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## Farmers current practices, and their opinion on supplying straw for production of second-generation biofuels in Sweden

Justin Casimir and Carina Gunnarsson

RISE Report 2020:38



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# Abstract

## **Farmers current practices, and their opinion on supplying straw for production of second-generation biofuels in Sweden**

This report presents results from the EU project AGROinLOG (Grant Agreement 727921) and especially focuses on the results from a survey looking at the current practices with straw use in Sweden as well as the farmer's opinion on supplying straw for the production of second-generation biofuel. The survey was developed as a collaboration between LRF (Federation of Swedish farmers) RISE and Lantmännen.

The reader can first read about the context within which the survey was developed and analysed. The questions and the methodology are then presented. The main part of the report presents the questionnaire results before drawing conclusions in line with the project's objectives.

The survey shows that about 60% of the straw from farmers participating in the survey, remains in the field while 40% is harvested mostly for animal production. The county of Skåne, the "ÖSÖ" region (Östergötland, Södermanland, and Örebro counties), the region including Uppsala, Stockholm and Västmanland counties, and the county of Västra Götaland have the largest potential for collection of straw for industrial processes in Sweden. However, farmers from these regions are the most concerned about the decrease of soil quality due to straw removal. The current common practices for straw handling in Sweden, including baling, collection, transport, storage and sale, are highlighted.

Some interesting conclusions are drawn concerning the logistics needed for the handling of straw for the biobased industry. Moreover, the answers from the survey give some insights concerning a potential "straw contract" between Lantmännen and the farmers. The report also highlights the aspects to be further researched.

More information concerning the Swedish contribution to the AGROinLOG project can be found in the public report AGROinLOG (2020a).

**Keywords:** Straw, second generation biofuel, survey, farmers, Sweden, bioeconomy

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# Sammanfattning

## **Jordbrukarnas nuvarande bruksmetoder och deras inställning till leverans av halm för produktion av andra generationens biodrivmedel i Sverige**

Denna rapport presenterar resultat från EU-projektet AGROinLOG (bidragsavtal 727921) och fokuserar särskilt på en enkätundersökning om jordbrukarnas nuvarande bruksmetoder och rutiner för halmhantering samt deras inställning till att leverera halm för produktion av andra generationens biodrivmedel. Undersökningen gjordes i samarbete mellan LRF (Lantbrukarnas riksförbund), RISE och Lantmännen.

Inledningsvis presenteras bakgrunden till undersökningen och därefter frågor och metod. Huvuddelen av rapporten handlar om resultat och slutsatser.

Undersökningen visar att på cirka 60% av spannmålsarealen hos de lantbrukare som deltog i enkätstudien lämnas halmen kvar på fältet medan 40% skördas, framför allt för djurproduktion. Skåne län, ÖSÖ-regionen (Östergötland, Södermanland och Örebro län), regionen Uppsala- Stockholm-Västmanland, samt Västra Götalands län har den största potentialen för ökad insamling av halm för den biobaserade ekonomin i Sverige. Lantbrukarna från dessa regioner är samtidigt mer oroliga för negativ påverkan på markens bördighet vid skörd av halm. Nuvarande bruksmetoder för halmhantering i Sverige, inklusive pressning, insamling, transport, lagring och försäljning belyses.

Några intressanta slutsatser dras om den logistik som krävs för hantering av halm för den biobaserade ekonomin. Svaren från undersökningen ger dessutom en del underlag för utformning av ett potentiellt "halmavtal" mellan Lantmännen och lantbrukarna. Rapporten lyfter också fram områden för vidare studier.

Mer information om den svenska delen av AGROinLOG-projektet finns i den rapporten AGROinLOG (2020a).

Nyckelord: halm, andra generationens biodrivmedel, enkätstudie, jordbrukare, Sverige, bioekonomi



# 1. Introduction

Within the AGROinLOG project, a multidisciplinary team has looked at the feasibility to implement an Integrated Biomass Logistic Centre (IBLC) in the grain processing industry in Sweden. An IBLC is defined as a business strategy for agro-industries taking advantage of available capacities (in terms of facilities, equipment, side-streams, unused or under-used local resources and staff) as a resource for the processing of biomass as renewable feedstock for the bioeconomy including bioenergy, biomaterial, feed and fodder as well as food markets.

The study in Sweden focused on a specific case aiming to produce 2<sup>nd</sup> generation biofuel at Lantmännen Agroetanol in Norrköping (Sweden). At the moment, the ethanol plant is a 1<sup>st</sup> generation plant as it uses mainly cereal as raw material. The project looked at the technical, economic and environmental feasibility to produce ethanol from straw. To support this work and gather information directly from farmers concerning the current practices as well as their opinion on the potential to deliver straw for biofuel production, a survey was designed and sent to farmers.

The survey was developed and sent to farmers in tight collaboration between LRF (the Federation of Swedish farmers), RISE and Lantmännen. LRF provided access to their members database and was responsible to send the survey to farmers allowing a wide outreach of farmers throughout the country. RISE was in charge to analyse the survey. The survey aimed at understanding the current practices with straw use in Sweden. The survey was also developed to support a workshop organised by Lantmännen and RISE which aimed at gathering drivers and hinders for the supply of straw to Lantmännen. 17 farmers attended the workshop where preliminary results from the survey were presented. Results from the workshop are presented in AGROinLOG (2020b, deliverable 7.3), and in the RISE report 2020:39.

More information concerning the Swedish case and the results are found in the main project report (AGROinLOG, 2020a).



## 2. Methodology

The survey contained three main blocks covering the following aspects:

- Background information concerning the farm (location, size, production, etc.)
- Current practices concerning straw collection (how much straw is removed, how and by who)
- Interest and conditions for contracting straw for biofuel production in the future

The questions are presented in table 1.

Table 1: Questions included in the survey sent to farmers

Block	Question
Background	1 Which county is your farm located in?
	2 What is the main production on your farm?
	3 What is the area for your cereal crops?
	4 Do you sell cereal to the Lantmännen Agroetanol facility at the moment?
	5 Do you see the removal of straw as a risk for decreased soil quality or an opportunity for more profit?
Straw handling	6 Do you harvest straw from your field? If yes, how much (in %)
	7 What is it used for?
	8 Do you have experience of selling straw?
	9 How do you sell straw?
	10 Who bales the straw?
	11 Who collects the straw?
	12 Who transports the straw from the field?
	13 How do you store the straw?
	14 Do you have unused buildings on the farm? (what volume approximately?)
	15 If so, can they be used as they are for storage of straw?
	16 Can they be used for storage of straw after reconstruction?
Contract conditions	17 Which partner would you like to have a contract with concerning the sale/delivery of straw?
	18 Where should the point of delivery be?
	19 How would you like the contract to be in term of time?
	20 How would you like the contract to be in term of quantity?
	21 How would you like the setting of price to be?
	22 How much of the available straw would you like to contract?

Most answers had pre-filled alternatives including the choice for “other” to allow the participants to write their own answer if the offered alternative did not suit their situation. The pre-filled alternatives facilitated the quantitative data analysis while the option for free text gives the opportunity for more qualitative analysis.

The survey was sent to 9203 members of LRF with a farm larger than 5 hectares on the 27<sup>th</sup> of September 2019 to. A reminder was sent on the 21<sup>st</sup> of October 2019, and the survey was closed on the 28<sup>th</sup> of October 2019. In total 8990 received the mail, 3568 opened the mail and 1207 answered the survey. The farmers that answered but cultivating less than 5 hectares of cereal crops were removed, leaving 1061 answers.

The results were analysed using a pivot table in Excel and results were showed for three different types of factors:

- **Farms:** Number of farms answering a given question, expressed in percentage of total number of farms answering the question.
- **Area:** Cultivated area of the farms (in hectare) answering a given question, expressed in percentage of area of the total number of farms answering the question.
- **Removed straw:** Cultivated area with straw removal, in % of cultivated area of the farms answering a given question. This factor is calculated by multiplying the area by the straw removal factor (SRF, given by question 6 in table 1). This factor gives a figure related to the volume of straw removed. The mid-value for each interval was used, for example, if a farmer answered that he/she is removing between 20% and 40% of straw, the SRF is 30%.

