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Consumer Preferences for Sustainability in Food and Non-Food Horticulture Production

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Abstract: Although a large number of studies describe sustainability in horticulture for individual crops or use individual sustainability characteristics as examples, there is still a lack of information on what consumers regard as being the relevant criteria for sustainability in horticultural production in the German market. The aim of this paper is to provide a broad overview of the relevance of different sustainability characteristics for flowers and ornamental plants as well as for fruit and vegetables from a consumer perspective. First, the sustainability characteristics from the literature were grouped according to the four sustainability dimensions of ecology, economy, and social and corporate responsibility. Second, an exploratory online consumer survey was conducted for both non-food horticulture (ornamental plants and nursery products) and food horticulture (open field fruit and vegetables) with the aim of determining the initial significant indicators for various sustainability characteristics for consumers. A confirmatory factor analysis confirmed the four dimensions of the literature research. According to the survey results, the characteristics of ecology were highly relevant to the respondents, followed by the characteristics of social sustainability. However, some characteristics of social sustainability and corporate responsibility could not be confirmed by the model.

Keywords: factor analysis; consumer preferences; sustainability; sustainable characteristics

1. Introduction

Horticulture is a branch of agriculture concerned with the production of high value crops like vegetable, fruits, and flowers [1]. Horticulture can be defined as an intensive agricultural sector due to the combination of expensive resources, the large number of plants produced and the smaller production units [2].

Sustainability is a fundamental concept defined in the 1987 Brundtland Report, in which sustainable development is described as "[a development that] meets the needs of the present without compromising the ability of future generations to meet their own needs" [3].

On the basis of this concept, the model was further developed with three pillars representing the ecological, social, and economic dimensions. The three pillars model aims to create a balance between the ecological, social, and economic aspects according to the definition of sustainability in the 1987 Brundtland Report. Despite some studies that are critical of the three pillars model, this basic model forms the background of further development in horticulture in this study [4,5].

Sustainability in crop production was described in the first issue of the *Journal of Sustainable Agriculture* as follows: "Resource[s] in balance with their use through conservation, recycling, and/or renewal, practices preserve agricultural resources and prevent environmental damage to the farm and off-side acceptable levels and the systems works in concern with socio-economic realities" [6].

Poincelot [6] concludes that the focus of sustainable horticulture is on maintaining productivity, protecting environmental quality, and ecological and socioeconomic soundness. To this definition, Lopez et al. [7] added the promotion of economic performance and specified socioeconomic stability by promoting quality of life and society.

Agriculture, horticulture, and the food industry, together with many other sectors, are jointly concerned about ecological, social, and economic sustainability [8]. For this reason, sustainability has been investigated in a large number of studies. A distinction should be made between those studies focusing on consumption and those focusing on production (cultures, production systems). Using individual crops, sustainable production was studied for vegetables by Juroszek et al. [9], for fruit by Reganol et al. [10], and for the whole horticultural sector by Sumner. A number of studies have also examined the sustainable production of horticultural products and the associated implementation barriers or sales advantages for horticultural producers [2,11–14].

In addition to the added benefits for the horticultural companies, the implementation of these sustainability goals also entails production risks, which, in some cases, are not identifiable [15]. One of these barriers is implementing the sustainability features into the existing production system as well as the associated costs and time involved [11]. Gabriel and Bitsch [16] describe pressure from the retail chain and pressure from the public and/or media as motivation drivers for companies to focus more on sustainability in the production process. For many consumers, despite their reduced knowledge and experience with the subject, sustainability is an important product characteristic and way of life [17,18]. Furthermore, many consumers still have a knowledge gap between the general concept of sustainability and the specific characteristics of a sustainable food industry [19]. There is also inconsistency between consumer expectations and the implementation of sustainability in horticultural production. This has already been demonstrated by Selfa et al. [20] in the differing attitudes of producers and consumers towards ecological characteristics in production. In order to close this gap between producers and consumers, it is necessary to make sustainability actions measurable, because the indirect benefits are insufficient for creating a clear motivation for producers to implement sustainability practices [8]. Further studies exist on the evaluation of sustainability in production processes in agriculture and the food industry, but not for horticulture [8,20–23].

Consumer studies on ornamental plants and nursery products for the American market have been conducted to better understand consumer expectations [24]. In addition, consumer studies have also been carried out on individual aspects, such as organic production or social standards in horticulture [25–27]. Regardless of which characteristics consumers associate with sustainability in horticulture, studies on their willingness to pay are available [28,29]. A study by Rihn et al. [30] for the American market showed an additional willingness to pay for sustainably produced ornamental plants. Consumer studies have also been conducted on sustainability labels in the food industry [31] and on German tomatoes. Thus, efforts have been made to make sustainability characteristics transparent for the consumer [32].

