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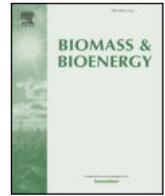
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Research paper

Bioenergy and its effects on landscape aesthetics – A survey contrasting conventional and wild crop biomass production

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ABSTRACT

The number of biogas plants in Germany that operate with renewable raw materials, especially maize, increased considerably between 1992 and 2016. The associated rise of areas farmed with maize has led to changes in the landscape. The present article investigates how these changes are perceived by chosen actor groups and whether wild plant mixtures as an alternative substrate are offering aesthetic value. In order to pursue this question, two independent surveys were conducted in the Münsterland area in North Rhine-Westphalia. We first used landscape photos in accordance with the Q methodology design; the second survey was part of the Regionale 2016 “GrünSchatz” project and used questionnaires and guideline-based interviews. The surveys reach the following conclusion: landscapes poor in structures and monotonous are assessed as less worth living in. Landscapes with only few maize fields were not assessed worse than landscapes without maize. Compared with that, landscapes dominated by maize fields were considered significantly worse. The evaluation shows a significantly better assessment of wild plant areas than maize areas regarding landscape aesthetics and are seen to improve the landscape. Due to the higher aesthetic value of wild plant mixtures, agriculturists also expect to improve the image of their profession. According to the two studies presented in this article, the attitude of exclusively considering the “tidiness” of the landscape, which had been prevalent in the past, seems to have given way to a more popular varied landscape.

1. Introduction

In Germany, 9209 biogas plants were installed between 1992 and 2016 [1]. Around 50% of these were fuelled with renewable raw materials, as statistics for the years 2010–2015 show [2]. Silage maize was the most frequently used substrate among the renewable raw materials, as is exemplified by a share of 73% in 2016 [3]. With the increase in bioenergy production and the associated demand for maize, the proportion of maize areas in the agricultural landscape has also risen visibly in recent years [4].

The increase in maize areas inevitably led to changes in the landscape. According to a study, maize acreage replaced set-aside areas to a large extent, which led to a more homogenous landscape associated with a loss of habitat and habitat structures [5]. The loss of habitat diversity is expected to have a negative impact not only on the landscape aesthetics [6] but also on the fauna and flora [7–9].

The present article deals with the effects of bioenergy production on the landscape in Germany. The focus is on finding out how the energy source maize is perceived in the landscape. In addition, results from the

“GrünSchatz” project will be presented. The “GrünSchatz” project has been developed and implemented since 2015 in the course of “Regionale 2016”, a regional structural development programme of the state of North Rhine-Westphalia in the West of Germany. The project on alternative crop production for anaerobic digestion of maize is realized in cooperation between the University of Münster, the North Rhine-Westphalian chamber of agriculture and the city of Dorsten. A wild plant mixture is cultivated as an alternative substrate for biogas plants in the western Münsterland and the Lippe region, which is funded by the state of North Rhine-Westphalia as an innovation project. The aim is to determine whether it is possible to mitigate the negative effects of maize monocultures on the landscape and the flora and fauna through the cultivation of wild plants as a substrate for biogas plants, as has been investigated by Venjakob et al. [10]. The project examines the ecological and economic advantages and disadvantages as well as the effects of wild plant crops on landscape aesthetics and the public image of farmers. This article presents in particular the results relating to the aesthetic dimensions.

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2. Methods

The results of two independent studies are presented in this article. In addition to opinion surveys using questionnaires and interviews as part of the “GrünSchatz” project described above, a survey on changes in the landscape caused by maize cultivation areas using the so-called Q methodology was conducted independently of these. In both studies, the personal opinion of various groups of people on bioenergy was asked. The surveys concern the conventional cultivation of maize plants on the one hand and the alternative cultivation of wild plants as a substrate for the production of bioenergy in Münsterland on the other hand.

2.1. Surveys using Q methodology

In the first part of the study, a survey in accordance with the Q methodology design was conducted. The Q method offers an opportunity for individual evaluation and ranking of a series of (landscape) photographs by respondents. Due to the structure of the method, each evaluation can be statistically analysed [11–14].