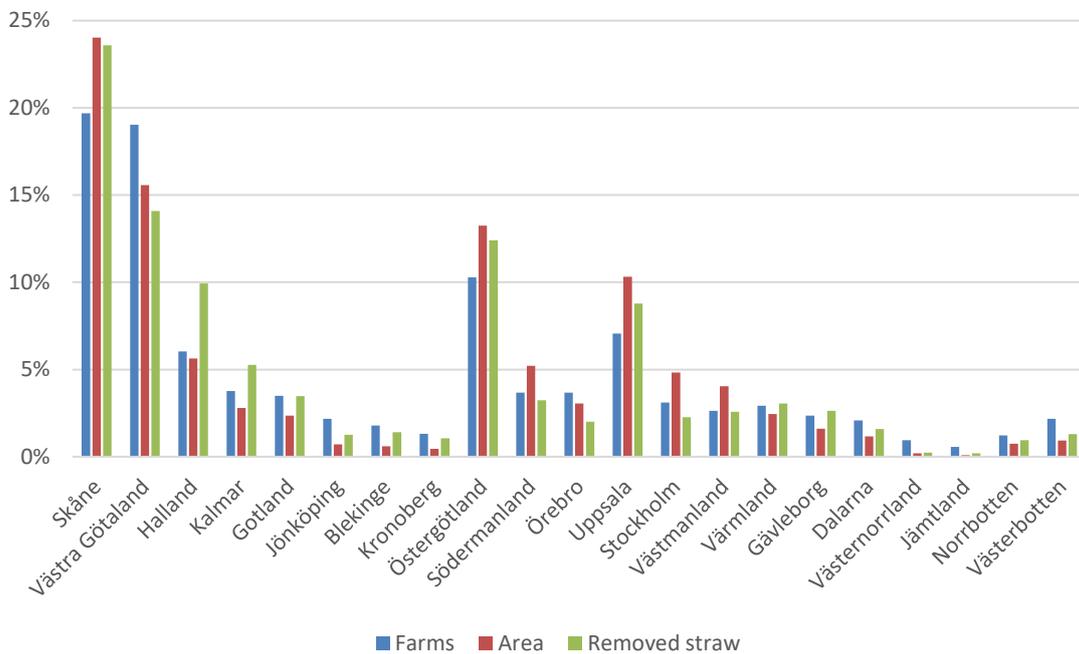
This allow us to show some trends between farm size and current practices in term of straw removal.

As some counties had only few respondents, neighbouring counties were clustered to be able to do more relevant analysis. Clusters were made for: “ÖSÖ” region (Östergötland, Södermanland, and Örebro counties); the region including Uppsala, Stockholm and Västmanland counties; South of Sweden except Skåne (Kalmar, Gotland, Jönköping, Blekinge, Kronoberg); Värmland/Gävleborg/Dalarna, and the northernmost counties (Jämtland, Västernorrland, Västerbotten and Norrbotten).

## 3. Results

### 1.1 Background

Around half of the respondents were from the three most represented counties: Skåne, Västra Götaland and Östergötland (figure 1a and 1b). Figure 1a also shows that cultivated area per farm was significantly larger in Skåne, Östergötland and Uppsala counties. It also shows that farms in the county of Västra Götaland cultivate on average a smaller area and leave more straw in the fields than average. Farms in the county of Halland remove significantly more straw from their field than average. The different counties are shown on a map in figure 1c.



*Figure 1a: Which county is your farm located in?*

The farms in counties from the South of Sweden (Kalmar, Gotland, Jönköping, Blekinge, Kronoberg) except Skåne, have a smaller cereal area than average (figure 1b). The “ÖSÖ” region which gather the counties of Östergötland, Södermanland, and Örebro is of particular interest for the AGROinLOG project as it is the region in which the case study is located. From figure 1b we can see that in general farms in this region cultivate a larger crop area but remove less straw than average. Farms in the Uppsala/Stockholm/Västmanland region have similar characteristics.

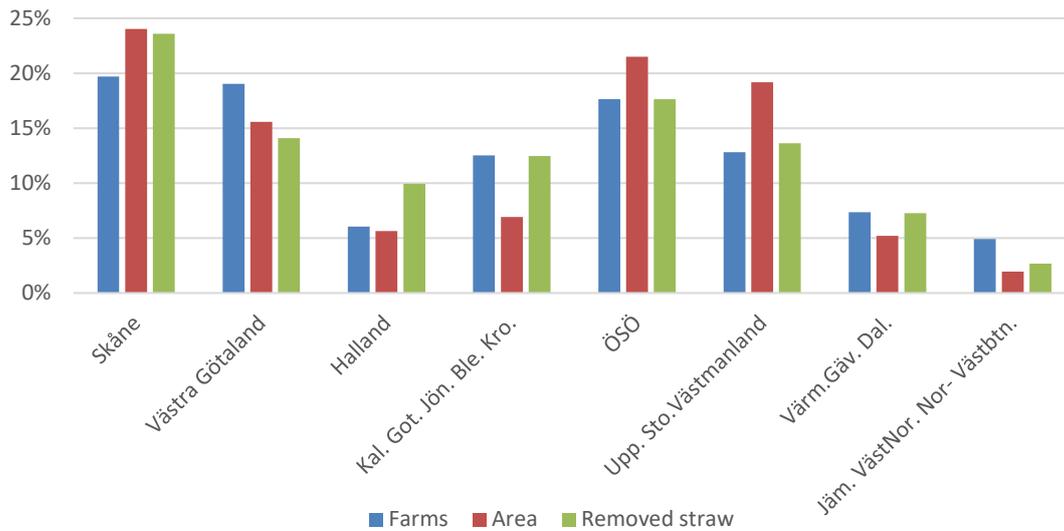


Figure 1b: Which county is your farm located in? (Presented for counties or cluster of counties).



Figure 1c: Map of Sweden's counties

Figure 2 shows that cereal farms are larger but remove less straw than average. The cultivated area of the dairy farms is close to average size of all farms participating but they remove more straw than average. Beef farms cultivate a smaller area of cereal than average but remove significantly more straw than average. In the “other” category are a number of lamb producers, horse stables, farmers specialised in fodder and grass, vegetable and potato growers, and some having a diversified production. Some also are part time farmers and manage their farm outside their other primary work.

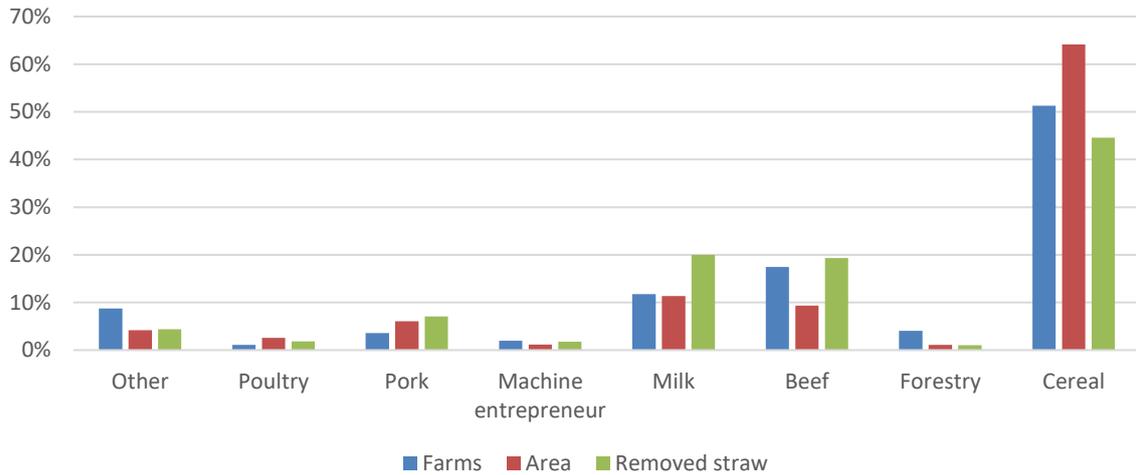


Figure 2: What is the main production on your farm?

The x-axis in figure 3 represents the number of farms sorted per area of cultivated cereal, from the smallest on the left hand-side to the largest on the right hand-side. The y-axis indicates the cumulative cereal area cultivated by the x-smaller farms. For instance, the 600 smaller farms (in term of cultivated cereal area) cultivate in total about 20,000 hectares of cereal. Figure 3 shows the disparity in cultivated area between farms. About 20% of the largest farms that responded to the survey cultivate 60% of cereal area.