Despite the large number of studies in the field of sustainability, there is still a lack of knowledge on consumer preferences relating to sustainable production in German horticulture. The German market for horticultural products is highly competitive and characterized by a large number of international suppliers. In this case, the knowledge of consumer preferences can be used by individual producers for product differentiation. The targeted implementation of sustainability features together with a labelling of these products might be a way to strengthen German horticulture in comparison to international competitors. This is particularly an advantage if goods from foreign producers are offered at lower prices on the German market. German horticultural products can thus secure added value through sustainable production.

The focus is on consumer preferences regarding sustainability characteristics. Due to the heterogeneity of horticulture, attitudes towards sustainability in food and non-food products are examined separately. Differences in the relevance of sustainability characteristics between the two production sectors (food and non-food horticultural products) can thus be better understood and

compared. In addition, the characteristics are aggregated into groups of sustainability dimensions that correspond with the pillars of sustainability. Where the characteristics could not be completely assigned to any of the three pillars, an additional dimension was created. Each sustainability dimension is defined by those horticulturally relevant characteristics assigned to it. The purpose was to identify important fields of action in horticultural practice.

2. Conceptual Background

Sustainability in horticulture can be described using various characteristics. Individual aspects relating to sustainability have been used in the context of consumer studies, e.g., [25,33]. However, these studies do not provide a complete view of sustainability in terms of the three pillars of sustainability (ecological, economic, and social aspects). Since this study focuses on a holistic view of sustainability, only publications that describe sustainability using all three dimensions were considered. In addition, the literature analysis only considered publications relating to horticulture (i.e., agriculture, the food industry).

Standards for sustainable production in horticulture have been described since 2003 [34]. Sumner [35] places sustainable horticulture in the context of sustainability, organic horticulture, and rural development. Basic knowledge from agriculture can also be transferred to horticulture [1]. However, in contrast to horticulture, various different sustainability assessment systems exist for the agricultural and food industries [21]. Ehrmann and Kleinhanß provide an overview of existing sustainability systems in agriculture [36]. For Germany, these include the Criteria System for Sustainable Agriculture (known in Germany as the KSNL), the Environment and Business Management System "REPRO," and the DLG certificate "Sustainable Agriculture" [37–39]. Further international sustainability assessment systems in agriculture include Response-Inducing Sustainability Evaluation (RISE) and the Sustainability Assessment of Food and Agriculture Systems (SAFA) [40,41]. The characteristics used in these systems form the basis of this study to measure consumer preferences in horticulture (Table 1). In addition, there are generally valid systems for sustainability reporting, which also include a holistic view. Examples of these include the German Sustainability Code (GSC, known in Germany as DNK) and the Global Reporting Initiative (GRI). Both systems were considered in the analysis since there is no equivalent reference in horticulture.

On the basis of the literature analysis, 27 characteristics were described and grouped according to the four dimensions. This required another dimension to be added to the classic model of three pillars. This new dimension of "corporate responsibility" is considered necessary because the characteristics of mission statement, innovation, regional added value, certification, transparency, and responsibility are not considered key factors of economic success. The dimension of corporate responsibility incorporates soft facts relating to corporate management, and was therefore described separately from the key economic factors (hard facts).

Environmental sustainability is described by the characteristics of plant protection, fertilization, soil-protecting production, biodiversity, water, conservation of resources, greenhouse gas (GHG) emissions, recycling, and the use of peat.

Social sustainability characteristics include occupational safety, gender equality, education and training, remuneration of employees, commitment to the region, stakeholder dialogue, legal violations, and employee satisfaction.

The economic dimension is characterized by the characteristics of liquidity, stability, profitability, and investment. Liquidity includes the capacity to meet principal payments and cash flow. Creditworthiness and the equity ratio are included under stability. Investment also includes investments in real capital.

Table 1. Initial model with four sustainability dimensions and corresponding characteristics from the literature.

Dimension	Characteristic	Literature
Economic	Liquidity	[37,40,41]
	Stability	[37,38,42]
	Profitability	[37,38,40]
	Investment	[38,42,43]
Corporate responsibility	Mission statement	[38,40,41]
	Change and innovation	[44]
	Regional added value	[40,44,45]
	Certification	[40]
	Transparency	[7,40,42]
	Responsibility	[40,44]
Social	Occupational safety	[7,37,38,40–42]
	Gender equality	[37,40]
	Education and training	[38,41]
	Remuneration of employees	[37,38,41]
	Commitment to the region	[37,38]
	Stakeholder dialogue	[40]
	Legal violations	[40]
	Employee satisfaction	[40,41]
Ecological	Plant protection	[7,12,37,38]
	Fertilization	[12,29,37,38,41,44]
	Soil-protecting production	[37,38,41]
	Biodiversity	[37,38,40]
	Water	[7,12,40,41]
	Conservation of resources	[7,12,41,42]
	Greenhouse gas emissions	[7,29,37,38,40–42,44]
	Recycling	[7,12,29,40,41]
	Peat use	[7]

