons why manure is not used for biogas production. In addition, it will be recorded which changes are necessary from the point of view of the livestock farmers in order to promote the energetic use of liquid manure.

In the following, results for the distribution of the response and evaluations of the relevant questions are presented.

### **Dispatch and return**

The survey was conducted in summer 2019 as an online survey using a partially standardized questionnaire. The survey was advertised to farmers via online editions of various agricultural magazines (Elite, TopAgrar, BauernZeitung) and DBFZ newsletters and they were invited to participate. Participation in the survey was via an online questionnaire. It was also possible to download and complete the questionnaire as a form.

In total 147 responses from livestock farmers are available for evaluation. Figure 1 and Table 1 show the regional distribution of the responses. It turns out that the return flow is unevenly distributed. In eastern Germany, the number of participants is very small. In total, only 7 responses were received for the federal states of Mecklenburg-Western Pomerania, Brandenburg, Saxony-Anhalt, Saxony and Thuringia. More than half of the total number of participants in the survey can be attributed to livestock farms in Bavaria, Lower Saxony and North Rhine-Westphalia. With regard to the regional distribution of agricultural holdings with cattle, the distribution of the return flow is well in line with the total stock. Federal states with comparatively many cattle farms also show the largest share in the return flow (see Table 1) (Destatis 2019).

Table 1: Response livestock farmer survey 2019 DBFZ differentiated according to federal states, database: livestock farmer survey 2019 DBFZ, Destatis 2019

	response [number]	share response [%]	Distribution of agricultural holdings with cattle [%]
Baden-Wuerttemberg	14	9.5	11.2
Bavaria	32	21.8	31.8
Berlin/ Bremen/ Hamburg	-	-	0.2
Brandenburg	1	0.7	3.0
Hesse	15	10.2	5.8
Mecklenburg-Western Pomerania	3	2.0	2.3
Lower Saxony	28	19.0	14.7
North Rhine-Westphalia	26	17.7	12.0
Rhineland-Palatinate	6	4.1	3.5
Saarland	-		
Saxony	1	0.7	0.5
Saxony-Anhalt	1	0.7	4.8
Schleswig-Holstein	12	8.2	2.1
Thuringia	1	0.7	5.3
anonymous	7	4.8	2.9
total	147	100	100

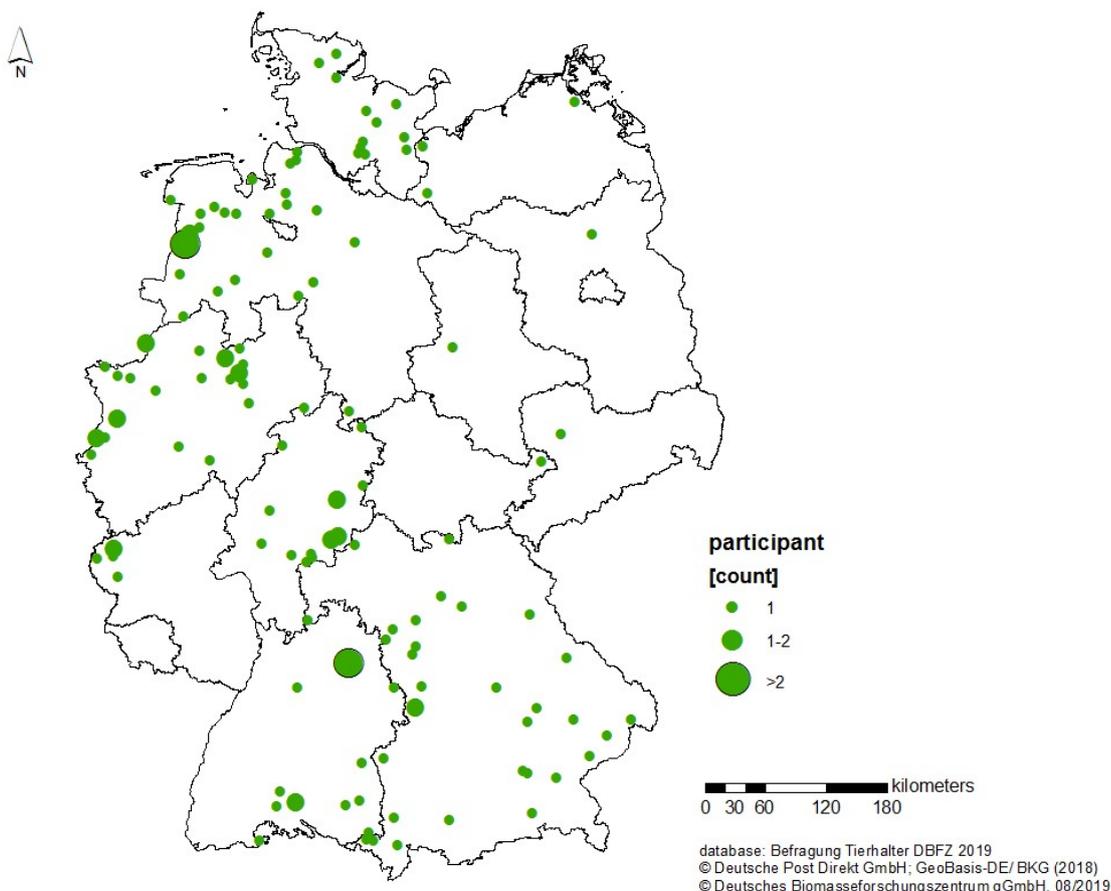


Figure 1: Locations response livestock farmer survey 2019 DBFZ, reference level: postcode