2.1.1. Selection of landscape photos (Q sample)

The photographs that make up the so-called Q sample were selected from around 300 photographs taken in the greater Münster area (North Rhine-Westphalia) as far as Lingen (Lower Saxony) in 2014. The chosen locations were at footpaths and cycle paths in order to show landscapes that cyclists and walkers can experience in reality. According to Müller & Kals, 66 landscape photos depicting the energy source bioenergy in different constellations in the landscape were selected [12]. The pictures showed the technical plant for the production of renewable energy as well as those agricultural crops that are necessary to produce the substrate for operating the plant.

The photos were divided into five categories representing the different characteristics of the energy source: “Landscape with renewable energy plant” (biogas plant, fermenter, silage heap; 5 pictures); “Landscape with maize fields only/predominantly” (30 pictures); “Landscape with scattered maize fields” (11 pictures); “Landscape without maize fields” (reference photographs; 16 pictures); and “Landscape with conventional energy production” (coal and nuclear energy; 4 pictures). The comparatively large number of photographs in the group “Landscape with maize fields only/predominantly” resulted from two categories being combined later; it was not possible to argumentatively distinguish them from each other clearly. A further subdivision of the categories was created on the topographical characteristics of the landscape: “flat landscape” and “hilly landscape”. Here, the proportion of pictures of flat landscape (41 photographs), distributed over the five categories, outweighed pictures with hilly landscape (25 photographs) due to the rather flat relief of Münsterland and Emsland.

The selection of 66 photos was a comparatively large set of photographs that was presented to the test persons for evaluation [13]. The aim was to ensure that, by pondering the different aspects of the landscape during the sorting process, respondents would be concerned with different facets of the landscape. The greatest possible correspondence to the experienced reality was to be created thus, where the landscape shows different landscape sections from different angles.

The photographs were taken with a digital camera whose focal length of 50 mm corresponds to the human eye's natural angle of vision [15]. The criteria for the selection of the photos for the Q sample were, among other things, the sharpness of the picture as well as light and weather conditions. Extreme sunshine and rainy weather were avoided in order not to influence the evaluation by such effects. To ensure that creative aspects had no influence on the evaluation of the photographs either, care was taken to ensure that the horizon was in the centre of the image. All pictures were photographed while standing and with the camera at eye level in order to render a pedestrian's or walker's angle of

vision.

2.1.2. Survey technique and actor groups

Respondents were given a scale of +5 to –5 on which to classify the images. Due to the resulting forced allocation procedure, each photograph was assigned an evaluation in each interview. The landscape photographs were evaluated in relation to each other [12].

The terms “worth living in” (+5) to “not worth living in” (–5) were used as labels of the scale. The attribute “worth living in” was included in the instruction for the classification process, thus forming the basis for the evaluation of the individual test persons:

“Our landscape has changed due to the production of bioenergy. In your personal opinion, which of the present pictures show a landscape worth living in and which a landscape not worth living in? Classify all pictures within the scale of +5, I think it's worth living in, to –5, I don't think it's worth living in.”

After the allocation process, the test persons were asked about leisure and holiday activities as well as socio-demographic parameters. In addition, each respondent was asked to give a brief explanation for his/her classification of certain images. Four pictures with technical elements, such as fermenters, a wind turbine, a power plant in the background and a road with signs, were selected in advance to that end.

The surveys on bioenergy were conducted in parallel with surveys on wind energy [14]. As part of the present study, agriculturists and restaurateurs were interviewed.

Firstly, farmers were included as it is their land on which the maize is grown and who have therefore a direct relation to it. They earn money with it by either using the corn for their own biogas plant or by selling the crop to a biogas plant owner. Additionally, the rural landscape as farmers know it might have changed with both the biogas plants and the maize monocultures being part of it today.

Secondly, actors from the gastronomy sector were included as they might profit from tourism that is related to the landscape, even though this effect has to be considered as indirect. This means that restaurateurs and hoteliers are not necessarily to be seen as field owners or land users but rather as beneficiaries of a landscape that is perceived as attractive by tourists. The landscape is like an asset and part of their touristic offer.

The study might have extended to other actor groups, e.g. tourists, experiencing landscape aesthetic for recreation. But such actor groups are temporary visitors and not bound on a special landscape scenery like agriculturists and restaurateurs. The two present actor groups were chosen because their economic gain depends, among other things, on the landscape structure.