3. Materials and Methods

3.1. Questionnaire (Assessment of Sustainability Characteristics)

An online survey was conducted to determine consumer preferences for sustainable production in horticulture. The questionnaire was divided into four sections representing the dimensions of ecology, economics, and social and corporate responsibility (Table 1, questionnaires in Supplementary Materials). Each section contained one question for each of the characteristics in Table 1. Respondents were asked to indicate how important these characteristics were for them in sustainable production in order to determine the individual relevance of the characteristic (e.g., fewer resources were consumed in production (e.g., through energy savings)).

Each item was evaluated using a four-point Likert scale. A four-point Likert scale was chosen to force the respondent to choose either a negative or positive response. The possibility of a neutral answer, in the sense of "I have no opinion," was not provided in this scale. Studies have shown that the number of scale points (four or six) has no effect on the quality of the evaluation [46,47], thus a four-point Likert scale was chosen to make the decision easier for the respondents.

Ecological sustainability included nine items, social sustainability included eight items, economic sustainability had four items, and corporate responsibility had six items. In addition, the questionnaire recorded sociodemographic characteristics and characteristics relating to purchasing behavior.

3.2. Data Collection

Since horticulture consists of a variety of products, the survey was conducted separately for food and non-food horticultural products. The items in the questionnaire were adapted to the specifics of the production methods.

In the first phase, the survey on non-food products (flowers, ornamental plants, and nursery products) was conducted from May to September 2017. By targeting participants via garden blogs, garden shops, and garden plot associations, the intention was for the participants in the survey to have an increased involvement with flowers, ornamental plants, and/or nursery products. The hypothesis behind this selection of respondents in the exploratory study was that consumers who regularly buy ornamental plants or nursery products would be more suitable for evaluating the sustainability characteristics of horticultural production, i.e., only respondents linked to production would be able to evaluate the importance of sustainability in production.

The survey was then repeated in the second phase from November 2017 to January 2018 for food horticulture (open field fruit and vegetables). In order to reach participants with an increased involvement with fruit and vegetables, subscribers to a fruit and vegetable box delivery service were addressed.

The questionnaire was available online and was created using LimeSurvey, version 2.6.6 (LimeSurvey GmbH, Hamburg, Germany).

3.3. Statistical Analysis

A descriptive evaluation of the sociodemographic data (gender, age, family situation, size of residence) and purchasing behavior (place of purchase, frequency of purchase of horticultural products) was conducted. The a priori relationships between the characteristics and the sustainability dimensions (ecological, social, economic, and corporate responsibility) were examined using a factor analysis. The suitability of the items for performing a factor analysis was tested using an anti-image correlation matrix and the Kaiser-Meyer-Olkin (KMO) test with a value limit of 0.8 [48]. Based on a significant Bartlett test, a random correlation between the characteristics was excluded.

Since the structure was already provided from the literature analysis, a confirmatory factor analysis using principal component analysis (PCA) to extract a fixed number of factors (4) was carried out. Varimax rotation was used and factors with an eigenvalue >1 were taken into account. Items with cross loadings were removed from the model. The quality of the factor analysis was checked using the Kaiser criterion. In addition, Cronbach's alpha was used to check internal consistency and the extent to which the questions were related to each other.

Evaluation of the closed questions was performed by IBM SPSS Statistics 25 (IBM, Armonk, New York, NY, USA).

4. Results

4.1. Sample Structure

The average age of the sample for non-food products (sample 1, N = 144) was 34 years, and in the sample for food products (sample 2, N = 386) it was 37 years. The ratio of female and male respondents was also similar in both samples, with 66% female and 34% male respondents in sample 1, and 63% female and 37% male respondents in sample 2. For 65% of the respondents in sample 1 and 57% of the respondents in sample 2, the highest educational level achieved was a degree from a university of applied sciences. Vermeir and Verbeke [49] note the advantages of a young average age in a sample. This group represents the consumers of the future who will probably continue to pursue their consumption behavior and lifestyle in the future. In addition, a higher level of education can be associated with an increased awareness of sustainability [49]. A relationship to plants or fruit and vegetables, i.e., a greater involvement of the participants in the topic of this study, was ensured by purposefully contacting interested persons. This greater level of involvement was also reflected in the purchasing behavior of the respondents. In the previous four weeks, 52% of the respondents had bought an ornamental plant and 14% a nursery product. In the previous 12 months, 74% of the respondents had bought an ornamental plant and 33% a nursery product. The most common purchases of the respondents were bedding and balcony plants and green house plants (Table 2).