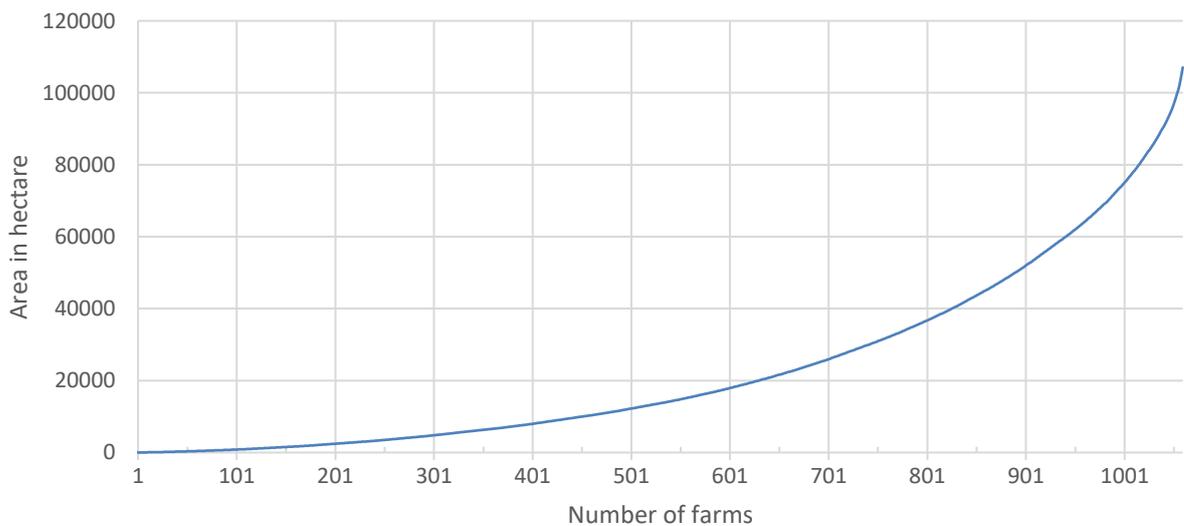


Figure 3: Cumulative cereal area from respondents

To get a view of the current situation for straw removal on farm level, a question from the survey asked from how large part of the area cultivated for cereal production straw was removed. This figure can also indicate the potential available for additional removal of straw. Almost a quarter of the respondents answered that they remove all straw from their fields (figure 4a). However, this group represent only 10% of the cultivated area of respondents. Around 42% of the cultivated area of respondents remove less than 20% of straw from field. This represents the largest potential for new use of straw.

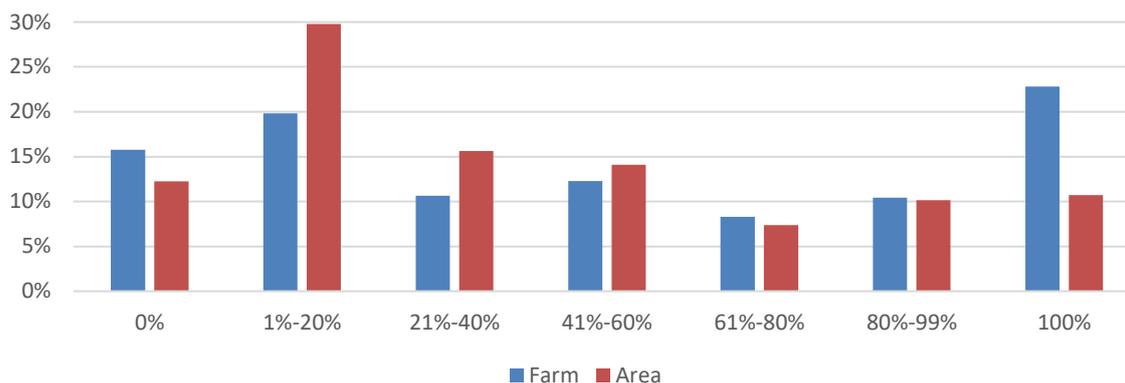


Figure 4a: How much of your cultivated area with cereals do you remove straw from?

Figure 4b shows how large part of the straw that is removed on county level. It can clearly be seen that in four regions (or regional clusters) more than 60% of the straw is left in field. In average for Sweden, it is estimated in this survey that about 60% of straw remain in the fields while 40% is removed from the fields, mostly for bedding and fodder. AGROinLOG (2020a) showed from a statistical analysis that about 60% of straw was used and 40% remain in field.

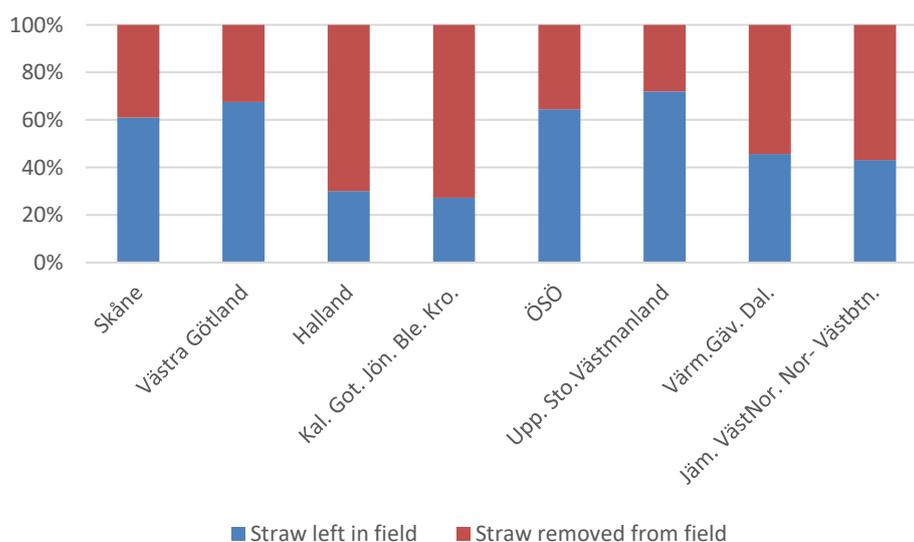


Figure 4b: Regional straw removal factor (shown in red).

By multiplying the crop area by  $(1 - \text{straw\_removal\_factor})$  we could get a sense of the potential of straw that is not harvested today, on a regional level, based on the answers collected in this survey. Four regional clusters seem to have an obvious potential to deliver large volume of straw (figure 4c). But note that there may be other factors limiting the actual outtake of straw such as soil fertility aspects, farmers interest etc.

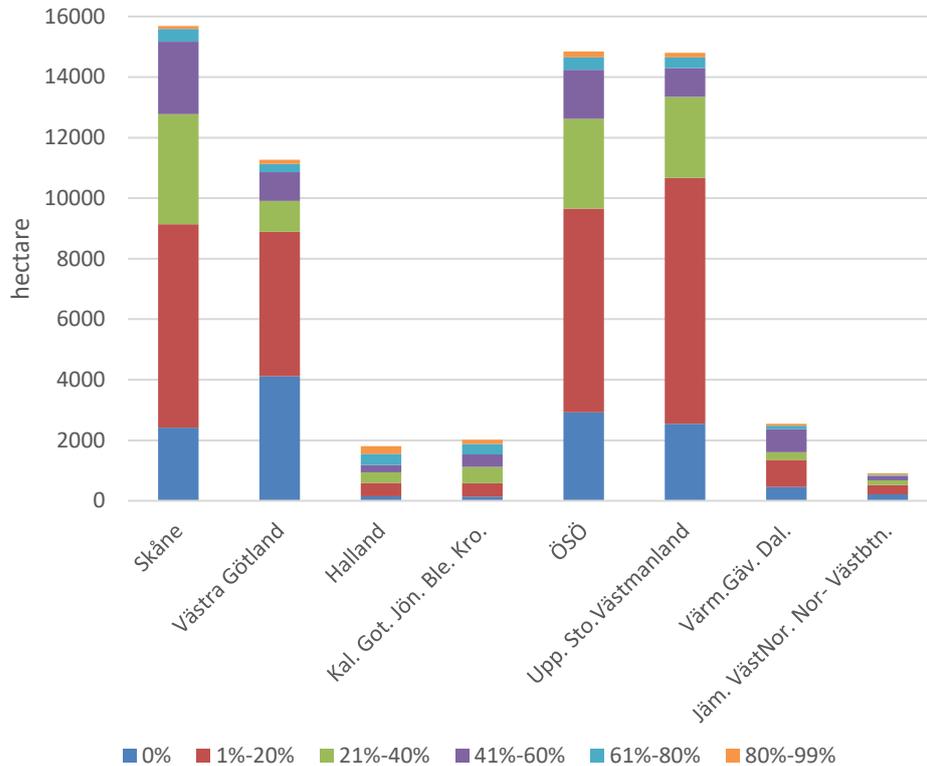


Figure 4c: Area with cereal production available for additional straw removal in different regions in Sweden divided in different straw removal factors (see figure 4a and question 6 in table 1).