The majority of the participants in the survey stated that they operate the livestock holding as a full-time occupation. About 11 % of the participating livestock farmers state that animal husbandry is a sideline activity. With regard to the type of farm, feedback mainly came from conventional farms (about 95 %). About 5 % of the participants indicated that they run an organic farm (see Figure 2).

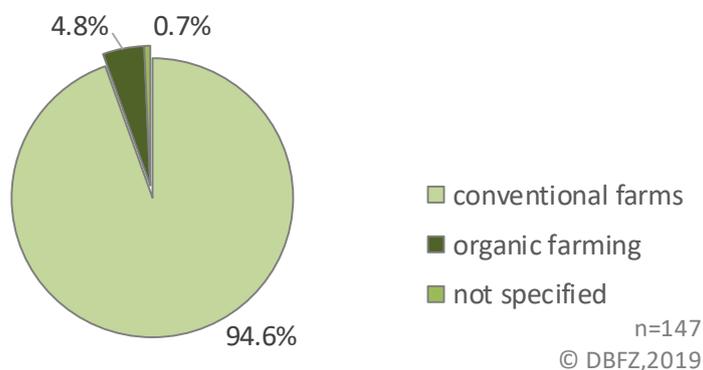


Figure 2: Response livestock farmer survey differentiated by type of agricultural holding, database: livestock farmer survey 2019 DBFZ

With regard to the business orientation of the survey participants, farms with cattle farming dominate (exclusively or in addition to other livestock farming). They were addressed via the corresponding online journals due to the focus of the project. 71 % of the participants say that they keep cattle (lat. bovis) (see Figure 3). 56 % of the livestock farmers of the survey solely have cattle in their herds (n=81). In

addition, about 31 % of the farms report that they raise pigs, 12 of them exclusively. Farms raising poultry, horses, sheep or goats account for only a small proportion of the returns.

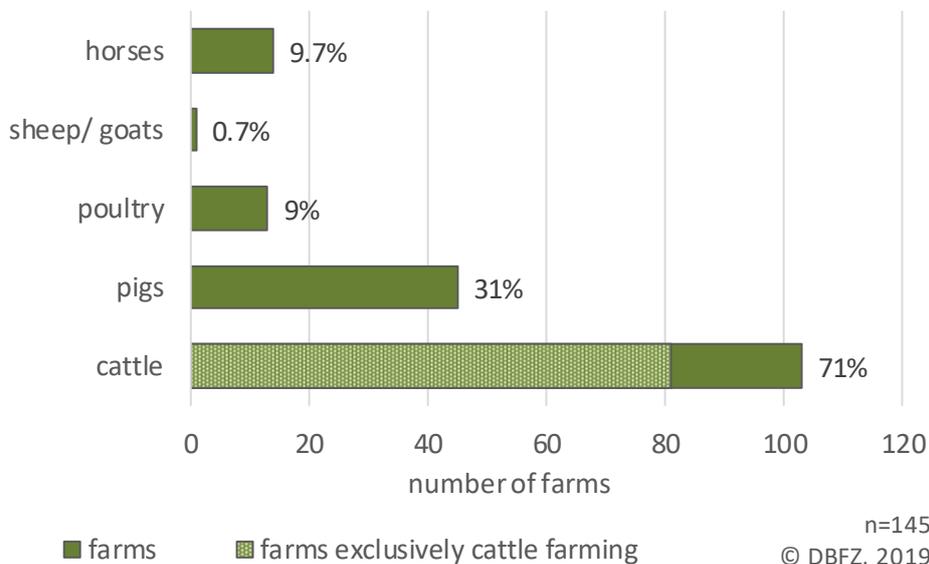


Figure 3: Response livestock farmer survey differentiated by livestock, multiple answers possible; database: livestock farmer survey 2019 DBFZ

A breakdown of the available quantities of manure from livestock farms shows that the average available quantities of liquid and solid manure from cattle and pigs exceed 4,500 t/a (corresponds to approx. 15 - 26 kW install. el. output, depending on the substrate). About 1/4 of the participants state that the available quantities of cattle manure (liquid/ solid) are over 6,500 t/a (corresponds to about 50-60 kW install. el. output) (see Table 2).