Table 2. Demographic data of the samples.

Sample: Ornamental Plants and Tree Nursery Products	
N	144
Age (Mean)	34
Female	66%
Male	34%
Purchased ornamental plants	
Bedding and balcony plant	40%
Green house plants	19%
Flowering house plants	10%
Pot plants	10%
Cut flowers	10%
No knowledge about the purchased plant	3%
Never bought a plant before	9%
Place of purchase of ornamental plants	
Garden centers	22%
Specialist flower shop	19%
DIY markets	17%
Food retail	11%
Other places of purchase	31%
Sample: Vegetable and fruit	
N	386
Age (Mean)	37
Female	63%
Male	37%
Place of purchase of vegetables and fruit	
Food retail	47%
Discounter	26%
Weekly market or farm shop	10%
Fruit and vegetable box delivery service	12%
Other places of purchase	5%

Of these respondents, 67% had acquired the bedding and balcony plant in the previous four weeks. Ornamental plants were mainly bought in garden centers, specialist flower shops, and DIY markets (Table 2). The respondents reported that tree nurseries (21%) and garden centers (14%) were their preferred places to buy tree nursery products. The food products of horticulture (open field fruit and vegetables) were purchased by 47% of the respondents in food retail (e.g., supermarkets). A further 22% of the respondents had recently purchased fruit and vegetables at a weekly market or farm shop, or obtained them through a fruit and vegetable box delivery service (Table 2).

4.2. Factor Analysis for Ornamental Plants and Tree Nursery Products

The suitability of the characteristics derived from the literature to describe the various sustainability dimensions was examined for non-food horticultural products. The suitability of each characteristic for factor analysis was shown using the KMO test (KMO = 0.854). The significant Bartlett test showed the existence of a correlation between the characteristics. Based on PCA, four factors were identified (Table 3). These factors correspond to the four dimensions of sustainability already described in the model (Table 1). The extracted factors were confirmed by the Kaiser criterion and cumulatively explained 60.843% of the variation. The measure of internal consistency (Cronbach's alpha = 0.874) confirmed that the four factors extracted measure the construct sustainability.

Table 3. Descriptive results and rotated factor loadings of items for ornamental plants and tree nursery products (N = 144).

Sample: Ornamental Plants and Tree Nursery Products	Mean Value	SD	Factor Loading
Factor 1: Ecological sustainability/environment			
Greenhouse gas emissions in production have been reduced.	3.299	0.758	0.813
Less fertilizer (e.g., nitrogen, phosphate) was used for production.	3.424	0.735	0.768
Fewer pesticides were used in production or biological pesticides and beneficial insects were used.	3.229	0.808	0.767
Recyclable materials were used in production.	3.313	0.762	0.766
Fewer resources were consumed in production (e.g., through energy savings).	3.368	0.697	0.764
Water was used sparingly in production.	3.174	0.831	0.725
The diversity of plants in the production and production environment was promoted.	3.174	0.831	0.674
The plants grow in a peat-reduced substrate (plant soil).	2.938	0.846	0.668
Factor 2: Economic sustainability			
Stability: The company has financial stability and is creditworthy.	2.451	0.767	0.848
Investment: The company invests more than is consumed, for example, by the wear and tear and aging of buildings and machinery.	2.563	0.834	0.821
Liquidity: The operating revenue can cover all operating costs.	2.479	0.755	0.819
Profitability: The company achieves a high profit.	2.660	0.763	0.711
Factor 3: Social sustainability			
The company's human resources management pays attention to employee satisfaction.	2.597	0.918	0.774
The company remunerates its employees appropriately.	2.875	1.030	0.742
The occupational safety and health of the employees is taken care of by the company.	3.090	1.024	0.700
The company promotes the training and further education of its employees.	2.639	0.913	0.691
The company is in dialogue with critics and contributes to the resolution of conflicts.	2.681	0.874	0.444
Factor 4: Corporate responsibility			
The company has long-term goals and a mission statement for the orientation of managers and employees.	2.965	0.797	0.876
Management promotes change and innovation within the company.	2.951	0.796	0.842
Quality is ensured by certification and is recognizable to the consumer.	3.090	0.801	0.591
Cumulative (%) rotated		60.843	
Cronbach's alpha		0.874	

SD: Standard deviation; factor loading rotated component matrix; scale from 1 "completely unimportant" to 4 "very important."

From the view of the respondents, the sustainable production of ornamental plants and tree nursery products was most strongly influenced by ecological characteristics. Eight of the nine characteristics from the literature search were confirmed in the empirical study. The characteristic of soil-protecting production could not be included in the ecological factor due to double loading. For the respondents, the reduction of fertilizer was the most important characteristic of ecologically sustainable production, while peat reduction was the least important characteristic.