The survey also inquired farmers interest of harvesting straw. Farmers are quite split between using straw or leaving it on the soil due to soil fertility issues (figure 5a). In general, we could say that those who see straw removal as an issue for soil fertility remove less straw and cultivate a larger area of cereal. On the other hand, those who see an opportunity for profit with straw removal tend to remove more straw from their fields. When dividing the answers based on the type of production/activity on the farms, figure 5b showed that cereal farms are the most concerned about the decrease of soil quality due to straw removal.

The question on farmers interest was also evaluated on a regional level (figure 5c). Farmers from Skåne, Västra Götaland, the Uppsala/Stockholm/Västmanland region, and Värmland/Gävleborg/Dalarna region are most concerned about the decrease of soil quality due to straw removal. On the other hand, farmers from the southern counties

(expect Skåne) and the northernmost counties are the least concerned about the consequences of straw removal on soil fertility. Those concerns will have to be considered as regions with the most concerned farmers are those regions with the largest technical potential (see figure 4b).

Many of those under the “other” category already use straw as bedding and fodder for animals and recirculate the straw with manure to the field later. Those who do not have own direct use of straw give it or sell it to animal farms and then get the manure back. Some reflected that cover crops are very effective to sustain and even increase the soil quality.

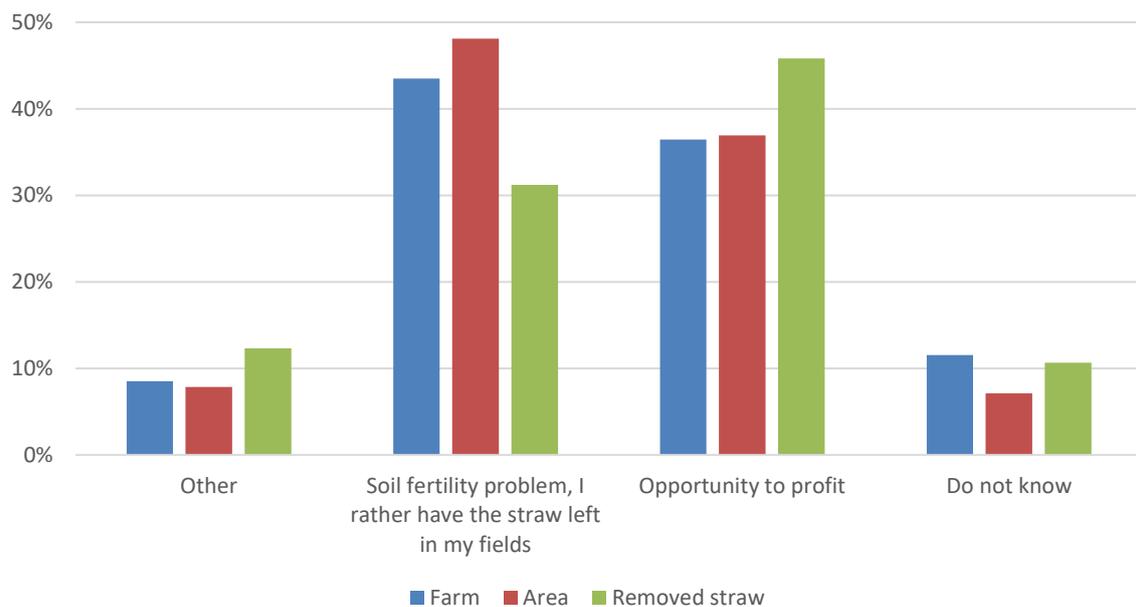
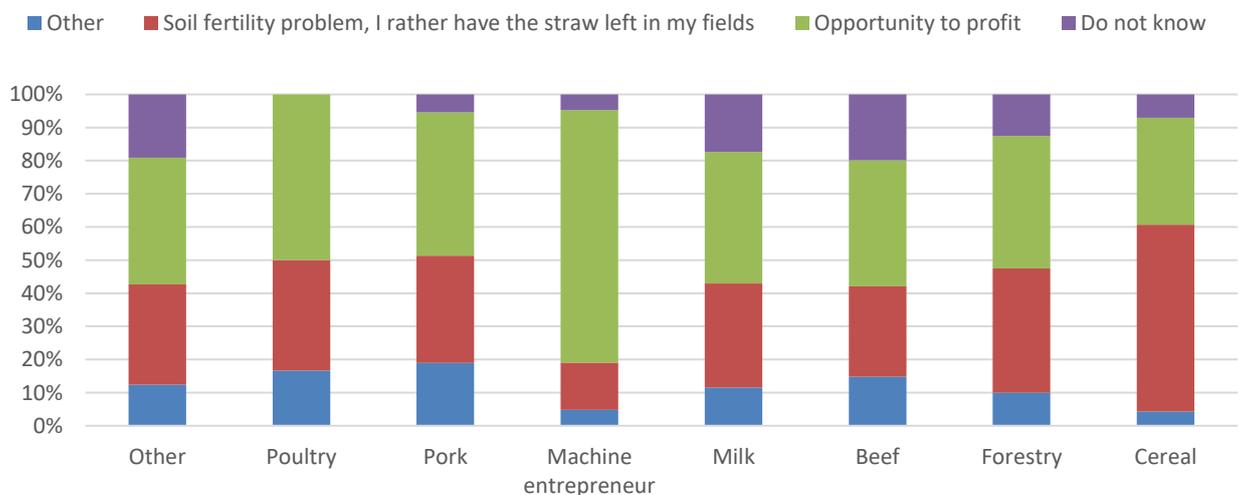
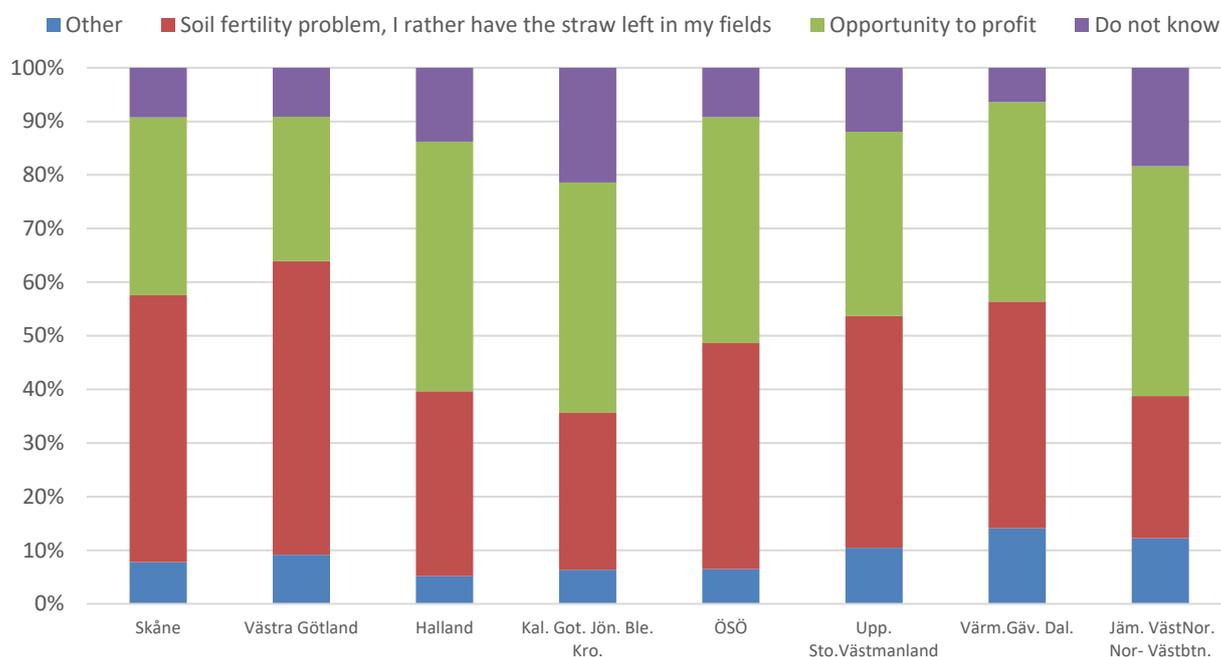


Figure 5a: Do you see straw removal as a problem for decreased soil fertility, or an opportunity for more profit?