2.1.3. Statistical evaluation of the Q sorts

The data set was evaluated using the RStudio software via the main component analysis (PCA) and redundancy analysis (RDA) [16]. A photo-based and a person-based PCA/RDA were carried out with the aim of identifying clusters of similar evaluations from the resulting ordination diagrams. In addition, the effects of categorizing the images in the ordination space were tested. The correlations between the individual evaluations of the photographs and the photograph characteristics (characteristics of the energy carrier; landscape form) were examined with the help of a linear mixed model (LMM) using the *lmer* function from the *lme4* package in RStudio.

The differences in the evaluations between the individual categories of the photographs (e.g. “Landscape with maize fields only/predominantly”, “Landscape with scattered maize fields”) were tested for significance in the course of post hoc tests using the *diffsmeans* function from the *lmerTest* package in RStudio.

2.2. Opinion surveys in the context of the “GrünSchatz” project

As part of the “GrünSchatz” project, the acceptance of renewable energies and especially wild plant crops was investigated by means of questionnaires and guideline-based interviews. In both cases comprehension of the questions and the way of carrying out the interviews was pre-tested with students. The list of questions was adjusted afterwards to better fit the research objectives. The main topic of the surveys was the effect of biogas plants and the cultivation of maize compared to the landscape aesthetic potentials of wild plants as an alternative substrate. The topics that emerged from the questionnaire survey were then examined in greater depth in a series of interviews. This method triangulation was also used to confirm the findings of the questionnaire.

2.2.1. Selection of the survey area

The survey area in which the data were collected is located in the western Münsterland between the border to the Ruhr area in the south and the Baumberge near Billerbeck in the north, extending to Warendorf in the east. This region, also known as “Münsterland parkland”, is traditionally characterized by agricultural land use and a mosaic of fields, meadows, hedges and small woodlands. 86% of the agricultural land is used for arable crops. Between 2009 and 2012, the proportion of maize increased sharply here, also for the purpose of biogas production [17].

2.2.2. Survey technique and actor groups

In order to investigate the aesthetical and ecological assessment of biogas plants and various agricultural crops for the production of the required biomass, a structured questionnaire was distributed to an interested expert public (conference participants, students, agriculturists) in 2016. Using a multi-point answer scale (Likert scale, from “strongly agree”, “agree”, “undecided” and “disagree” to “strongly disagree”), the basic attitude of the respondents towards the generation of energy in biogas plants was enquired [18]. In particular, they were asked to assess the aesthetic effects of biogas plants and the cultivation of maize as well as the landscape aesthetic potential of wild plants as an alternative substrate for biogas plants. In addition, data on the professional background were collected in order to be able to classify the answers causally in this respect, and to distinguish between the point of view of farmers and non-farmers.

The guideline-based interviews were conducted from spring to summer 2017 with farmers, in particular those who were growing the “GrünSchatz” wild plant mixture as part of the research project and with other agriculturists who were involved in substrate production for biogas plants. The central question in these interviews was whether and under what circumstances the cultivation of wild plants as a substrate for biogas plants could potentially be attractive and whether the interviewees classified this crop as of aesthetical and/or ecological value. Ultimately, it was to be clarified whether and under what conditions wild plants could be an attractive alternative for the production of biomass. During the interviews, a brief introduction was given to the background of the “GrünSchatz” project and the problem of biodiversity loss through monoculture-like maize cultivation. The project's approach of creating an ecologically and economically attractive alternative through the cultivation of high-yield wild plants was also outlined. If the interview partners did not spontaneously address the issues stated below, they were asked about the following core aspects:

- What effects on the landscape do you expect?
- What effects on the reputation in the neighbourhood and among colleagues are expected when farming “GrünSchatz” crops?
- What influence would the location of the area and thus the optical presence have?
- What effects on the biodiversity of plants and animals do you expect when planting “GrünSchatz” crops?
- How important do you think this biodiversity is?

The interview was accompanied by a short standardized questionnaire to collect socio-economic data, the size of the farm including the number of employees, the business orientation, the ownership structure and the question of whether the farm was run full-time or part-time.

2.2.3. Statistical evaluation of questionnaires and interviews

The questionnaire survey was carried out with EvaSys [19], a web-based software for the automated evaluation of questionnaires. The filled out questionnaires were fed in automatically. The generated SPSS data sets were used as a basis for the statistical analysis.

