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Sustainability in agricultural machinery production – an empirical study among farmers

In order to establish the attitudes of farmers when it comes to sustainability in agricultural machinery and commitment to sustainability on the part of manufacturers, 273 questionnaires (39 % of 700 questionnaires sent out) completed by leaders of agricultural operations were evaluated as part of an empirical study. The respondents consisted of customers of the agricultural machinery factory Rauch GmbH and leaders of agricultural operations that offer apprenticeships (who are not always customers). Overall, farmers gave positive feedback on the companies' commitment to sustainability. In particular, aspects attributed to the social pillar of sustainability are associated with a commitment to sustainability, such as steps taken to train staff. Moreover, special attention is given to a focus on the future and innovation when considering the economic pillar of sustainability. Regarding their assessment of sustainable agricultural machinery, farmers place particular importance on a machine's quality, whether or not it can be upgraded, and the quality of the work the machine delivers.

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Abstract
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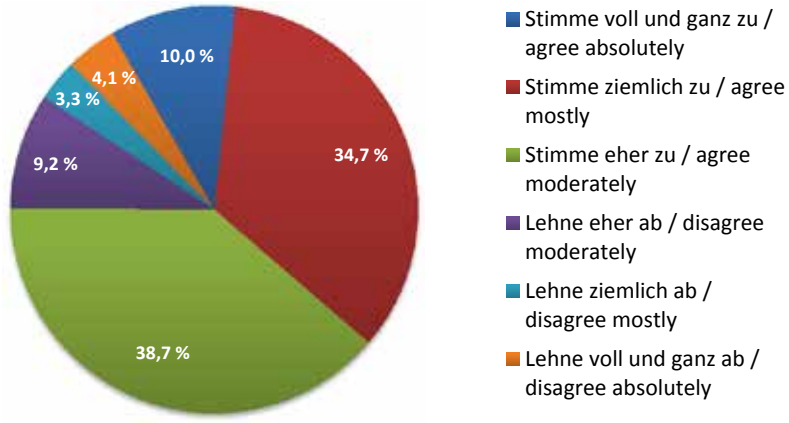
In light of an increased agricultural production made necessary to ensure an adequate food supply, as well as the global discourse on sustainability, it is becoming ever more important to consider the principles of sustainable development in agriculture. Current developments in the agricultural and food industries show that individual agricultural operations are attributing more importance to sustainability assessment. Examples include systems such as RISE, KSNL and the DLG-NHZ [1]. Yet the consideration and assessment of sustainability in supply chains and hence industry-wide commitment to sustainability (such as between agriculture and agricultural machinery) are likewise in the development stages or have already been implemented to some extent. The Guidelines for Sustainability Assessment of Food and Agricultural Systems (SAFA) formulated by the FAO represent a key step in the agricultural and food industry [2]. Experts see transparency and comparability as some of the advantages of this kind of industry-wide commitment to sustainability [3].

As durable goods, the agricultural machinery has a significant impact on sustainable production processes in agricultural operations. Therefore, sustainable agricultural machinery can be considered a vital tool in sustainable agriculture. The manufacturers of agricultural machinery face the challenge of producing sustainable machines while also designing their own production processes to be environmentally friendly, efficient and socially responsible, building on the three-pillar model of sustainability[4].

To survey and classify the significance of sustainability for manufacturers of agricultural machinery and their customers, a joint research project by the Institute of Farm Management (University of Hohenheim) and the agricultural machinery factory Rauch GmbH studied the attitudes of farmers regarding sustainability in the manufacture of machinery and manufacturers' commitment to sustainability. The goal was to determine responses to the following research questions:

- How do farmers value manufacturers of agricultural machinery who ensure that their production process is environmentally-friendly and socially-responsible?
- What information do farmers have regarding manufacturers' commitment to sustainability, and how do farmers obtain information?

Fig. 1



Appreciation of farmers for manufactures taking care of environmentally friendly and socially responsible manufacturing processes, one response (N = 271)

- In the opinion of farmers, which sustainability measures characterize a sustainable company in the agricultural machinery industry?
- In the opinion of farmers, what are the characteristic criteria of an agricultural machine that promotes sustainability?

Methodology

The study involved a two-tiered empirical process including a structured interview with two experts and a standardized written questionnaire to address the research questions.

First, a discussion was held with two experts to validate and supplement the standardized questionnaire. An initial draft of the standardized questionnaire served as a guideline. The experts included one industry representative and one representative of the agricultural machinery industry's association. The questionnaire was sent by email ahead of the interview. This permitted an analysis of the questionnaire content and response categories, as well as a review for plausibility.

