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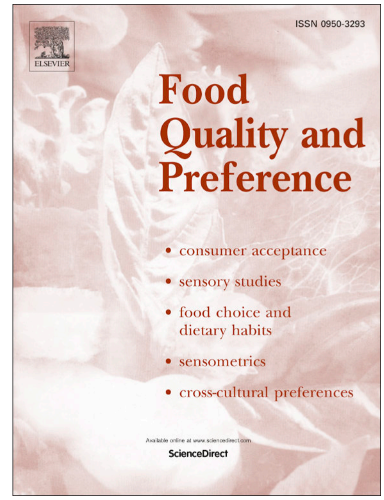

Short Communication

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Rita Saleh, Nadja El Benni, Sandie Masson, Jeanine Ammann

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Public acceptance and sustainability perceptions of food produced with chemical, digital and mechanical weed control measures

Rita Saleh[1,a], Nadja El Benni[2], Sandie Masson[3], Jeanine Ammann[4]

[1] Agroscope, Socio-Economics Group, Tänikon 1, 8395 Ettenhaussen, Switzerland

[2] Agroscope, Research Division Sustainability Assessment and Agricultural Management, Tänikon 1, 8356 Ettenhaussen, Switzerland

[3] Agroscope, Weed Science for Field Crops Group, Route de Duillier 50, 1260 Nyon, Switzerland

[4] Agroscope, Economic Modelling and Policy Analysis Group, Tänikon 1, 8395 Ettenhausen, Switzerland

[a] Corresponding author: rita.saleh@agroscope.admin.ch

Abstract

This study investigated public acceptance and perceptions of the sustainability of food produced with different weed control measures. An online survey with a within-subject design was conducted with 485 respondents from the French- and German-speaking parts of Switzerland. Acceptance of food produced using the investigated measures and social, economic and environmental sustainability perceptions were assessed for full-surface herbicide spraying, herbicide reduction (spot spraying, precise spraying) and herbicide-free mechanical technology (hoeing machine). The importance of food's naturalness, chemophobia, perceptions of farmers and sociodemographic variables were also recorded. The results revealed changes in social, economic and environmental sustainability perceptions based on the weed control measures, indicating that laypeople assess the impacts of these measures based on their type (chemical, digital, mechanical). The amount of herbicide sprayed is relevant for people's judgements, as well as the precise spraying that keeps crops intact. The use of hoeing machine is perceived to be the most sustainable, natural and acceptable compared to the other investigated measures. Overall, the findings suggest that communicating information on weed control measures, the quantity of herbicide applied and the precision of the spraying might help increase public acceptance of plant protection measures applied by farmers, promoting sustainability.

Keywords: public acceptance, sustainability perceptions, weed control, herbicide use, chemophobia

1. Introduction

Public interest in sustainable food production has increased although people struggle to define food sustainability (Sánchez-Bravo et al., 2021; van Bussel, Kuijsten, Mars, & van't Veer., 2022). Unlike experts who acknowledge the equal importance of the social, economic and environmental pillars of sustainability to achieve sustainable food production (Maynard et al., 2020), laypeople tend to be less or unequally concerned with the social and economic sustainability of food production. In fact, the public predominantly associates sustainability with environment-friendly food production requiring few to no chemical use (Sánchez-Bravo et al., 2021). Chemical use seems to be a key factor guiding people's sustainability perceptions of food production technologies.

Generally, public attitudes regarding chemicals impact acceptance of chemical use in food technologies (Saleh, Bearth, & Siegrist, 2019, 2021). People's negative attitudes, concerns and misconceptions regarding chemical use, particularly in food production, are typically persistent. For those who exhibit chemophobia, a fear of synthetic chemicals, the use of any amount of chemicals in food production is unacceptable (Entine, 2011). Chemophobics tend to prefer alternatives (e.g., organically grown food) that are perceived to be more natural and thus healthier and better for the environment (Rozin et al., 2004). Food's naturalness is therefore an important factor for public acceptance of food-related technologies (Rozin et al., 2004; Saleh et al., 2021; Siegrist & Hartmann, 2020).

Another factor that could impact public acceptance of food technologies is political orientation. For instance, in Switzerland, two political initiatives were introduced to ban pesticide use in agriculture in 2017 (Huber & Finger, 2019). Left-wing parties and citizens residing in urban areas mostly supported these initiatives. Lusk (2012) found similar trends; liberals tended to be more in favour of additional food safety regulation than conservatives. It seems that political ideologies are related to public attitudes of food-related technologies. Furthermore, previous research has shown that public trust in farmers can influence public attitudes towards farming technologies (Pfeiffer, Gabriel, & Gandorfer, 2020). Therefore, it is plausible that public perceptions of farmers impact public acceptance of food technologies.