Economic sustainability is defined by the four characteristics of stability, liquidity, profitability, and investment. However, compared to all the other characteristics, the economic characteristics were assigned a lower importance.

Based on the previously conducted literature research, eight characteristics were found to describe social sustainability. In our empirical study, social sustainability was described by only five characteristics, relating primarily to employees and workplace design (remuneration of employees, education and training, employee satisfaction, and occupational safety). Other characteristics, such as commitment to the region, gender equality, and legal violations could not be included under the factor

of social sustainability. Only the characteristic of stakeholder dialogue was included beyond those characteristics relating to the employees of the company.

The fourth factor, corporate responsibility, is described by the characteristics of mission statement, change and innovation, and certification. Certification was rated as the most important characteristic of this factor by the respondents.

4.3. Factor Analysis for Vegetables and Fruit

To examine the sustainability characteristics in food horticulture, the suitability of the characteristics for describing the four dimensions was evaluated (Table 4). All of these characteristics were considered suitable for carrying out a factor analysis. Both the KMO test (KMO = 0.909) and the significant Bartlett test showed that the characteristics were related and correlated with each other. The PCA selected four factors which corresponded with the four dimensions described in the theory (see Section 2.). These four factors were also verified using the Kaiser criterion. The four factors explain 61.871% of the total variance and the suitability of these four factors to describe the construct of sustainability was confirmed by Cronbach's alpha of 0.896.

Table 4. Descriptive results and rotated factor loadings of items for fruit and vegetable growing.

Sample: Vegetable and Fruit	Mean Value	SD	Factor Loading
Factor 1: Ecological sustainability/environment			
Fewer pesticides were used in production or biological pesticides and beneficial insects were used.	3.332	0.789	0.751
The plants were produced in a soil-protecting process.	3.282	0.699	0.732
Less fertilizer (e.g., nitrogen, phosphate) was used for production.	3.526	0.699	0.729
Recyclable materials were used in production.	3.399	0.725	0.728
Greenhouse gas emissions in production have been reduced.	3.415	0.706	0.718
The plants grow in a peat-reduced substrate (plant soil).	2.826	0.908	0.694
Water was used sparingly in production.	3.228	0.809	0.678
Fewer resources were consumed in production (e.g., through energy savings).	3.438	0.663	0.673
The diversity of plants in the production and production environment was promoted.	3.096	0.833	0.670
Factor 2: Economic sustainability			
Stability: The company has financial stability and is creditworthy.	2.729	0.718	0.859
Investment: The company invests more than is consumed, for example, by the wear and tear and aging of buildings and machinery.	2.618	0.730	0.811
Liquidity: The operating revenue can cover all operating costs.	2.793	0.719	0.802
Profitability: The company achieves a high profit.	2.762	0.684	0.738
Factor 3: Social sustainability/employees			
The company's human resources management pays attention to employee satisfaction.	2.987	0.807	0.782
The company remunerates its employees appropriately.	3.231	0.835	0.766
The occupational safety and health of the employees is taken care of by the company.	3.376	0.823	0.763
The company promotes the training and further education of its employees.	2.896	0.806	0.677
Factor 4: Corporate responsibility			
The company has long-term goals and a mission statement for the orientation of managers and employees.	2.995	0.752	0.737
Quality is ensured by certification and is recognizable for the consumer.	3.236	0.805	0.710
Cumulative (%) rotated		61.872	
Cronbach's alpha		0.896	

SD: Standard deviation; factor loading rotated component matrix; sale from 1 "completely unimportant" to 4 "very important."

Environmental sustainability includes the largest group of characteristics overall, and was more important for the respondents compared to the other sustainability pillars.

All items described in the initial model could be included in the ecological dimension (Table 1). Production with reduced fertilizer use was of utmost importance to the respondents when growing vegetables and fruit, while the reduced use of peat had the lowest importance of the ecological characteristics.

The economic dimension with the characteristics of stability, liquidity, profitability, and investment could also be combined into one factor. Compared with the other characteristics, economic characteristics were assigned the lowest importance. In the economic dimension, the investment characteristic ("The company invests more than is consumed, for example, by the wear and tear and aging of buildings and machinery") was the least important.

The factor of social sustainability includes characteristics that focus on the employees in the company. Occupational safety ("The occupational safety and health of the employees is taken care of by the company") was the most important factor for the respondents. Other characteristics that describe this factor are employee satisfaction, remuneration of employees, and promotion of education and training in the company. The other characteristics of social sustainability found in the literature research could not be included in the factor of social sustainability due to cross loadings. These characteristics (gender equality, commitment to the region, and legal violations) could also not be included in any other factor.