The study focused on an extensive, standardized written interview, for which pretests were completed in advance to validate the questionnaire. 700 questionnaires were sent out by mail between May and June 2013. The sample was split equally between customers of Rauch and select nation-wide agricultural operations that provide training and focus on crop cultivation.

The standardized questionnaire consisted of 26 questions in three categories concerning agricultural machinery and manufacture, the level of information among farmers regarding sustainability and sociodemographic questions and structural features of the agricultural operations.

The number of responses received within the specified period was above-average, with a response rate of 39 percent (≙ 273 questionnaires in total that were suitable for analysis). The data was analyzed using univariate and bivariate statistical tests using the SPSS 21 software.

Results

Sociodemographic and structural features of surveyed farmers

The majority of farmers who responded (94.5 %) have undergone professional training in agriculture at least once and manage the agricultural operation as their main source of income (95.6 %). The average area of the participating operations was 210 ha (median).

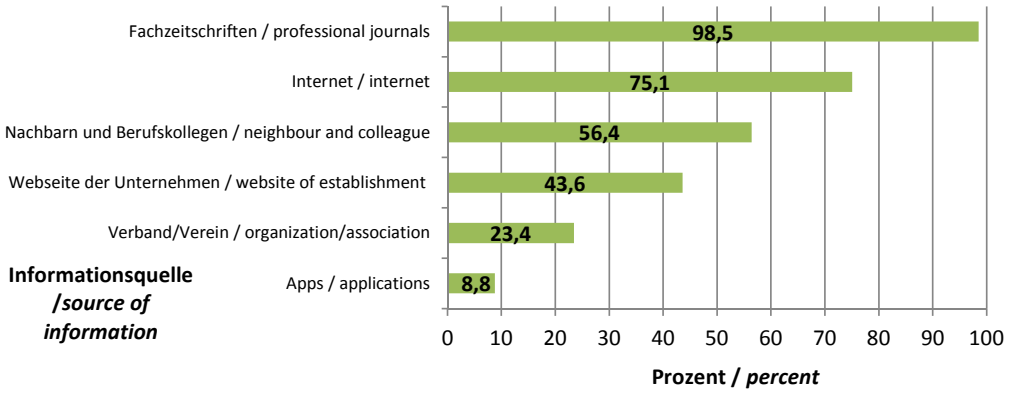
Significance of sustainability of agricultural machinery for farmers

At first glance, the survey results do not show a clear preference among participants regarding the question of whether they support manufacturer efforts to make the production process of the machines as environmentally-friendly and socially-responsible as possible. Slightly more than half (53.1 %) consider this issue very important or quite important, while slightly less than half (46.9 %) consider it unimportant or not very important. However, a detailed breakdown reveals that the vast majority of responding farmers feel a need for an environmentally-friendly and socially-responsible production process (**Figure 1**).

Despite this existing desire, the study showed that three quarters (75.3 %) of the participating farmers do not know if the particular manufacturers of agricultural machinery are even concerned with sustainability. Only 22.1 % knew that their manufacturers were committed to sustainability, while 2.6 % assumed that the manufacturers of their agricultural machinery were not committed. Nonetheless, only around one quarter (26.7 %) of the respondents did not wish to be informed about sustainability in the production of agricultural machinery at all. All other farmers (73.3 %) feel that a commitment to sustainability in the production of agricultural machinery is significant enough that they wish to be informed about this issue.

The participating farmers acquire information related to the subject most frequently through trade journals (98.5 %) or