To the best of our knowledge, existing studies investigated public acceptance without accounting for public perceptions of the sustainability of technologies. In this study, we aim to identify the changes and inter-relationships in people's perceptions of the social, economic and environmental sustainability of food technologies that reduce reliance on or eliminates entirely the use of chemicals. For this purpose, we examined public sustainability perceptions of herbicide-reduced and herbicide-free weed control measures. Spot spraying and precise spraying rely on artificial intelligence systems that detect weeds and localise spraying. In precise spraying, only weeds are sprayed, while in spot spraying, the zones of crops containing weeds are targeted. Herbicide-free technologies rely entirely on mechanical functions to remove weeds. For example, hoeing machines are tractors pulling a series of horizontal hoes that aerate the soil while simultaneously uprooting weeds in the inter-rows (Bowman, 2002). Moreover, we examine changes in acceptance and naturalness perceptions and investigate how individual factors (sustainability perceptions, trust in farmers, chemophobia) influence the acceptability of these measures. Overall, the study contributes to the understanding of public demand for sustainable food production by examining people's perceptions regarding all three pillars of sustainability. This informs risk communication efforts to effectively respond to public concerns about chemical-based weeding measures and ultimately secure public support for farmers' adoption of these measures.

2. Methods

2.1. Participants

We conducted an online survey in Switzerland in February 2023 via a consumer panel provided by a market research company. We applied quota sampling to gender (50% men), age (33% each for the groups 18–35, 36–54 and 55–75 years) and language regions (50% from the German-speaking and 50% from the French-speaking parts of Switzerland) to ensure a balanced distribution. To limit participation bias, respondents were not informed about the topic of the survey in the invitation to participate. There were 542 respondents. We excluded 57 due to their short participation duration in the survey (half the median = 5 min); their responses may have biased the results. The final sample comprised 485 respondents (51.1% women; mean [*M*] age = 46 years, standard deviation [*SD*] = 15 years, range = 20–75 years). The respondents' educations ranged from basic (4.7%) to intermediate (44.3%) to advanced (50.9%). Finally, 43.3% resided in rural areas, 22.3% in suburban areas and 34.4% in urban areas.

2.2. Survey design

The online survey had two parts. The second was focused on public perceptions of other farming technologies and are presented in another publication (Ammann, Mack, El Benni, & Saleh., under review). To limit any carryover effects from the first part on respondents' answers for the second part, we relied on a within-subject design for the first part.

At the beginning of the first part, after the respondents gave their informed consent, they indicated their genders, ages, education levels and residences. They also indicated their political orientations on a scale ranging from 0 (very left) to 100 (very right). Then, they read the description of the weed control problem, its negative consequences on crops and the need for management. They subsequently read descriptions of the four weed control measures which were presented randomly. This design allows determining reliably the impact of the measures on the respondent's responses. All descriptions were developed by experts and tested by a non-expert audience for clarity. To ensure the measures were evident to the respondents, images were provided (Appendix A contains all descriptions and images). The images focus on the technologies showing the tractors and sprayers and do not depict a specific crop to eliminate crops influence on respondents' answers.

To ensure precise measurements and differentiation between respondents' responses on their perceptions of each of the measures, we relied on 0-100 scales. More specifically, the respondents indicated their acceptance of food produced using each measure by specifying their willingness to consume food produced using these measures on a scale from 0 (not willing at all) to 100 (completely willing). They also indicated how sustainable they perceived the measures to be on social, environmental and economic dimensions using a scale from 0 (not sustainable at all) to 100 (completely sustainable). For this measurement, the respondents were provided with short definitions of the sustainability dimensions to ensure a common understanding (see Appendix A for definitions).

Respondents' perceptions of the naturalness of food grown with these measures were assessed using a scale from 0 (not natural at all) to 100 (completely natural).

Subsequently, we measured chemophobia, the importance of food naturalness and perceptions of farmers using scales developed and used in previous research.