*Figure 5b: Do you see straw removal as a problem for decreased soil fertility, or an opportunity for more profit? Answer for each type of main production.*

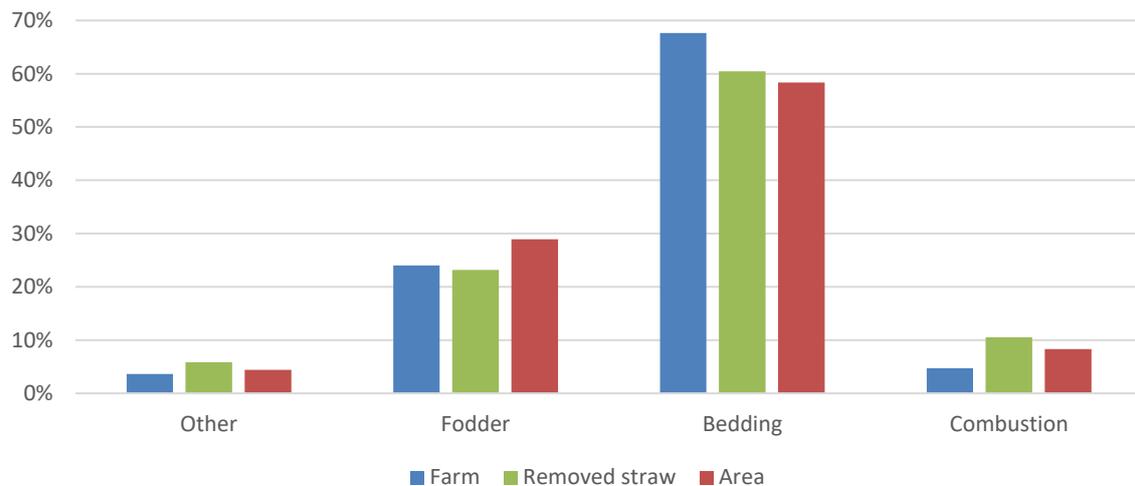


*Figure 5c: Do you see straw removal as a problem for decreased soil fertility, or an opportunity for more profit? Answer per county or cluster of counties.*

## 1.2 Straw handling

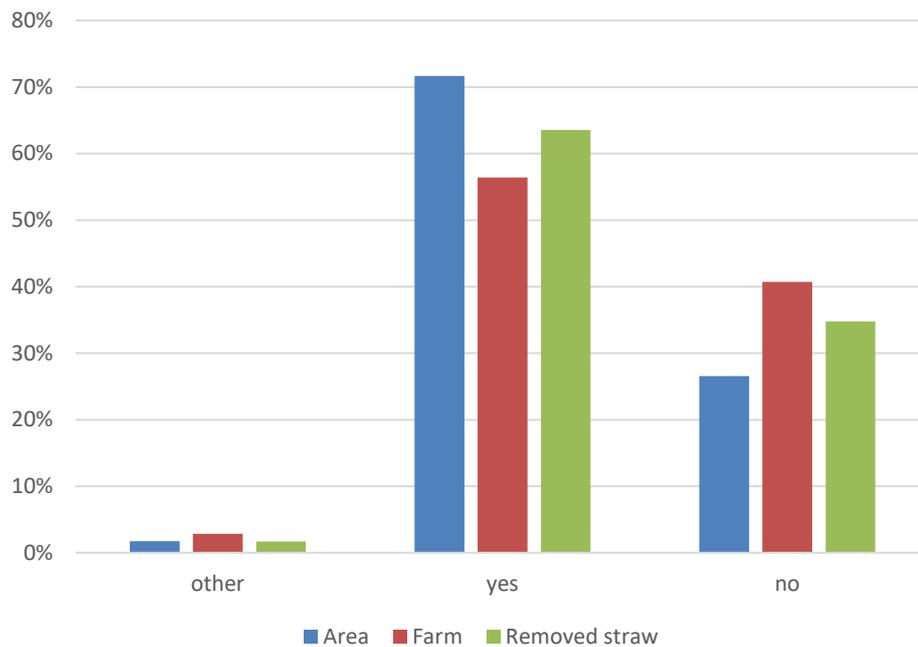
The following questions were asked only to respondents removing straw from their fields, therefore excluding farmers answering 0% to question 6 (table 1 and figure 4a).

Around 60% of the area of straw harvested is used for bedding and about 30% is used for fodder (figure 6). Many of those within the “other” category do not necessarily know what the straw is used for. Most of the remaining ones use straw as cover for the cultivation of beetroots, carrots and/or strawberry. One farmer uses straw bales as a wall element for the storage of crops.



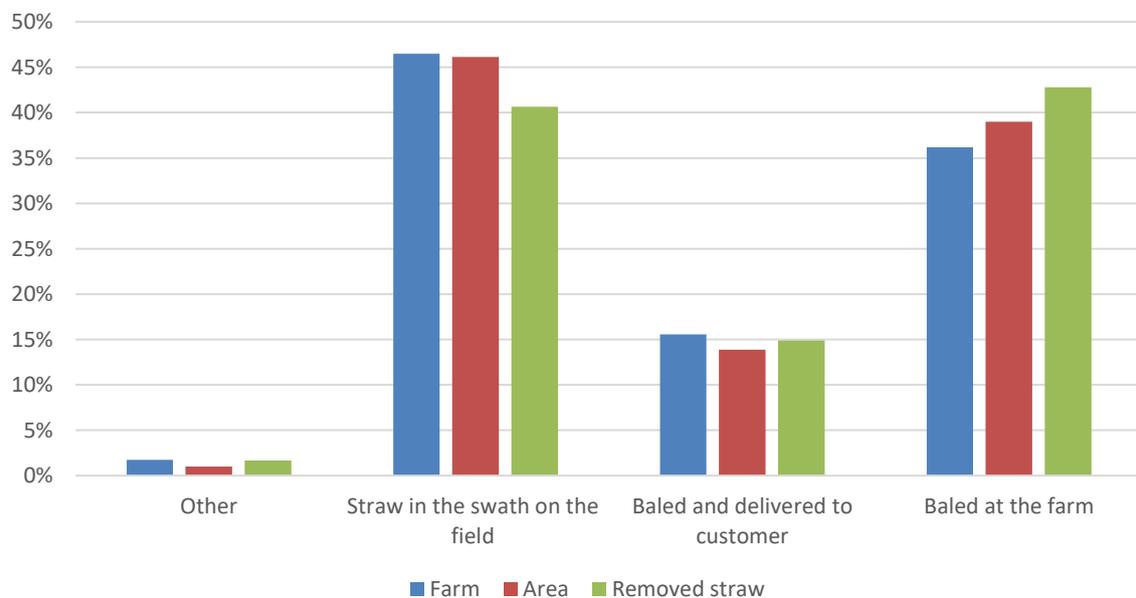
*Figure 6: If you remove straw from the field, what is it used for?*

Of those who remove straw from their field, 70% are selling straw or have had sold straw in the past (figure 7). The farms selling straw are smaller than the average. Most of the farmers within the “other” category do not sell their straw but exchange it for manure. Some others share it with their neighbours or within their own network.



*Figure 7: Do you have experience of selling straw?*

Concerning selling point of straw, most farmers sell their straw in the swath on the field before baling but the largest amount of straw is sold baled at the farm (figure 8). A lower amount is sold after being delivered directly to the customer. Those answering “other” do not sell all their straw the same way and therefore wanted to choose several alternatives.



*Figure 8: How do you sell straw?*

Figure 9 shows that in most of the cases, the farmers do not bale the straw themselves, especially for larger farms with a lower straw removal factor. The farmers baling themselves are smaller farms but with a higher straw removal factor. This could correspond to animal farms.

Within the “other” category it is mostly mentioned that the buyers/customers bale the straw themselves. Some also answered that they do not bale the straw but collect it loose. For this question, respondents could select several answers.