The interviews were transcribed and evaluated with Atlas.ti [20], a program for encoding and analysing qualitative data. The interviews were deductively analysed in accordance with Mayring [21] with regard to the perception of landscape aesthetics of maize and wild plant crops. Previously hypothetically postulated codes were e.g. aesthetic value, image gain or damage, ecological value as well as economic gain or loss through wild plant crops. In the course of the analysis, inductively emerging categories were also included in the evaluation.

3. Results

3.1. Results from surveys using the Q methodology

The interviews were made at four events in Rhineland Palatinate and North Rhine-Westphalia in 2015 and 2016. This resulted in a total of 21 usable Q-sorts, 14 of them from agriculturists and 7 from restaurateurs. The amount of surveys done does not allow a generalization of the results but offer to extract a tendency. They reflect the opinions of the actor groups that were included. The intention of the Q-method is to provide a focus on the opinions of the interviewees rather than offering a large quantity of data (13). When analysing the data, a distinction was made between the photo-based categories (characteristics of the energy source, landscape type) and the person-based parameters (age, gender, etc.). The PCA for the characteristics of the energy source showed a clear clustering of the individual categories in the scatter diagram (see Fig. 1). While the clusters of the categories “Landscape with conventional energy production (coal and nuclear energy)” and

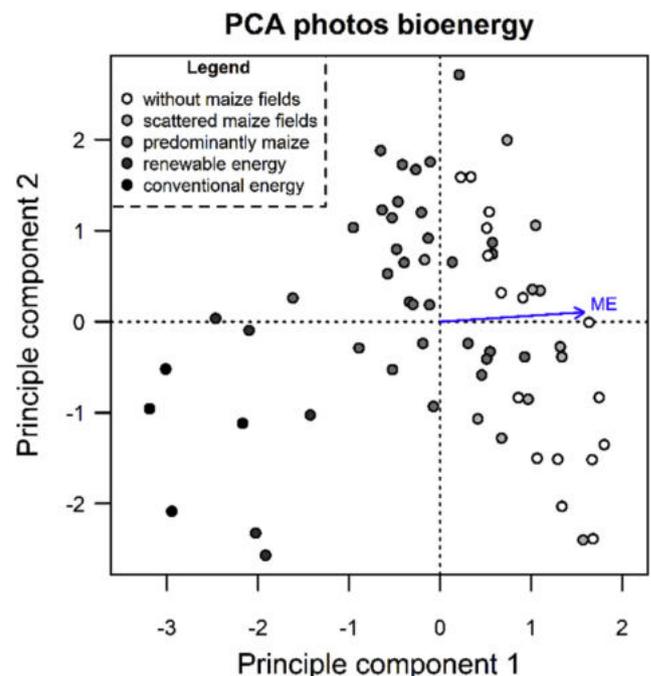


Fig. 1. PCA diagram of both groups of actors with overlay of photograph categories of energy source characteristics; ME = mean evaluation.



Fig. 2. Photograph no. 311, example for the category “Landscape with scattered maize fields” (photo: S. Feldmann).

“Landscape with renewable energy plant (biogas plant, fermenter, silage heap)” did not overlap in the scatter diagram, there was a strong overlap in the clusters of the categories “Landscape without maize fields (reference photos)” and “Landscape with scattered maize fields”. The latter two clusters also partly overlapped with the category “Landscape with maize fields only/predominantly”.

The LMM showed that photos with scattered maize fields (see example Fig. 2) were not rated worse than the reference photos without maize ($p = 0.157$; see example Fig. 3). All other categories were rated significantly worse ($p < 0.001$). From “Landscape with maize only/predominantly” (see example Fig. 4) and “Landscape with renewable energy plant (biogas plant, fermenter, silage heap; see example Fig. 5)” to “Landscape with conventional energy generation (coal and nuclear energy; see example Fig. 6)”, each of the ratings decreased significantly (post-hoc tests, $p < 0,001$; see Fig. 7).

For the landscape form category, the results in the LMM deviated from the results of the non-parametric MANOVA. There were significant differences between hilly and flat landscapes according to the results of both the Adonis test ($p = 0.0134$) and the LMM ($p < 0.001$).

Hilly landscapes were rated significantly better than flat ones ($p < 0.001$), but the difference was moderate (see Fig. 8).

The evaluation according to socio-demographic parameters, in particular gender and age ($< / > 40$ years), showed no significant differences in the evaluation of the images.