For chemophobia (Saleh et al., 2019), participants indicated how strongly they agreed with each of five items using a six-point Likert scale (1 = strongly disagree to 6 = strongly agree). The items related to concerns regarding chemical risks and the desire to avoid exposure to chemicals. For the importance of food naturalness (Steptoe., Pollard., & Wardle., 1995), participants indicated how important it was to eat food with no additives or artificial ingredients and containing only natural ingredients on a scale ranging from 1 (not important at all) to 4 (very important). For perceptions of farmers (Ammann et al., under review), participants indicated how strongly they agreed with each of five items on a seven-point Likert scale (1 = strongly disagree to 7 = strongly agree). Four items were taken from Pfeiffer et al. (2020) scales on public attitudes towards farming and trust in farmers and were related to the positive role of farmers in caring for animal welfare and the environment (items in Table 1). One item on farmers' value to society was added by the authors. With that, four of the five items have been tested before and were found useful.

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For each of these constructs, we conducted principal component analysis and reliability analysis on the items before taking the means of the items together to build the final scales. All three scales exhibited excellent Cronbach's alphas ($\alpha > 0.80$) indicating that all three scales can be built reliably (Table 1 shows item-total correlations and Cronbach's alphas).

INSERT TABLE 1

3. Results

3.1. Social, economic and environmental sustainability perceptions

We conducted analyses of variance with two repeated measure factors (the three sustainability dimensions and the four weed control measures) and Bonferroni's post-hoc tests to compare the effect of the measures and sustainability dimensions on public perceptions. The interactions between the sustainability dimensions and the weed control measures significantly affected public perception (F [4.97, 2406.14] = 57.94, $p < .001$, η_p^2 = .11). Therefore, we ran simple main effect analyses to compare public perceptions of the sustainability of the four weed control measures. The results revealed significant differences between the evaluations of the sustainability dimensions for each of the weed control measures. For full-surface spraying (F [2, 968] = 99.20, $p < .001$, η_p^2 = 0.17), spot spraying (F [2, 968] = 39.82, $p < .001$, η_p^2 = 0.08) and precise spraying (F [2, 968] = 20.89, $p < .001$, η_p^2 = 0.04), economic sustainability was rated significantly the highest, followed by social and environmental sustainability (Table 2 shows the means). For the hoeing machine (F [2, 968] = 37.86, $p < .001$, η_p^2 = 0.07), environmental sustainability was rated significantly the highest, followed by social and economic sustainability (Figure 1). The hoeing machine was also rated significantly as the most sustainable in terms of the environmental (F [3, 1452] = 379.21, p < .001, $\eta_p^2 = 0.44$), social (F [3, 1452] = 250.65, p < .001, $\eta_p^2 = 0.34$) and economic (F [3, 1452] = 103.14, p < .001, $\eta_p^2 = 0.18$) dimensions compared to the other three measures.

INSERT FIGURE 1 and Table 2

Pearson correlations examining the correlations among the sustainability perceptions revealed significantly high positive correlations (r > 0.6, p < .001) among the perceptions of the sustainability dimensions for each measure (Appendix B). Therefore, the sustainability perceptions scale was built by taking together the means of the three sustainability perceptions for each measure. The Cronbach's alpha value for this scale for each of the measures was excellent ($\alpha > 0.80$).

3.2. Acceptance and naturalness perceptions

Based on a one-way analysis of variance, acceptance (F [3, 1452] = 395.06, p < .001, $\eta_p^2 = 0.45$) and naturalness perceptions (F [3, 1452] = 485.16, p < .001, $\eta_p^2 = 0.50$) of food produced using the four weed control measures significantly depended on the measures used. Post-hoc tests revealed that all the differences between the acceptance levels and naturalness perceptions were statistically significant. The highest acceptance and naturalness perceptions were respectively reported for food produced using hoeing machines, followed by precise spraying, spot spraying and full-surface spraying (Table 2 shows the means).

3.3. Regression analysis

Pearson correlations between the dependent variable of acceptance of food produced using the respective measure and sustainability perceptions, naturalness perceptions, chemophobia, importance of food naturalness and perceptions of farmers are in Appendix B. Most of the variables were found to be significantly correlated. It is important to note that chemophobia had a positive significant correlation with the importance of food naturalness for all four measures. Similarly, sustainability and naturalness perceptions demonstrated strong and significant positive correlations. For the purposes of this study focusing on chemical-based measures and sustainability evaluations, and to avoid multicollinearity in the independent variables, chemophobia and sustainability perceptions were selected for use as predictors in the regression analyses.