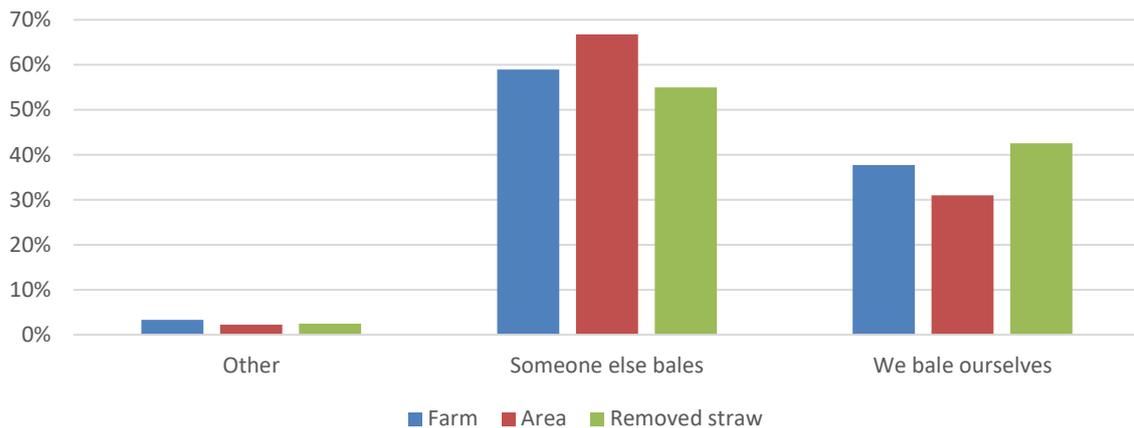


Figure 9: Who bales the straw?

To gather baled straw from the field requires less specific equipment than for baling straw for instance. A front loader on a tractor and a trailer would work fine. Therefore, most baled straw is gathered by the farmers themselves (figure 10). As well as for the question above (figure 9), most of the answers within the “other” category state that the buyers/customers collect the straw themselves. For this question, respondents could select several answers.

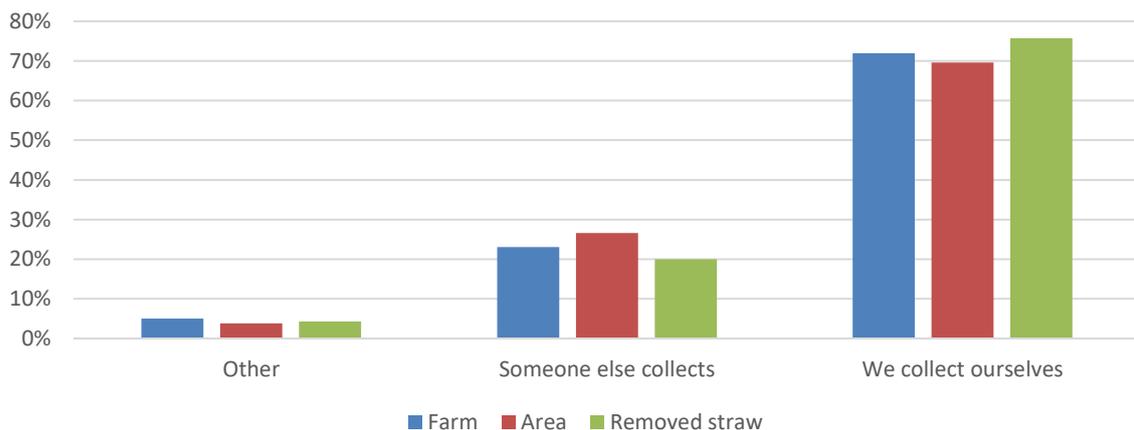


Figure 10: Who collects the straw?

It is clear that straw is mostly stored indoors at the moment (figure 11). It might be an issue to store more straw indoors to deliver to Lantmännen. However, farmers where

asked if there were unused buildings on the farm that could be used for straw storage (figure 12).

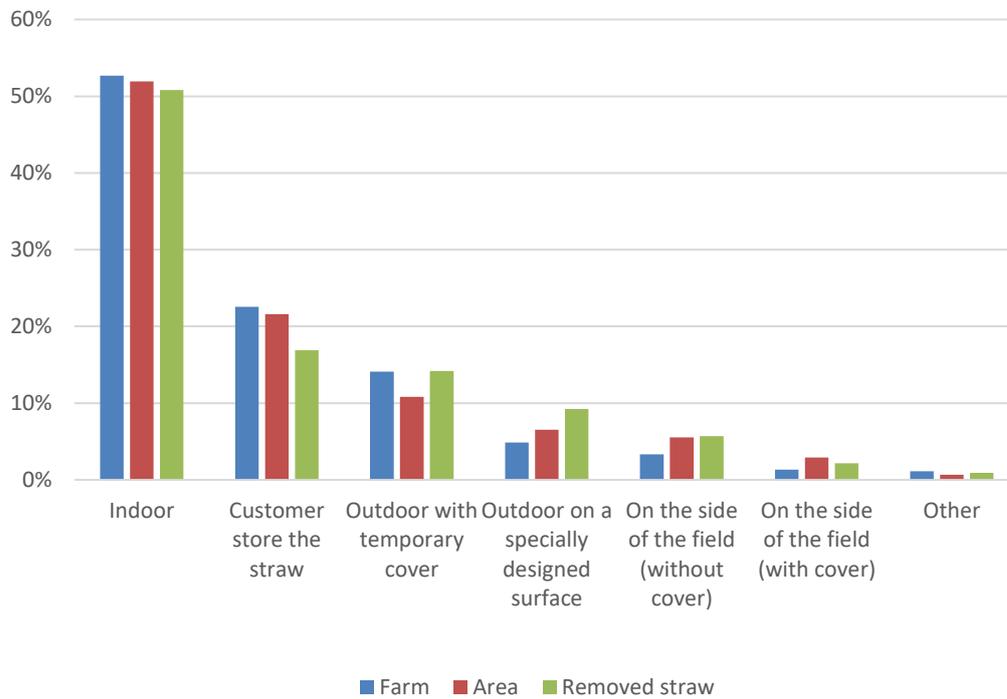


Figure 11: How do you store the straw?

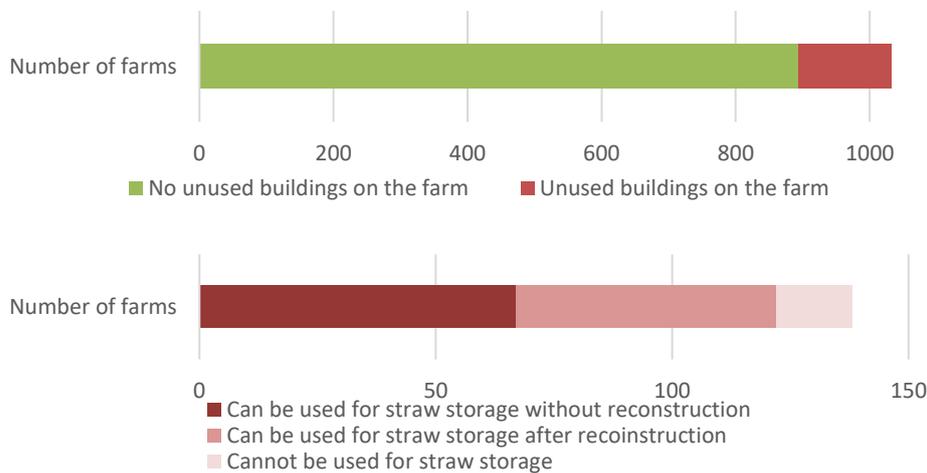


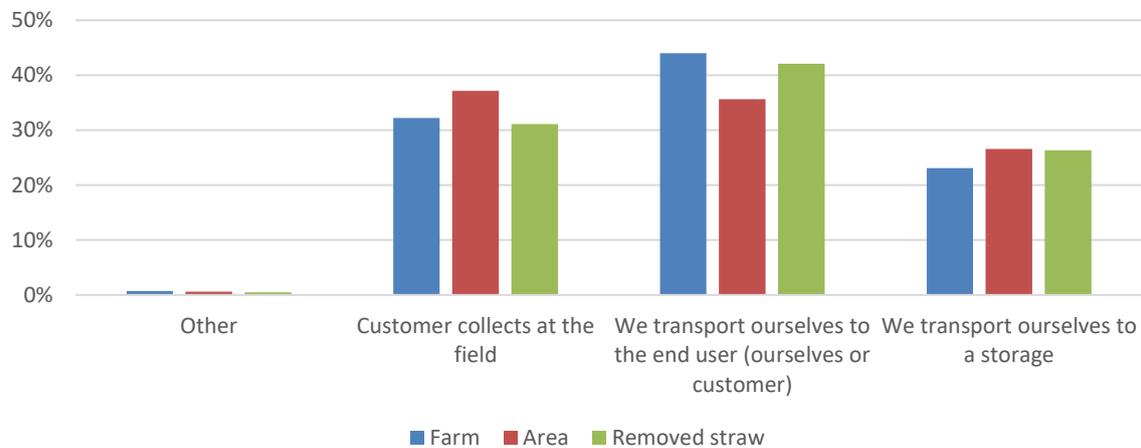
Figure 12: Do you have unused buildings on the farm? If so, what volume approximately, and can they be used for straw storage as they are, or after reconstruction?