Table 2: Response livestock farmer survey differentiated by livestock, multiple answers possible; database: livestock farmer survey 2019 DBFZ

Amount manure (solid/liquid)	Mean value [t/a]	Median [t/a]	1 <sup>st</sup> quartile [t/a]	3 <sup>rd</sup> quartile [t/a]	Number n
cattle	4,740	3,500	1,500	6,500	86
pig	4,931	2,450	1,800	4,625	42
poultry	665	555	500	800	10
horse	312	100	12.5	500	13

## Results

### Manure removal technology

The primary manure removal technology used on the farms is slatted flooring (see Figure 4). Around 74 % of the livestock farmers indicated in the survey that they had slatted floors as the predominant manure removal technique. Approximately 35 % of respondents stated that they use scrapers (exclusively or in combination with other manure removal techniques) in their operation. The term

"other" refers primarily to deep litter and pedal dung. In addition, other manure removal systems such as manure belts, wheeled loaders, manual manure removal and compost stables only play a minor role. Livestock farms that currently supply part of the available amount of manure to external biogas plants, mainly also have slatted floors. In fact, about 72 % of these farms use slatted floors. As shown in Figure 4, there are hardly any differences in the manure removal techniques used by the farms considered.

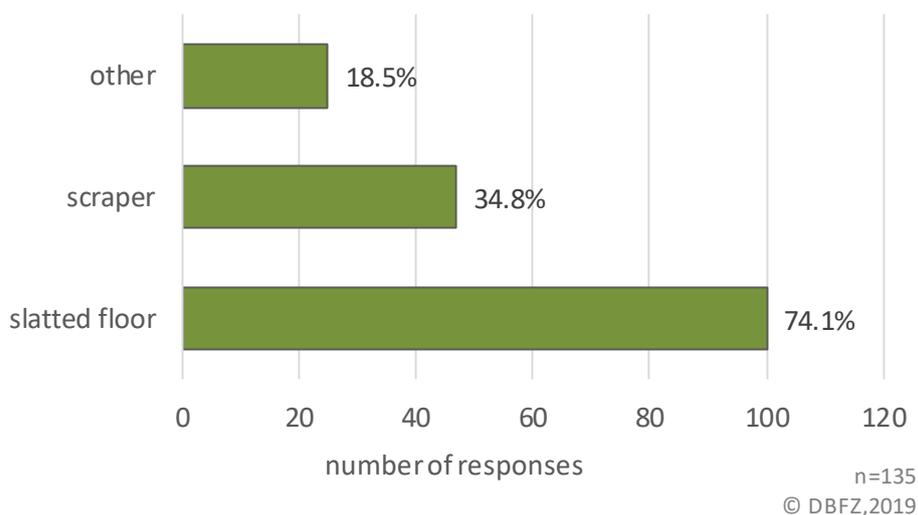


Figure 4: Used manure removal technology (cattle/pig), multiple answers possible; database: livestock farmer survey 2019 DBFZ

### Manure storage

The majority of manure on cattle farms is stored in a combination of indoor storage and outdoor storage. Around 42% of the participants stated this for their storage of liquid manure. Around 21% of farms store liquid manure under the barn alone (see Figure 5). Only those holdings, which exclusively keep cattle, are taken into account here.

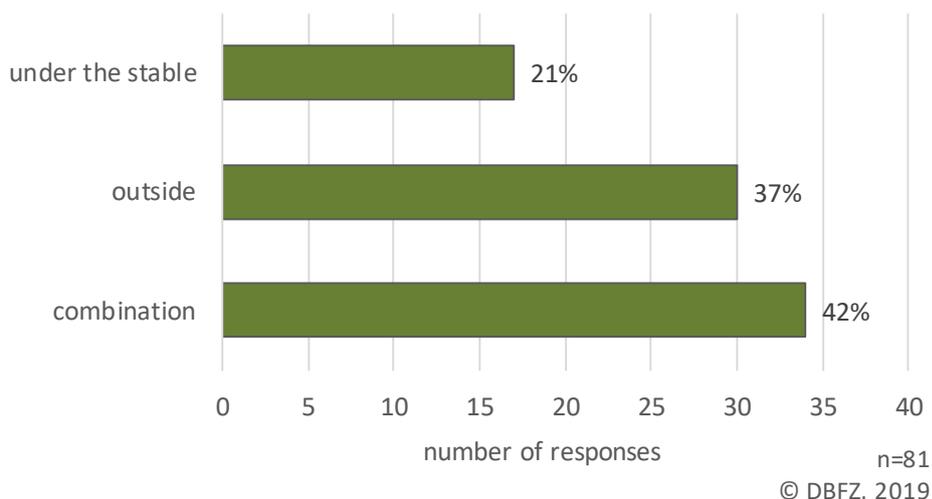


Figure 5: Manure storage in cattle farms; database: livestock farmer survey 2019 DBFZ

The information on bedding in livestock farming shows that straw is the main type of bedding used. About 87% of the participants stated that they use straw as bedding. In addition, lime and sawdust play an important role. These are used by around 16 % of the farms and are often used in addition to straw.