Fig. 2



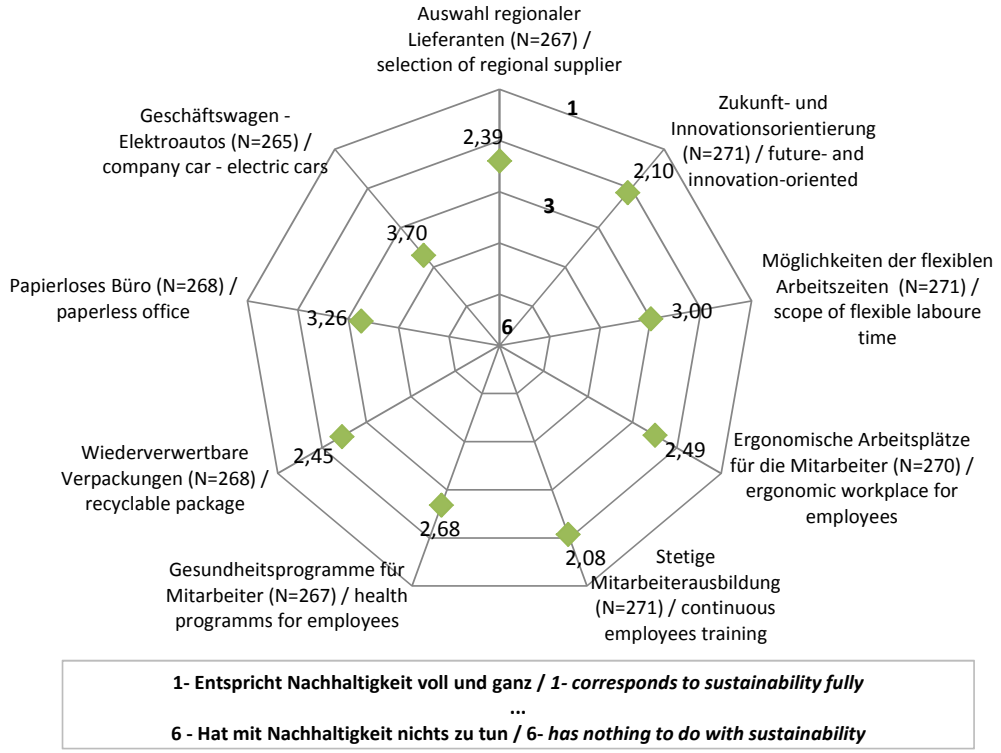
Sources of technical information, multiple selections

the Internet (75.1 %). Sharing information with neighbors and colleagues (56.4 %) also plays a major role. Only 8.8 % of respondents named apps as a source of professional information (**Figure 2**). The respondents included under miscellaneous in particular exhibitions, trade fairs, product presentations, consultancy networks and companies.

Sustainability measures taken by companies

As part of the survey, farmers were introduced by way of example to several concrete measures and activities undertaken by a company to ensure sustainability. Universal measures such as the reduction of energy consumption and emissions were presupposed in this context and through the remainder of the study and were not explicitly surveyed again. Analysis of the results reveals that farmers acknowledge most the social activities undertaken by companies (**Figure 3**). Farmers do not associate conventional activities in the ecological sustainability pillar with the sustainability of agricultural machinery manufacturers as much as they do activities in the social pillar. Accordingly, farmers view recyclable packaging, company cars that are electric and paperless offices as only marginally characteristic of a sustainable company, whereas aspects such as ongoing employee

Fig. 3



Sustainability measures taken by producers from the perspective of the farmers, mean values, multiple selections

training or an orientation towards the future and innovation are more likely to be perceived as sustainability measures. **Figure 3** graphically illustrates the measures and activities taken by companies to assess sustainability according to the respondents. Assessments in the outer ring (1) agree that this activity fully corresponds to a sustainability measure in a company. The six-tiered scale ends at the center (6) of the web diagram. The closer assessments are to the centre, the less activities are deemed by respondents to have anything at all to do with sustainability. The arithmetic means of participants' assessments concerning their evaluation of the measures are indicated.

Characteristic criteria of a sustainable agricultural machine

Farmers were given predefined criteria to use in their assessment to enable an analysis of the relevance of various criteria of sustainable agricultural machinery. Farmers view criteria such as a machine's quality and the quality of work performed with the machine as particularly characteristic for a sustainable agricultural machine (**Figure 4**). The ability to retrofit accessory parts and to perform upgrades, as well as ease of repairs are likewise described as characteristics of a sustainable agricultural machine. Criteria such as recyclability, as well as intuitive and ergonomic machine operation tend to rank lower in importance. Even though all evaluated criteria are close in the analysis, there is a tendency for farmers to consider economical criteria included in the questionnaire as characteristic of sustainable agricultural machinery.

In this survey, ecological and social criteria are of secondary importance in terms of sustainability of agricultural machinery (**Figure 4**).