Significant interactions emerged between the occupational groups of actors and the characteristics of the energy source category. The groups of people (restaurateurs, agriculturists) evaluated the landscape characteristics differently to some extent (interaction Ausprägung:P.Gruppe, $p = 0.001$). Agriculturists rated landscapes with maize only/predominantly ($p = 0.006$), with renewable energy plants ($p < 0.001$) and with conventional energy production ($p = 0.019$) significantly better than restaurateurs. In addition, agriculturists rated renewable energy plants more positively than conventional energy generation (post-hoc test, $p = 0.002$), whereas there was no significant difference between these two categories among restaurateurs ($p = 0.249$).

The evaluation of the questionnaires accompanying the Q test showed the following result: regarding their attitude toward renewable



Fig. 3. Photograph no. 422, example for the category “Landscape without maize fields (reference photo)” (photo: S. Feldmann).



Fig. 4. Photograph no. 222, example for the category “Landscape with maize fields only/predominantly” (photo: S. Feldmann).

energy, 16 of the 21 test persons generally rated themselves as proponents, 5 were neutral. The question whether their attitude depended on the type of renewable energy source was answered in the affirmative by 9 people. Of these, 1 respondent answered positively (advocated) to the issue of bioenergy, 3 stated to be opponents, and 5 were neutral. For the remaining 12 respondents, the attitude did not depend on the type of regenerative form of energy.

3.2. Results of the questionnaires conducted as part of the “GrünSchatz” project

A total of 51 questionnaires was evaluated. We are aware that with this amount of interviews no generalization can be made. However, the aim of the study was to gain insights into how inhabitants of an area that is strongly shaped by the intensive farming of maize perceive the changing landscape aesthetics. 36% of our participants described themselves as full-time or part-time farmers; 64% as non-agriculturists. In detail, 69% male and 31% female participants took part. 55% of

these participants were between 41 and 60 years old (modal value 51 years). At 45%, almost half of the respondents lived “in a family”. 50% of those surveyed lived in rural areas, 24% in small towns and 26% in cities. Overall, those surveyed showed a relatively strong affinity with nature, with 91% stating that they often spend time in the rural environment for recreational purposes.

The vast majority of respondents regards biogas production as a positive contribution to the production of renewable energy (see Fig. 9). Opinions diverged as to whether maize crops for the production of biogas enrich the landscape. 70.8% of the respondents disagreed or strongly disagreed. The average was 3.8 and the median was 4 (disagree that maize enriches the landscape). However, the standard deviation of 1.1 and the fact that 14.6% were undecided, 14.6% perceived maize as enriching the landscape, show the wide range of opinions. It is clear that agriculturists and non-agriculturists had different opinions here. When dividing the results according to occupational groups, almost 20% of farmers considered the cultivation of maize for biogas plants to be rather enriching for the landscape.



Fig. 5. Photograph no. 112, example for the category “Landscape with renewable energy plant (biogas plant, fermenter, silage heap)” (photo: S. Feldmann).



Fig. 6. Photograph no. 521, example for the category “Landscape with conventional energy generation (coal and nuclear energy)” (photo: S. Feldmann).

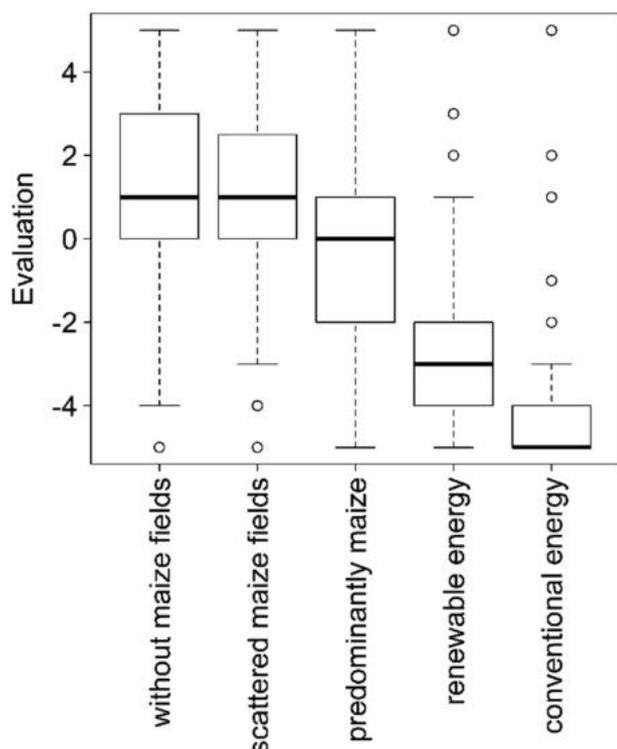


Fig. 7. Box plot of the photograph categories that represent the characteristics of the energy source in the landscape.