The fourth factor describing the sustainability of fruit and vegetable production includes the characteristics of corporate responsibility, including the characteristics of mission statement and certification. These two characteristics could not be combined into the third factor of social sustainability.

4.4. Comparing the Sustainability Dimensions of Food and Non-Food Horticulture

When comparing food and non-food horticulture, the ecological characteristics are more relevant in fruit and vegetable growing than in ornamental plant growing and tree nurseries (Figure 1). In both types of production, the ecological dimension contains the majority of the characteristics. Only in non-food horticulture is the characteristic of soil-protecting production not included in the ecological factor. However, this characteristic is of little relevance in non-food horticulture, and for ornamental horticulture in particular, since a large part of production takes place in pots using a substrate and is thus not grown in the soil (Table A1). Overall, the high importance of ecological sustainability in horticulture is shown by both the number of items and by the high rating given by the respondents.

Economic characteristics are described for both food and non-food horticultural sectors by the characteristics of stability, investment, profitability, and liquidity. For the respondents, the economic characteristics in food horticulture were slightly more important than in non-food horticulture.

It is noteworthy that in food horticulture the economic characteristics of stability and liquidity are significantly more important to the respondents than in non-food horticulture (Figure 1; Table A1). However, compared to the other characteristics, the economic characteristics were assigned the least importance in both groups.

In both food and non-food horticulture, the social sustainability factor includes above all characteristics that describe work conditions in horticultural companies. The two horticultural sectors differ in social sustainability only in the characteristic of stakeholder dialogue. This characteristic was only considered for the production of ornamental plants and nursery stock. For both sectors, the characteristics of legal violations, commitment to the region, and gender equality could not be included in the factor of social sustainability. However, occupational safety was the most relevant social characteristic in both sectors.

Another factor that can be regarded as an interface between economic and social sustainability is corporate responsibility. In both sectors, this factor included the characteristics of mission statement and certification. In non-food horticulture, this factor was further characterized by change and innovation. In both sectors, certification was assigned the highest relevance by the respondents, while the characteristics of regional added value, transparency, and responsibility were not significant in corporate responsibility.

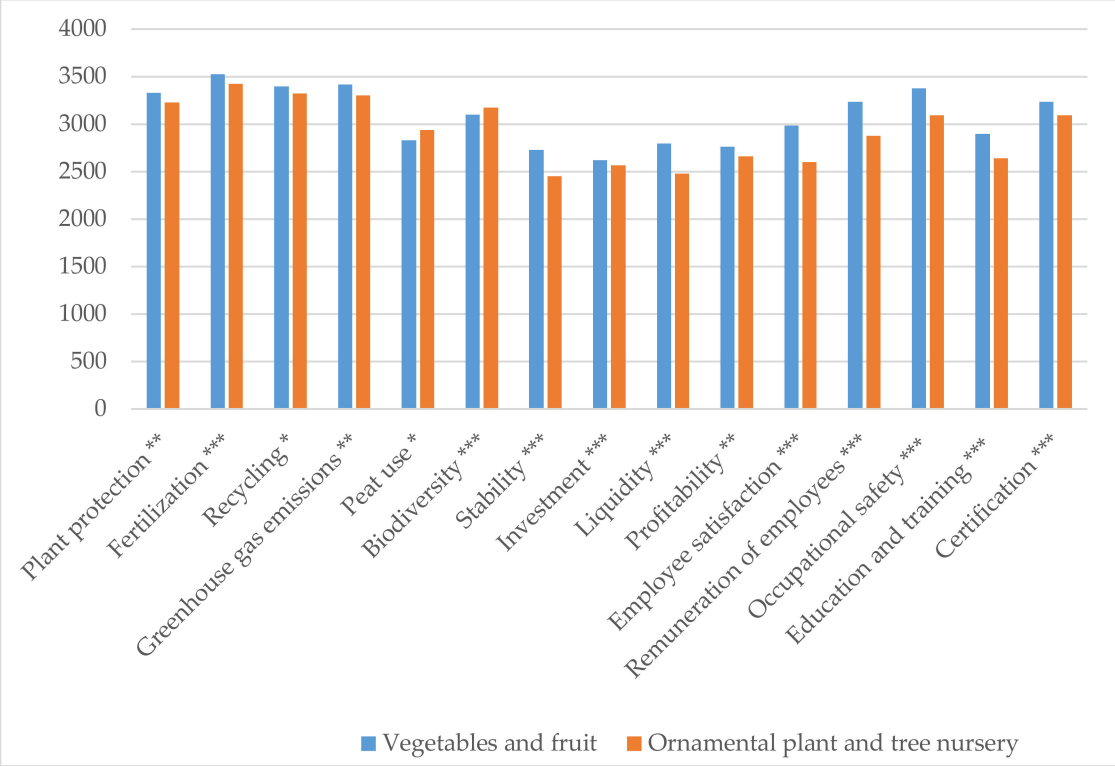

Figure 1. Significant differences in mean values between the non-food and food samples (Mann–Whitney U-test: *** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$).