Table 3 shows the results of the survey. The term "other" includes additional bedding materials such as compost soil and coffee powder.

Table 3: Bedding in livestock farming – material and frequency of use; database: livestock farmer survey 2019 DBFZ

Bedding	Mentions [number]	Share of participants (n=79) [%]
straw	69	87.3
lime	13	16.5
dung	5	6.3
sawdust	12	15.2
other	2	2.5

### Potential biogas utilization

In the context of the survey, 31 livestock farmers without an own biogas plant stated that the available quantities of liquid and solid manure are currently already being supplied, either proportionately or completely, to an external biogas plant. This corresponds to about 21% of the respondents. The majority of respondents stated that liquid and solid manure are currently not used for biogas production (see Figure 6).

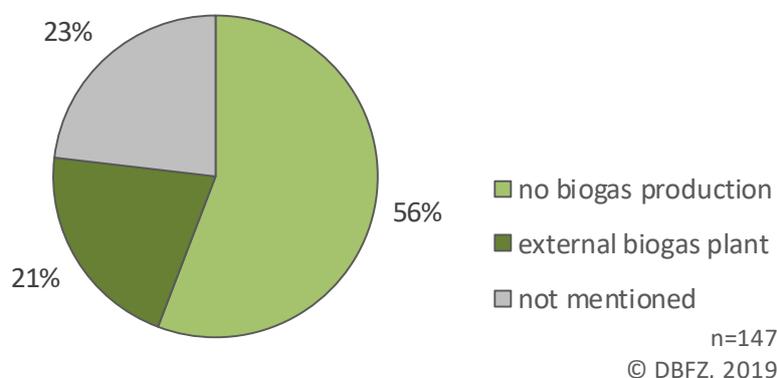


Figure 6: Current use of manure (liquid and solid) in biogas plants on farms without own biogas production; database: livestock farmer survey 2019 DBFZ

Figure 7 shows the quantities of manure (liquid and solid) used for biogas production. Information is available for 29 livestock farmers on the total amount of manure available and the proportion delivered to an external biogas plant. On average, around 50 % of the total quantities at the site are passed on to biogas plants. Half of the respondents stated that more than 35 % of the total amount of manure is delivered to an external biogas plant.

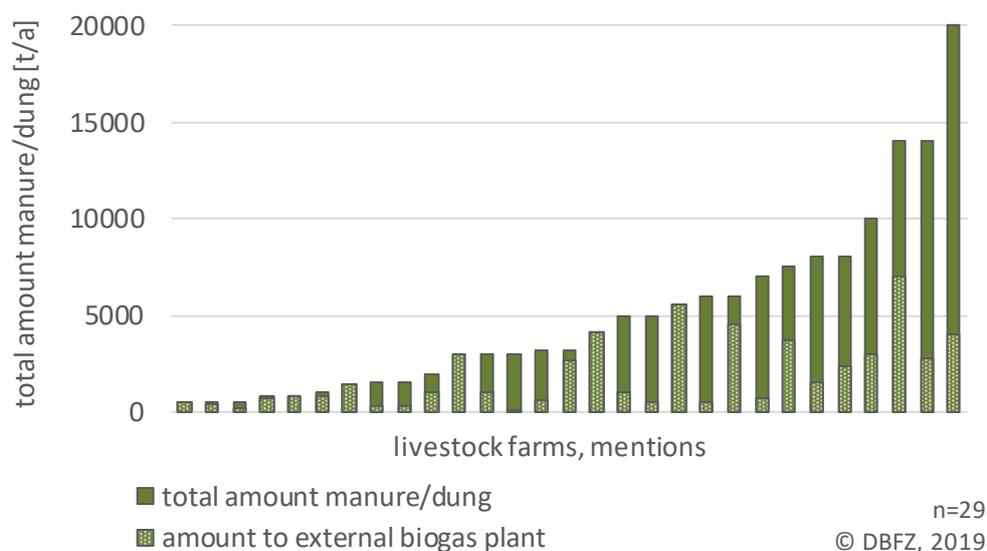


Figure 7: Total quantities of manure (liquid and solid) available and quantities used for biogas; database: livestock farmer survey 2019 DBFZ

Table 4 shows the average proportion of the available total quantity of manure (liquid and solid) used in an external biogas plant. It can be seen that with an increasing total quantity of liquid and solid manure at the location of the cattle farm, the proportion of manure that is delivered to external biogas plants decreases. Livestock farmers who produce comparatively small quantities of liquid and solid manure at their farm site ( $\leq 1,000$  t/a) on average transfer around 80 % of the available quantities to a biogas plant. On the other hand, livestock farmers with high manure quantities at the farm site give significantly fewer substrates of the total quantity available for biogas production to a biogas plant (in average 30 %). It should be noted that, due to the small number of cases, this only represents a trend, but not statistically reliable results. More extensive surveys are needed for further consideration and validation of the results.