Some farms have unused buildings on their farms that could be used for storage of straw, as they are or after reconstruction. The case study from the Swedish demo is aiming to process 80,000 tonnes of straw yearly which correspond to about 800,000 m<sup>3</sup> storage



capacity if square bales are used. Based on the information collected with the survey, rough estimations show that there are about 160,000 m<sup>3</sup> storage capacity in unused buildings within the respondents. Looking at the ÖSÖ region (Östergötland, Södermanland and Örebro counties) the storage capacity among respondents is around 25,000 m<sup>3</sup>. Further study would be needed to investigate the potential for extra straw storage capacity in the region. However, it is not yet clear whether straw to be processed for 2<sup>nd</sup> generation biofuel production would need the same storage conditions as straw used for animal bedding and fodder. Indeed, quality requirement for straw quality still has to be specified.

Finally, regarding the transport of straw, figure 13 shows that most of the straw is transported by the farmers themselves, either to their own farm and storage for own use, or to the customer. However, still around 30% of straw is transported by the customers. For this question, respondents could select several answers.

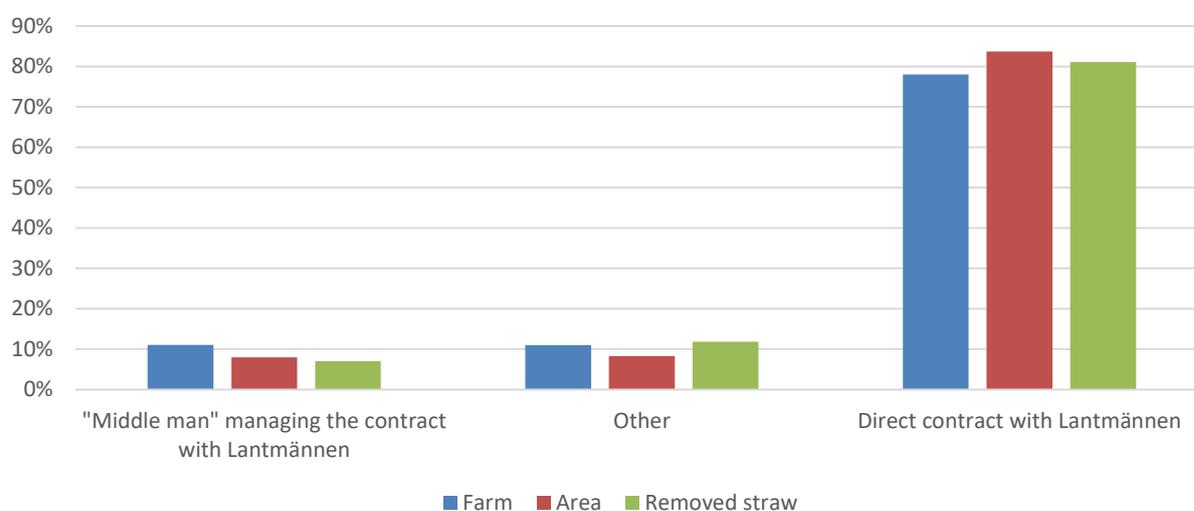


*Figure 13: Who transports the straw from the field?*

## 1.3 Contract conditions

Farmers were asked some questions concerning the potential to contract straw to gather larger volumes for second generation bio-fuel production. The questions cover what type of contract and condition farmers would prefer in the future.

From figure 14 it is quite clear that farmers would like to have contract directly with Lantmännen. Those answering “other” are in principle against selling straw as they either need all their straw and fear that it will drive the market toward an increase of the price for straw.



*Figure 14: Which partner would you like to have a contract with concerning the sale/delivery of straw?*

Looking at the answers for the amount of straw currently handled (Area\*SRF), respondents were quite split between the three different options: sell after transport to the bio-ethanol plant, sell bales at the field, or sell unbaled straw on the field (figure 15). Some general conclusions for each group could be drawn. Those willing to sell baled straw at the gate of the bio-ethanol plant cultivate larger areas and remove more straw than average at the moment. Those willing to sell straw in the swath on the field cultivate areas slightly larger than average but remove less straw than average at the moment. The category “other” included mostly farmers not willing to sell their straw.

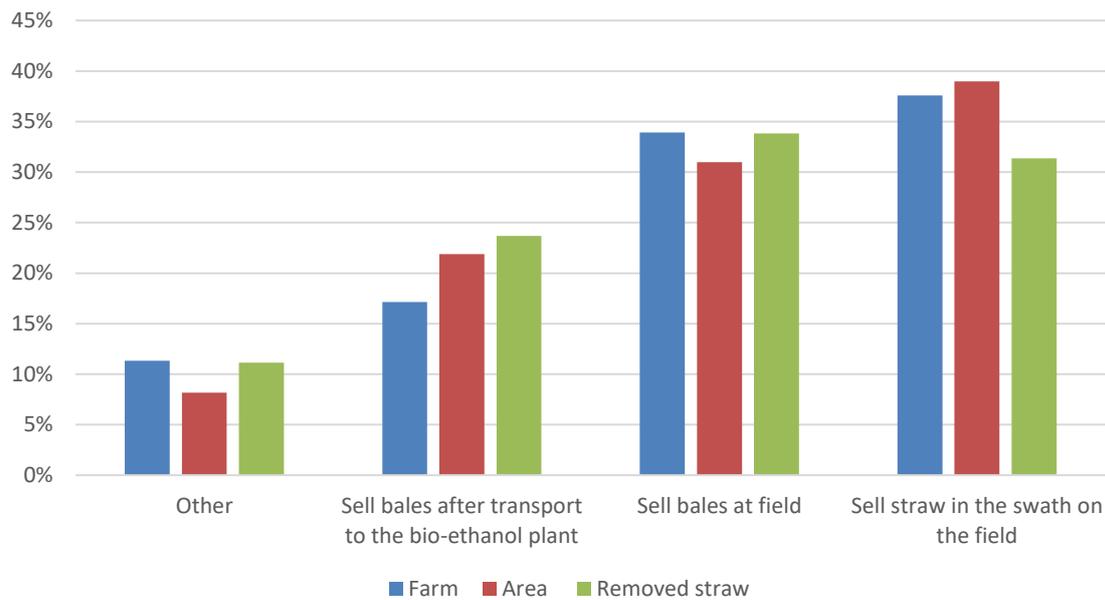


Figure 15: Where should the point of delivery be?

Concerning the length of the contracts most farmers preferred to have a 1-year contracts, even though more than 30% of the respondents did not have an opinion (figure 16). Farms with large cereal area would rather have a contract lasting more than one year. In general farmers are scared to sign binding contract for straw as it includes risks that can be difficult to handle like weather during the growing season and at harvest.