5. Discussion

The goal of this paper was to compare the attitude of consumers to sustainable production in food and non-food horticulture. A further objective was to combine the characteristics into groups (factors) in order to identify the sustainability fields relevant for action.

For many consumers, sustainability is an important product characteristic and way of life [17]. With the exception of a few economic characteristics, this study also highlighted the importance of sustainability as already described in the literature.

The ecological characteristics of sustainability are of the highest relevance compared to the other pillars of sustainability. Peschel et al. [19] point to scientific studies showing that many consumers have become more aware of ecological sustainability. The authors also draw attention to an increased willingness to pay for both ecological and social products. These findings can be associated with a general change in values towards an environmentally and climate friendly lifestyle [50].

Furthermore, the high importance of ecological attributes is partly due to negative reports on product safety and animal husbandry and its environmental impacts, such as soil erosion or nutrient leaching over the last 10 years [8]. As a result, this sustainability pillar in particular has led to growing pressure on the sector. However, negative externalities that influence climate change or biodiversity, among other things, can also be attributed to horticulture (as well as agriculture and forestry). This influence on the climate, nutrient leaching, and biodiversity was also perceived by the respondents of this study and this was reflected in the importance of the characteristics of plant protection and fertilization in the open field production of fruit and vegetables.

From a consumer perspective, the characteristic of peat use was less relevant in food horticulture than in non-food horticulture. The reason for this might be that the respondents assumed a lower use of peat in fruit and vegetable growing. However, 51% of the peat used in German commercial horticulture is used in vegetable growing [51]. For the consumer, peat use is directly visible, especially in potted plants. It is therefore surprising that this characteristic was of rather low significance in regard to ornamental horticulture, especially in light of the ongoing discussions on the restrictions in peat extraction.

The characteristic of soil-protecting production was not taken into account in non-food horticulture. This characteristic is of little relevance in ornamental horticulture in particular, as production is mainly in pots.

For non-food horticulture, the characteristic of water was not included in the factor of ecological sustainability. However, Lea-Cox et al. [2], among others, emphasize the importance of water management and water quality for tree nurseries and in greenhouse production as important processes for increased sustainability. Water management strategies can be particularly important in practice, especially regarding legal water regulations, which can be very different from region to region [12].

Overall, public interest in and increasing individual awareness of ecological sustainability, as well as media coverage of negative externalities (climate change) resulting from plant production, are explanations for the high relevance of ecological characteristics in horticulture.

Social sustainability characteristics are rated lower than environmental sustainability characteristics, but higher than economic sustainability characteristics. For horticulture in New Zealand, De Silva and Forbes [11] showed that due to high minimum social standards only a small need for action is seen in the social sustainability pillar. In contrast, despite high minimum standards in occupational safety in Germany, this study regarded work safety in horticultural production to be the most important characteristic.

The economic characteristics of sustainable production were divided into two groups for food horticulture and three groups for non-food horticulture. This grouping was confirmed in the factor analysis based on the empirical data. Economic characteristics were less relevant than corporate responsibility characteristics in both the food and non-food horticultural sectors. This low importance could be linked to a lack of economic knowledge, which likely made it difficult for respondents to assess these characteristics [29].

Characteristics describing corporate responsibility were important attributes of a sustainable horticultural company for the respondents. Characteristics of corporate responsibility, such as transparency and food safety, are drivers for local products [52] and due to the globalization of supply chains in horticulture and food crises, these topics are becoming increasingly important to consumers. This development can also be seen in this study for the characteristic of certification. De Jonge et al. [53] also pointed to the confidence of consumers in company management, which compensates for the lack of knowledge about food production. In this study, confidence in the company's management is demonstrated by the mission statement characteristic, and was relevant in both sectors.

This study provides the first indications of the preferences of German consumers in sustainable horticultural production. Social desirability influences the evaluation of the characteristics. Therefore, in this study, which used a survey based on a closed questionnaire, real buying behavior was not addressed. Rather, attitudes towards items that characterize sustainable production were described. The low average age of the participants must also be taken into account. A study from Belgium shows that young consumers with a high level of involvement have a positive attitude and a higher willingness to pay for sustainably produced products (especially milk) [49]. For ornamental plants, vegetables, and herbs, Hawkins et al. [28] also showed that young consumers in the state of Maine (USA) had a greater interest in sustainably produced plants than older consumers, however, an increased willingness to pay could not be demonstrated for this group.