Table 3 presents the results of multiple linear regression analyses conducted on participants' acceptance of food produced using various weed control measures. The standardised regression coefficients, p-values and confidence intervals are shown in Table 3. The four models were found to be statistically significant for full-surface spraying (F [9,475] = 87.09, p < .001), spot spraying (F [9,475] = 110.45, p < .001), precise spraying (F [9,475] = 120.89, p < .001) and hoeing machines (F [9,475] = 59.32, p < .001). The models explain 52% (hoeing machine), 62% (full-surface spraying), 67% (spot spraying) and 69% (precise spraying) of the variances in acceptance of food produced using the measures. Sustainability perceptions were the most important predictors and exhibited a significant positive relationship with the dependent variable of the four measures. The perceptions of farmers displayed a (marginally) significant positive relationship with the dependent variable of full-surface spraying, spot spraying and precise spraying. No significant relationship was found between the perceptions of farmers and the dependent variable of hoeing machines. Similarly, chemophobia displayed a significant negative relationship with acceptance of food produced using each of the measures, except for hoeing machines. The sociodemographic variables exhibited mixed relationships with the dependent variables, albeit less important ones than the variables discussed above.

INSERT TABLE 3

4. Discussion

We aimed to compare changes in public perceptions of the social, economic and environmental sustainability and acceptance of food produced with chemical-free and chemical-reduced weed control measures. Changes in the social, economic and environmental sustainability dimensions for the investigated measures indicate that people might perceive and value the dimensions differently based on the measure type (chemical, digital, mechanical).

For all three chemical-based measures, social and environmental sustainability were perceived to be lower than economic sustainability (which was close to neutral), suggesting that respondents' environmental and social concerns were more relevant to them when evaluating the sustainability of the chemical-based measures (Pfeiffer et al., 2020; Spykman, Emberger-Klein, Gabriel, & Gandorfer, 2022). For hoeing machines, evaluations of sustainability were the highest across all dimensions. This could be due to a halo effect which is the tendency for positive perceptions in one area to be carried over to others (Kahneman, 2011). The use of hoeing machines as a chemical-free measure can lead people to perceive it as positive and sustainable on all dimensions, which is unwarranted. Respondents' perceptions of the sustainability dimensions were positively related, even though for the weed control measures, the sustainability dimensions entail trade-offs (Heitkämper, Reissig, Bravin, Glück, & Mann, 2023). Respondents might not have considered the risks of these measures, such as hoeing machines entailing disrupting soil structure and a higher fuel consumption than chemical-based measures. Thus, it is worthwhile examining if and how public sustainability perceptions and acceptance of chemical-free and chemical-based measures change when people are informed about their risks and impact on the environment, economy and farmers' social lives. This examination could depict the risks they are willing to tolerate for which measure. Ultimately, it can guide the development of risk communication materials that fosters a greater public understanding of the complexity and challenges of weed control.

Furthermore, the study corroborates the notion that chemical processes or changes reduce perceived naturalness and acceptance more than physical transformations (Siegrist & Hartmann, 2020; Spykman et al., 2022), since the use of hoeing machines was overall perceived positively. Acceptance and naturalness perceptions increase with not only the reduction in herbicide amounts, but also whether the herbicides are sprayed on crops. Precise spraying entails spraying on weeds only, keeping the crops intact. This information plausibly led respondents to perceive the crops' natural attributes as preserved compared to crops subjected to other chemical-based measures, making the former more acceptable. However, people with high levels of chemophobia may still oppose the use of precision spraying, believing chemicals should not be used in food production (Entine, 2011). Notably, previous research has shown that providing information on safe quantities of chemicals used in food production can reduce chemophobia and preference for naturalness (Saleh, Bearth, & Siegrist, 2020). Therefore, the type of weed control measure (mechanical vs chemical), the quantities of chemicals applied at the plot scale (full-surface vs reduced) and the precision technology used (spot vs precise spraying) are all relevant for public acceptance. However, it is important to note that it remains unclear how to communicate this information to consumers. In a standard shopping environment, consumers rely on labels (e.g., organic, GMO free) to make their purchasing decisions especially when they are not well-informed about agricultural practices. Currently there are no labels or indications (e.g., price premium) which explicitly inform consumers of the weed technology and quantity of pesticides used in growing crops. Given the increasing political and societal pressure on the use of plant protection products, it is worthwhile examining if and how such information can be communicated (e.g., through a certification program for farmers that could provide indication of adherence to sustainable weed control standard), test consumers' reactions to it and subsequently its impact on their decisions. In addition, maintaining farmers' good public image might ensure public trust in farmers and acceptance of new measures.