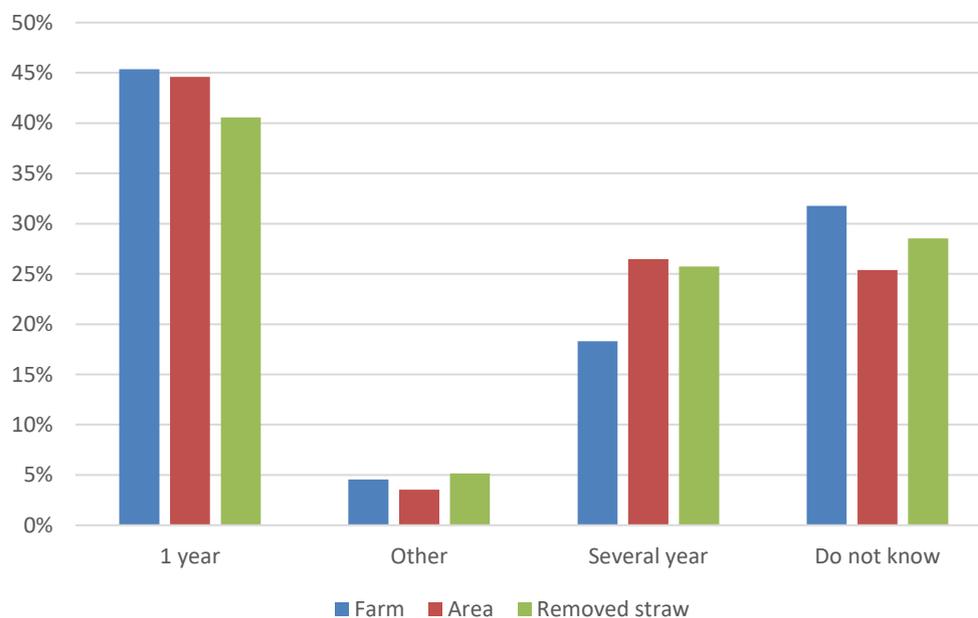
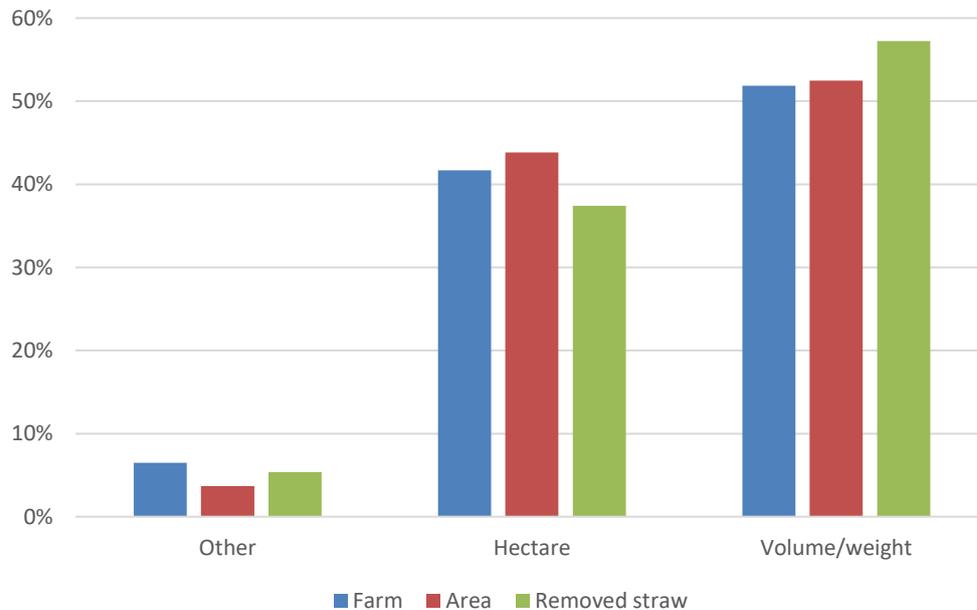


Figure 16: How would you like the contract to be in term of time?

As it can be seen in figure 17, farmers are quite split between the different kind of contracts: per area or per volume/weight. Those interested in area-based contract are at the moment removing less straw from their fields than those interested in a volume-based contract.

Here again, farmers are almost equally split between having fixed price and having a price indexed on the energy market and the cost for nutrient removal (figure 18). Only few farmers were interested to have a contract based a pool-price calculated at the moment of transaction.



*Figure 17: How would you like the contract to be in term of quantity?*

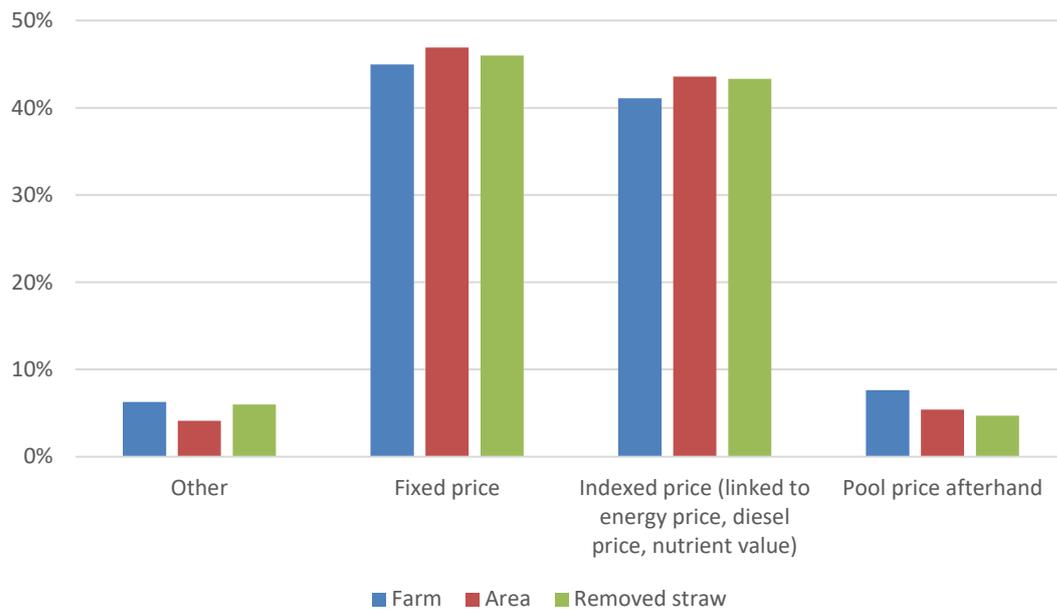


Figure 18: How would you like the setting of price to be?

## 4. Conclusions

The survey shows that about 60% of straw remains in field in Sweden while 40% is harvested mostly for animal production. Four regional clusters seem to stand out in terms of relative (in %) and absolute (in area) potential for collection of straw for industrial processes. Those regions are the county of Skåne, the “ÖSÖ” region (Östergötland, Södermanland, and Örebro counties), the region including Uppsala, Stockholm and Västmanland counties, and the county of Västra Götaland. When looking at farmers interest to harvest straw, farmers in the same regions as mentioned above are also most concerned about the decrease of soil quality due to straw removal. Those concerns will have to be analysed deeper in further analysis of straw potential.

The current common practices for straw handling in Sweden were highlighted with the results from the survey. Farmers mostly sell straw in the swath at field or baled and sold at the farm. The baling process is often outsourced to agricultural machine entrepreneurs while the collection of bales is often performed by the farmers themselves. Straw is mostly stored indoors at the moment and there could be storage capacity in unused buildings if the quality standards for biofuel production requires indoors storage. Further research would be needed to estimate the actual storage capacity available. The transport of straw is done by both the farmers themselves and the customers.

Some interesting conclusions concerning the logistics needed for the handling of straw in an industrial process could be drawn. As the baling process is often outsourced, the extra capacity for baling might be lacking at the start. Further research concerning the current margin capacity for baling is needed. It is most likely that baling process will not

be performed by the farmers themselves and therefore new actors will need to step in and cover for the additional capacity needed. The collection of the baled straw on the field could be performed by the farmers themselves as they are used to this task and have the required equipment. The quality standard for the straw need to be clarified to further investigate the storage capacity issue. Farmers are used to transport straw at the moment but delivering straw to the bio-ethanol plant in Norrköping might be too long and not cost efficient to be performed using tractors. Lantmännen will most likely need to offer transport solutions from field to plant or from farm to plant.

Finally, the survey gave some insights concerning a potential “straw contract” between Lantmännen and farmers. Most farmers wish to have a direct contract with Lantmännen without using a middleman. The straw should be sold in swath at the field and baled at field. Few farmers are willing to deliver the straw to the plant, but this will depend on their location. Most farmers would like to have annual contract. However, many were not certain at the time of the survey. Farmers are interested in contracting their straw both in term of volume/weight, and in term of area, therefore, both options should be included in the “straw contract”. Similarly, farmers were interested in both having a fixed price for straw and having an indexed price based on energy price and nutrient value for instance. These results can be valuable input if or when straw outtake for 2<sup>nd</sup> generation biofuel is going to be realised.

## 5. References

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