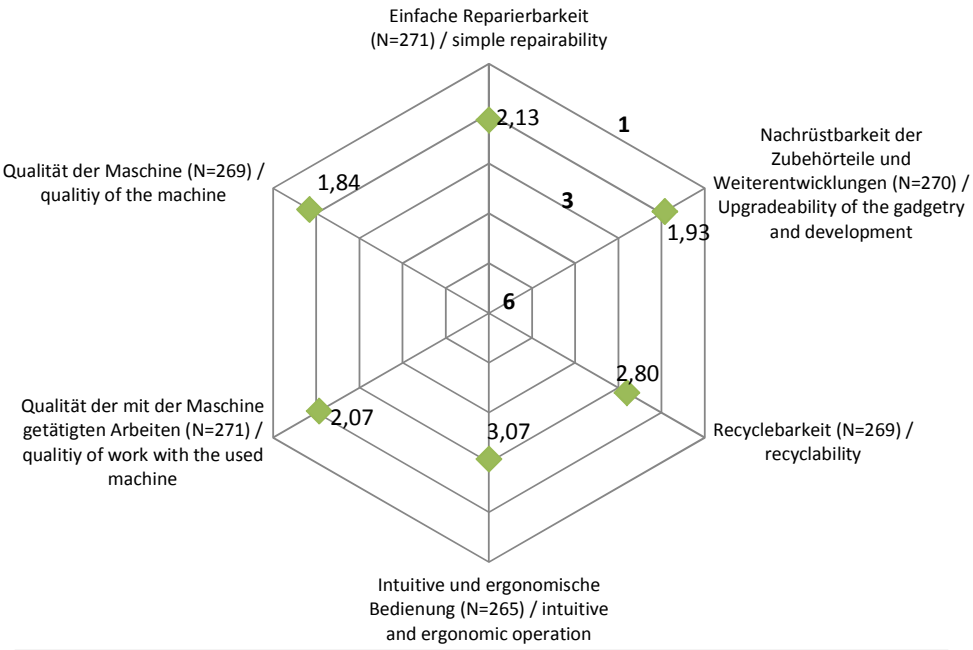
Discussion and conclusion

In terms of developments towards systems for sustainability assessment (such as RISE, KSNL and DLG-NHZ) [1] within individual companies and the growing importance of measuring and assessing sustainability in supply chains (such as SAFA) [2], this study shows that sustainability in agricultural machinery and its manufacture is still perceived as a fledgling field in the subjective opinion of the surveyed farmers.

The results of a relevant survey indicate that most farmers agree with the initiative of manufacturers of agricultural machinery to make the production process environmentally-friendly and socially-responsible.

The survey results also reveal that farmers obtain technical information from trade journals, the Internet and company and consulting company websites, as well as neighbors and colleagues. These are the best resources by which to reach and effectively inform farmers. Zimmermann [5] found comparable results regarding levels of information among farmers. Prior to making any investment, farmers predominantly utilize dealer information, trade journals, colleagues, brochures and consulting companies as sources of information. However, in this context the study also identifies existing information deficits on the part of farmers regarding manufacturers' commitment to sustainability. Ways to close these gaps can be found both

Fig. 4



Criteria for sustainable agricultural machine from the perspective of farmers, mean values, multiple selections

through increased communication via the channels named above and by integrating this content into vocational training and further education.

When discussing sustainability management and implementation of the concept of sustainable development within companies, the literature shows that all three pillars of sustainability must be considered together and implemented into the company strategy and production processes [4]. The farmers taking part in this survey consider the social pillar to be a highly significant aspect of the sustainability measures undertaken by companies. Statements on the social commitment of the companies received the most agreement. The farmers' responses suggest that a sustainable company is, for example, associated with taking care of employees and their health and training. Farmers would like companies to take responsibility for society and future generations and to make the daily routine more satisfying for their employees. Orientation toward the future and toward innovation is given special attention in the economic pillar of sustainability. Farmers associate the characteristic elements of the ecological pillar of agricultural manufacturers' commitment to sustainability less with sustainability as a term than they do the typical criteria of the social pillar. Farmers do not strictly view recyclable packaging, electric company cars or paperless offices as sustainability measures. On the other hand, a representative population survey conducted by the Federal Environment Ministry (BMU) and the Federal Environmental Agency (UBA) demonstrated that 86 percent of respondents noted that the industry is not doing enough to protect the climate [6]. Thus, according to the overall study conducted by BMU and UBA, respondents have high expectations of companies concerning protection of the environment. The differing results of the present study might be explained by the fact that conventional ecological aspects such as energy consumption and emissions were presupposed to be universal in the questions that were analyzed and in contrast to the other study were not included in the questionnaire. Another possibility is that activities undertaken by companies to protect the environment are not necessarily associated with their commitment to sustainability. This fact could be another indication that the breadth and depth of information being communicated about companies' commitment to sustainability needs to be expanded upon.

Farmers consider the economical pillar to be the most important when it comes to the sustainability criteria of an agricultural machine. Whether or not a machine can be retrofitted and the quality of the work its delivers are deemed by farmers to have overriding importance.

Conclusions

In conclusion, this study was only able to reveal individual aspects of sustainable production of agricultural machinery. Nevertheless, this study clearly shows the growing importance of the subject of sustainability in agricultural machinery and reveals the need for further research; in particular, this would include information deficits of farmers concerning agricultural machinery manufacturers' commitment to sustainability.

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