Table 4: Percentage of liquid and solid manure delivered to external biogas plant differentiated according to the total amount available at the farm location; database: livestock farmer survey 2019 DBFZ

Total amount liquid/ solid manure [t/a]	Medium share manure delivered to biogas plant [%]	number
$\leq 1,000$	80	6
1,001 - 5,000	47.1	12
5,001 - 10,000	40.4	8
> 10,000	30	3

With regard to the energetic utilization of the available quantities of manure and dung in biogas plants, the livestock farmers were asked whether the construction of an own biogas plant had previously been considered. Around 73 % of the respondents indicated that they had already considered this. However, the majority of livestock farmers decided not to build their own biogas plant (see Figure 8). About 22 % of the respondents stated that they had not yet considered setting up their own biogas plant. The

majority of livestock farmers, who are currently already supplying manure to external biogas plants, have decided against a biogas plant of their own (about 55 %).

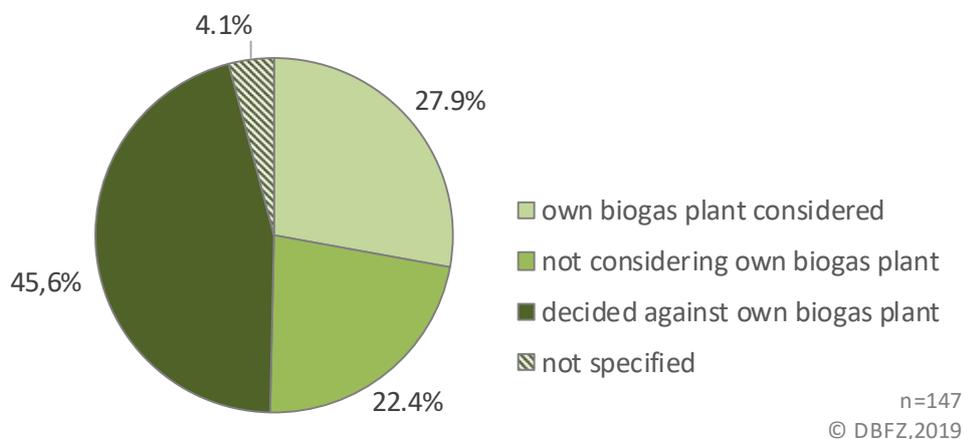


Figure 8: Consideration of an own biogas plant; database. Livestock farmer survey 2019 DBFZ

### Obstacles to the utilization of biogas

The livestock farmers state numerous different reasons why liquid and solid manure are not or not completely used for biogas utilization. Feedback on this has been received from 139 livestock farmers. The majority of livestock farmers name economic and legal aspects as major obstacles to the use of biogas. Around 96 % of the respondents stated economic reasons against the use of manure in a biogas plant. Legal aspects were also mentioned by around 94 % of livestock farmers as an obstacle to the energetic use of the substrates (see Figure 9).