The cultivation of maize for biogas production was viewed critically by 69% of respondents with regard to its consequences for biodiversity. The average was 3.8 and the median was 4 (disagree that maize is unproblematic for biodiversity). However, opinions differed widely, especially between farmers and non-agriculturists. The standard deviation was relatively high at 1.3, with 20% of respondents and 39% of farmers considering maize to be unproblematic for biodiversity.

The analysis of the questionnaires showed a significantly better ecological and landscape aesthetic assessment of wild plants compared to maize for n = 51 respondents (see Fig. 9). It should be emphasized that the questionnaires were answered to a similar extent by farmers and non-agriculturists. A clear opinion was seen regarding the

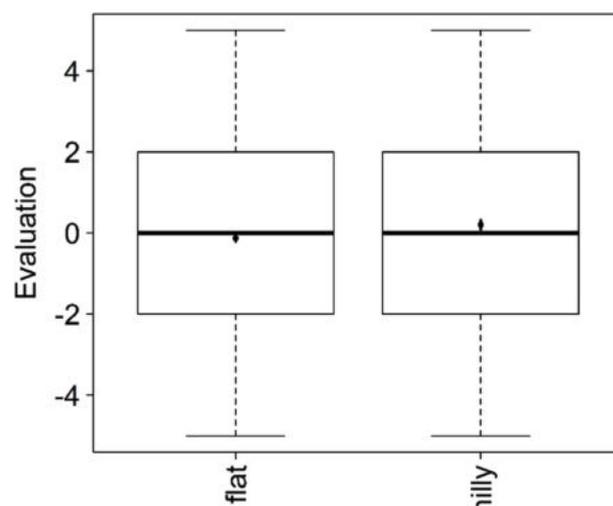


Fig. 8. Box plot of the photograph category landscape form containing pictures with flat and hilly landscape.

statement that wild plant areas contribute to improving the landscape (see Fig. 9): all respondents agreed or strongly agreed (18% agreed; 80% strongly agreed). Even when distinguishing between farmers and non-agriculturists, the preference remains very clear. There was no voice of dissent and only one undecided person. Farmers and non-agriculturists agreed on this statement. The question of whether the areas are perceived as messy – various interview partners had expressed this before the interviews, and it had been formulated as an issue in the literature [22] – was answered in the affirmative by only 8% of respondents, another 8% were undecided and 84% disagreed or strongly disagreed (see Fig. 9). It should therefore be noted that the cultivation of wild plants as a substrate for biogas plants is not only regarded as an ecologically attractive alternative to maize cultivation, but that it is also classified as suitable for improving the landscape – by all participants, regardless of whether they are farmers or non-agriculturists.

In all the interviews conducted, farmers showed great interest in the idea of combining agriculture and commitment to greater biodiversity through the cultivation of wild plants. However, critical opinions were expressed regarding the feasibility of implementation. In the interviews, the most frequently expressed and strongest “pro” argument was