In addition, demographic characteristics influence the different preferences between the two samples. The preferences within a sample can also be based on demographic characteristics. However, initial statistical calculations indicated that the present sample is too small for a more comprehensive analysis of the influence of demographic characteristics on sustainability preferences. A correlation between the age and purchasing behavior of ornamental plants has already been demonstrated by Kaim and Altmann [54]. In the ornamental plant market, however, it should be noted that the sale of flowers and plants is concentrated in the generation over 50 years and that this consumer group had already been buying ornamental plants in their younger years [54]. This long-term attitude towards flowers and ornamental plants is included in the age pyramid (cohort effect). If this effect can be transferred to sustainable horticultural products, the positive attitude of young consumers with a high level of involvement identified in this study may offer a market opportunity for sustainable horticultural products in the future.

6. Conclusions

For both samples (ornamental plants and tree nursery products and vegetable and fruit), the results of the factor analysis correspond to the dimensions of the sustainability model described above. From a consumer's perspective, sustainable production in horticulture focuses on ecology, regardless of the production type. The importance of the characteristics that describe ecologically sustainable production only has slight differences between food and non-food horticulture. Differences between food and non-food horticulture can be found in the characteristics of social sustainability. Social sustainability was less important in non-food horticulture than in food horticulture. Economic characteristics were only of minor importance in horticulture in this study.

The results of the study make it clear that ecology offers the highest practical relevance for action. The implementation of environmental characteristics can help to reduce the gap between consumer expectations and actual production. Sustainability features that have already been implemented should be communicated to consumers by the horticultural companies. In addition, this information could help to reduce any potential barriers to implementation in order to employ further sustainability characteristics [11]. Implementation barriers include combining sustainability characteristics into the existing production system, the associated costs and time involved, as well as invisible added value for producers [11,15]. The consumer preferences identified show that the implementation of sustainability characteristics can add value. Within these sustainability dimensions, the characteristics can be used to implement sustainable production in horticultural companies concretely on the basis of the analyzed characteristics. In this way, the costs and time involved can be calculated in advance for specific sustainability characteristics and individual sustainability strategies for each horticultural company can be developed.

Supplementary Materials: The following are available online at http://www.mdpi.com/2071-1050/12/17/7004/s1, Questionnaire 1: Ornamental plants and tree nursery products; Questionnaire 2: Vegetables and fruits.

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Appendix A

Table A1. Mean value comparison between the two samples.

	Vegetables and Fruit	Ornamental Plant and Tree Nursery	*p*-Value
	Mean Value	**Mean Value**	
Factor 1: Ecological sustainability/environment			
Fewer pesticides were used in production or biological pesticides and beneficial insects were used.	3.332	3.229	0.017 **
The plants were produced in a soil-protecting process.	3.282		
Less fertilizer (e.g., nitrogen, phosphate) was used for production.	3.526	3.424	0.008 ***
Recyclable materials were used in production.	3.399	3.323	0.099 *
Greenhouse gas emissions in production have been reduced.	3.415	3.299	0.013 **
The plants grow in a peat-reduced substrate (plant soil).	2.826	2.938	0.061 *
Water was used sparingly in production.	3.228	3.174	0.224
Fewer resources were consumed in production (e.g., through energy savings).	3.438	3.368	0.120
The diversity of plants in the production and production environment was promoted.	3.096	3.174	0.001 ***
Factor 2: Economic sustainability			
Stability: The company has financial stability and is creditworthy.	2.729	2.451	0.001 ***
Investment: The company invests more than is consumed, for example, by the wear and tear and aging of buildings and machinery.	2.618	2.563	0.004 ***
Liquidity: The operating revenue can cover all operating costs.	2.793	2.479	0.000 ***
Profitability: The company achieves a high profit.	2.762	2.660	0.023 **
Factor 3: Social sustainability/employees			
The company's human resources management pays attention to employee satisfaction.	2.987	2.597	0.000 ***
The company remunerates its employees appropriately.	3.231	2.875	0.000 ***
The occupational safety and health of the employees is taken care of by the company.	3.376	3.090	0.000 ***
The company promotes the training and further education of its employees.	2.896	2.639	0.000 ***
The company is in dialogue with critics and contributes to the resolution of conflicts.		2.681	
Factor 4: Corporate responsibility			
The company has long-term goals and a mission statement for the orientation of managers and employees.	2.995	2.965	0.823
Quality is ensured by certification and is recognizable for the consumer.	3.236	3.090	0.002 ***
Management promotes change and innovation within the company.		2.951	0.982

Mann–Whitney U-test: *** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$.

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