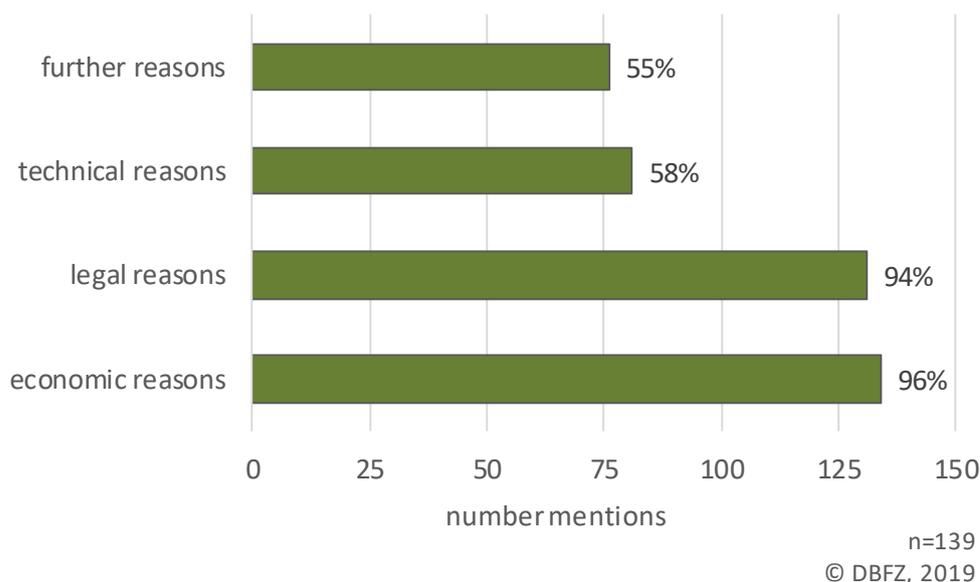
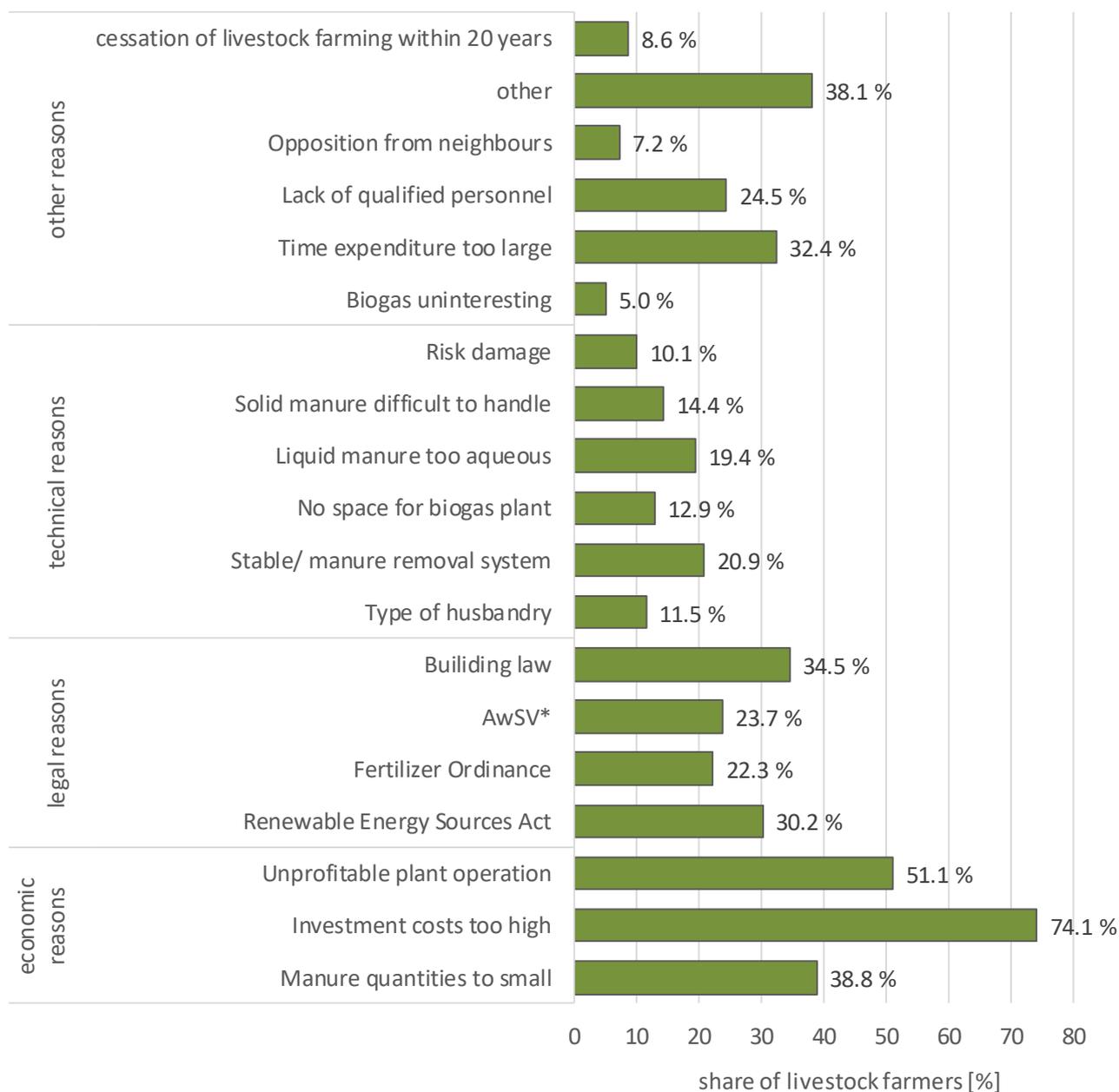


Figure 9: Reasons against the use of liquid and solid manure in biogas plants, number of mentions and proportion related to number n, multiple answers possible; database: livestock farmer survey 2019 DBFZ

An analysis of the reasons against a (complete) utilization of manure in a biogas plant can be found in Figure 10. It becomes clear that economic reasons are named by the majority. A major obstacle to the use of biogas is the high investment costs for a biogas plant. Around 74 % of the respondents indicated

this as an obstacle to the use of manure for biogas production. In addition, unprofitable plant operation, building regulations, high expenditure of time and other reasons are mentioned. Technical aspects represent significantly fewer obstacles to a biogas use.