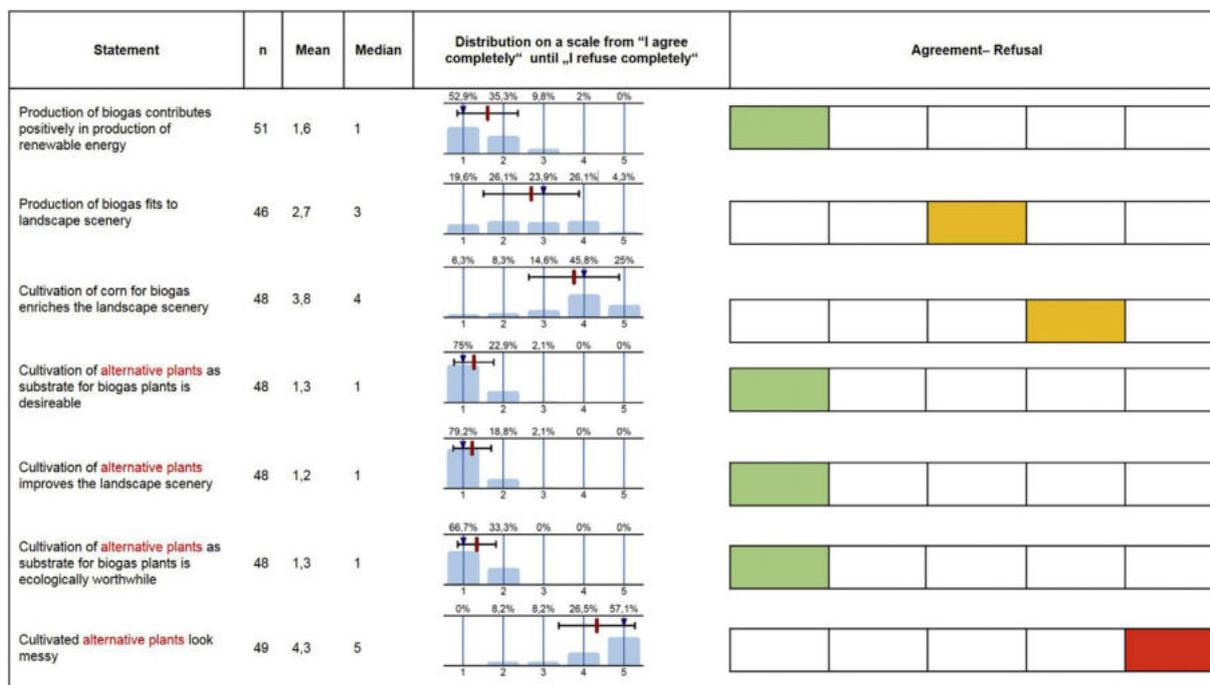


Fig. 9. Questionnaire analysis on the acceptance of bioenergy production using maize crops and its effects on the landscape, as well as the assessment of the aesthetical and ecological potential of wild plant crops as an alternative substrate.

the expected image gain, which was linked to the aesthetic value. In order to increase this gain, it was additionally desired – as was expressed in several interviews with farmers – that supportive public relations work should convey the aesthetic and ecological benefit of such crops to visitors and fellow citizens through information boards, events and the like [23]. The analysis of the questionnaire shows that wild plant areas were not perceived as messy by the respondents (cf. Fig. 9).

4. Discussion

Conducted completely independently of each other, the two studies presented point in a very similar direction with regard to the assessment of the optical effects of maize crops and the aesthetic preferences of the landscape. In the analysis of the surveys using the Q method, the clustering in the PCA diagram (see Fig. 1) suggests that the images were rated similarly by the respondents. The images that ranked highest as “worth living in” were the reference photographs without the energy carrier as well as the photographs showing the energy carrier – i.e. the maize acreage – as a subordinate structure in the image (e.g. in the background). In the four most positively perceived images, grassland use prevails, followed by grain cultivation as agricultural form of use. All pictures share a structural diversity, i.e. the agricultural areas are framed or interrupted by trees and hedge structures so that the visible landscape section appears vivid and versatile. Diversity and individual character in the sense of historically grown cultural landscapes are protected in accordance with Section 1 of the Federal Nature Conservation Act (BNatSchG). The law requires their permanent protection. The results of this study indicate that the diversity and character of a landscape section, i.e. the type of pre-industrial cultural landscape that comes close to the ideal landscape [24], are perceived as worth living in by the respondents and therefore as worth preserving.

The less structured and more monotonous the landscape section, described by Nohl [25] as the “modern production landscapes”, the less an image was rated as “worth living in”. In these pictures, extensive areas of maize often take up the predominant part of the landscape. However, other crops cultivated in a monoculture-like manner were also evaluated less positively than the structured landscape sections.

“Since landscape is considered beautiful and good, ugly landscapes usually exist only as a result of a destruction of landscape that is to be rejected” [26].

Technical elements were classified as least “worth living in” in the landscape (see chapter 3.1). The result of this survey with regard to the presence of technical elements in the landscape confirms the results of Huth & Thiele [14]. In this study conducted to explore the effect of wind turbines on the landscape, they showed that sceneries containing technical elements such as highways or high voltage lines were rated the least “worth living in”. Even the fact that the above mentioned technical infrastructure serves as public good did not improve the acceptance [14].