\*Ordinance on Installations for Handling Substances Hazardous to Water

Figure 10: Obstacles to the use of liquid and solid manure in biogas plants; database: livestock farmer survey 2019 DBFZ

A closer look at the reasons against a biogas plant among livestock farmers who claimed to have decided against owning their own biogas plant shows a very similar distribution. Contrary to the distribution of the barriers shown in Figure 10, the energy content of the slurry (slurry too aqueous), other reasons and the unprofitable operation of a biogas plant are named as barriers much more frequently by those livestock farmers who deliberately decided against a biogas plant. Table 5 shows the results.

Table 5: Obstacles to use liquid and solid manure in biogas plants for livestock farmers who have deliberately decided against a biogas plant; database: livestock farmer survey 2019 DBFZ

Obstacle		mentions [number]	Share of participants (n=67) [%]
Economic reasons	Manure quantities too small	20	29.9
	Investment costs too high	45	67.2
	Unprofitable plant operation	38	56.7
Legal reasons	Renewable Energy Sources Act	21	31.3
	Fertilizer Ordinance	17	25.4
	AwSV*	14	20.9
	Building Law	24	35.8
Technical reasons	Type of husbandry	4	6.0
	Stable/ manure removal system	15	22.4
	No space for biogas plant	6	9.0
	Liquid manure too aqueous	20	29.9
	Solid manure difficult to handle	12	17.9
	Risk damage	6	9.0
Other reasons	Biogas uninteresting	1	1.5
	Time expenditure too large	23	34.3
	Lack of qualified personnel	19	28.4
	Opposition from neighbours	3	4.5
	other	34	50.7
	Cessation of livestock farming	4	6.0

\* Ordinance on Installations for Handling Substances Hazardous to Water

## Adjustments to increase the energetic use of liquid and solid manure

Within the scope of the survey, it was determined which adjustments/changes would be necessary from the perspective of the livestock farmers in order to achieve a complete energetic use of liquid and solid manure. About 1/3 of the respondents stated that none of the changes could result in a decision for an own biogas plant because there was either no interest in biogas or a sensible use of manure was not seen possible (see Figure 11). Nearly half of the respondents stated that the use of the available substrates in an external biogas plant via cooperation is conceivable. A joint biogas plant would also be an option for about 1/3 of the livestock farmers.