Since the increased production of renewable energy as such is socially desirable [27] and no technical problem [28] and since the production of the required biomass in the form of monoculture-like expanding maize crops appears to be aesthetically problematic according to the surveys conducted, a positive contribution here could be to at least partially replace maize by wild plant crops. The surveys conducted as part of the “GrünSchatz” project suggest precisely these potentials for such a positive contribution to the landscape (see Fig. 9). The results of Huth & Thiele [14], according to which colour aspects in the landscape such as blooming canola fields or flower crops (in the present case a photograph with a crop of flowers for picking) are rated as “worth living in”, also suggest that wild plant crops are positively perceived by the viewer due to their blooming effect. In addition, the investigations underway in the wild plant areas have also found significant ecological advantages. Thus, the wild plants grown for energy production could indeed increase the aesthetic attractiveness and ecological value of our agricultural landscape.

In addition to saving energy, the conversion of energy production and a shift away from fossil fuels are necessary if climate changes are to be kept as minor as possible. The German Federal Government is aiming for a share of 35% renewable energy by 2020. In order to achieve this goal, the government has implemented the Renewable Energy Law (EEG) as a means to financially incentivize the development of renewable energy sources. The firm compensation structure and privileged feeding of renewable energy into the public grid in the first years

of the EEG has led to a massive expansion of renewable energy production, including the production of energy based on biomass [1]. As of now, the cultivation of wild plants as a source of biomass energy is not competitive on a stand-alone basis [29]. Policies, such as a modification of compensation structures in the EEG could influence this situation positively [30]. On this point we have to underline that the technical feasibility and the influence on the biogas production process by adding a new substrate is not part of the present investigation.

The expansion of renewable energies also has visible consequences in the landscape [31], as the conflicts over monoculture-like maize acreages clearly show. It would be an opportunity to channel technical progress into paths that are both economically and aesthetically as well as ecologically advantageous.

The Q sort investigations show that the respondents rate landscapes more positively, the more varied the structure and colour is. Interestingly, the test persons of the studies in the “GrünSchatz” project also assessed the structurally richer and ecologically more valuable wild plant crops as aesthetically more pleasing at the same time. “An aesthetic value has often been assigned to biodiversity” is also what Lindemann et al. [32] found in their study on the effect that the biodiversity of grassland has on individuals. The exclusive focus on “tidiness” in the past [33] has, according to our studies, given way to a popularity of varied landscape – which at the same time is supposed to have more of an ecological function.

At this point, the results of the questionnaire differ from previous examination results: the literature emphasizes the importance of “tidy” fields and cultivated cultural landscape [22]. The author also encountered just this in preliminary discussions with some farmers. In the present study – in consideration of the defined actor groups –, only a negligibly small proportion of respondents rejected wild plant areas as messy.

It is also conceivable that the popularity of structured landscape pictures is based on a similarity with traditional and therefore familiar and positive views of the landscape.

Another success factor not to be underestimated would be the public relations work desired by some farmers. This could probably further increase the willingness of agriculture to cooperate, as then not only the actors would present wild plant crops as a sensible and effective measure. The correlation of this insight and the support of ecological measures is sufficiently proven in the literature [34,35]. In addition, as suggested by some farmers, conveying the positive effects of wild plant cultivation (aesthetics, biodiversity, etc.) via information boards, for example, could improve the image of the profession.

5. Conclusions

In general the concept of using biomass including wild crops for producing energy is well known [27]. Companies in the bioenergy-producing industry could use the following aspects as an opportunity to increase the acceptance of bioenergy. A landscape richer in structure

- ⇒ ... could be achieved if wild plants were grown, instead of maize, as a substrate for biogas plants to increase structural diversity.
- ⇒ ... is perceived as more attractive.
- ⇒ ... finds approval not only among the farmers' group of actors, but also among the test persons from the restaurant trade, for whom the landscape can represent a tourist potential in the context of landscape-related recreation.
- ⇒ ... with wild plant crops is classified as superior to maize crops in terms of both aesthetics and ecology by the majority of respondents.

The strong expansion of renewable energy will make energy production more visible again in the landscape. In the case of energy production from biomass, there is the possibility of averting the danger of monotization of the landscape, which leads to the assessment of “not worth living in”. In this way wild crop plants offer the opportunity

to reach aesthetic and ecological goals inside working land. It might be worthwhile to look for ways to optimize the existing approaches.

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