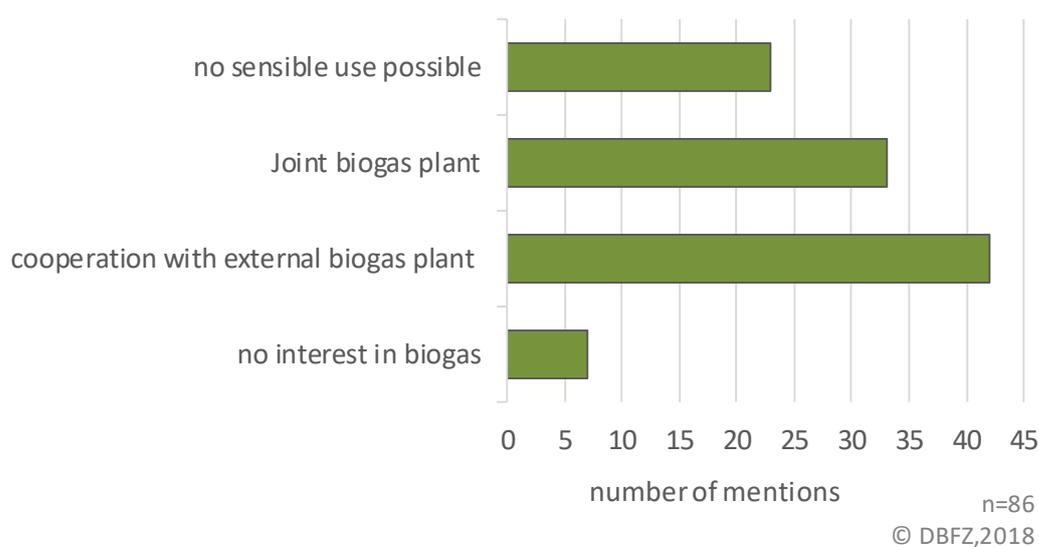
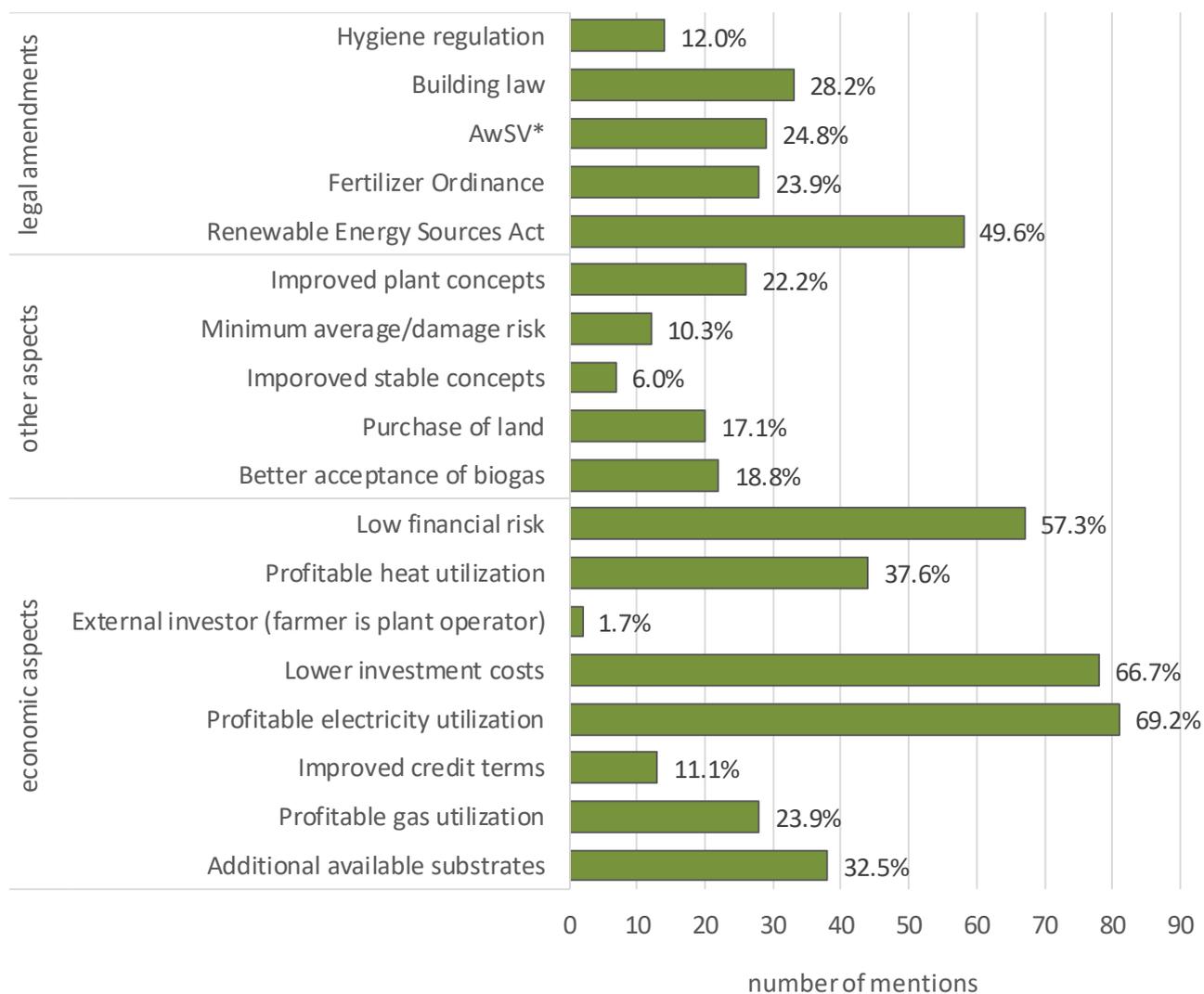


Figure 11: Possibilities to use available substrates for biogas production; database: livestock farmer survey 2019 DBFZ

According to the respondents, an operation of their own biogas plant (new construction) can only be considered if different economic aspects change. Accordingly, the construction and operation of a biogas plant can only be regarded if:

- the investment costs for biogas plants decrease
- profitable electricity utilization is possible and
- there is a lower financial risk during the construction and operation of the biogas plant.

Figure 12 shows the measures and improvements required to achieve complete energy use of liquid and solid manure. In addition to economic aspects, the amendments to the Renewable Energy Sources Act (EEG), which has primarily promoted the construction and operation of biogas plants in recent years, are mentioned above all.



n=117  
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Figure 12: Measures and adjustments to improve the energetic use of liquid and solid manure in an own biogas plant from the point of view of livestock farmers; database: livestock farmer survey 2019 DBFZ

## Summary

This survey of livestock farms without their own biogas plant shows that livestock farmers often consider biogas production as an energetic use of liquid and solid manure. The vast majority of these livestock farmers have already considered the subject of "their own biogas plant", but in the end about 2/3 of the respondents decided against having their own BGA or did not consider it from the outset. Economic and legal reasons are cited as the main obstacles to an own biogas plant (> 90 % of farmers). High investment costs, unprofitable plant operation and insufficient quantities of manure are the main obstacles identified. With regard to necessary legal adjustments and changed framework conditions, about 50 % of the survey participants stated that the use of the available substrates in an external biogas plant is conceivable through cooperation. Similarly, for about 1/3 of the livestock farmers, a joint biogas plant would be an option in order to feed the available quantities of slurry and manure into energy recovery. From the point of view of livestock farmers, lower investment costs, profitable plant

operation and adjustments to the Renewable Energy Sources Act (EEG) are the key aspects that need to be adapted to biogas production.

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