5. Conclusion

In our study, precise herbicide spraying was the most promising measure in terms of public acceptance between the chemical-based measures as it keeps crops relatively intact. Hoeing machines were the most acceptable overall. They are perceived as not only more environmentally sustainable but also more socially and economically sustainable and acceptable than chemical-based measures. However, weed control relies on using a combination of measures for successful weed management. The respondents evaluated the measures individually. Therefore, examining public acceptance of integrated or agroecological weed management and comparing the findings to organic and conventional production systems might help elucidate and address their position.

Another important limitation of the study is that social sustainability was defined in terms of farmers' health and working conditions. It did not incorporate other important social aspects, such as farmer-consumer interactions (Röös, Fischer, Tidaker, & Nordström Källström, 2019). This aspect could be perceived differently, affecting people's social sustainability perceptions and acceptance. Future studies should include other relevant social aspects in the participants' evaluations of the social sustainability of weed control measures to ensure a more concrete understanding of the influence of social sustainability perceptions on acceptance of the measures.

Competing Interests and Funding

The authors declare no conflicts of interest. This study did not receive any third-party funding.

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Table 1. Mean (*M*) and standard deviation (*SD*), item-total correlation (Item-total r), and Cronbach's alpha (α) for scales for chemophobia, importance of food naturalness and perceptions of farmers.

Chemophobia scale (α = .89)	***M* (*SD*)**	**Item-total r**
	4.14 (1.22)	
I think chemical substances are the cause of environmental problems.	4.28 (1.39)	0.74
The chemical industry is responsible for more people suffering from cancer.	4.17 (1.45)	0.73
I would like to live in a world where chemical substances do not exist.	4.15 (1.57)	0.74
I do everything I can to avoid in my daily life contact with chemical substances.	4.09 (1.40)	0.68
Chemical substances scare me.	4.02 (1.54)	0.75

Importance of naturalness of food scale (α = .82)	***M* (*SD*)**	**Item-total r**
	3.28 (0.65)	
It is important to me that the food I eat on a typical day:		
Contains natural ingredients.	3.56 (0.64)	0.55
Contains no artificial ingredients.	3.16 (0.83)	0.77

Contains no additives.	3.11 (0.81)	0.73

Perceptions of farmers (*α* = .84)	***M* (*SD*)**	**Item-total r**
	5.78 (0.94)	
The work of farmers is important and valuable to society.	6.42 (0.98)	0.58
Family farms are important and must be preserved.	6.37 (1.02)	0.58
I am generally positive about farmers.	5.89 (1.22)	0.76
Farmers are committed to animal welfare.	5.24 (1.38)	0.68
Farmers are very environmentally conscious.	4.98 (1.39)	0.62

N = 485; chemophobia scale: 1 = completely disagree, 6 = completely agree; importance of food naturalness: 1 =not important at all, 4 = completely important; farmers' perceptions: 1 = completely disagree, 7 = completely agree

The item-total correlations (>0.3) for the items of every scale indicate that the items are consistent within each other in measuring the constructs of interest, therefore, the scales can be built. Cronbach's alphas (>0.80) indicate that the scales are reliable.

Table 2. Mean (*M*), standard deviation (*SD*) of acceptance, naturalness and sustainability perceptions of the four measures.

	Weed control measures			
	Full-surface spraying	**Spot spraying**	**Precise spraying**	**Hoeing machine**
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Acceptance of food produced using the respective measure	43.31 (29.56)	50.93 (27.69)	58.01 (29.29)	83.99 (18.92)
Naturalness perceptions	34.69 (28.13)	44.06 (26.52)	50.81 (28.67)	81.95 (20.13)
Environmental sustainability	36.82 (28.85)	46.88 (26.79)	52.95 (29.04)	79.92 (19.27)
Social sustainability	42.31 (27.66)	50.94 (25.93)	56.07 (27.61)	76.34 (20.72)
Economic sustainability	51.49 (28.70)	54.85 (24.74)	58.77 (26.48)	72.92 (20.50)

***p < .001

N = 485; acceptance of food produced using the weed control measures measured with willingness to eat the respective food: 0 = not willing at all, 100 = completely willing; naturalness perception scale: 0 = not natural at all, 100 = completely natural; sustainability scales: 0 = not sustainable at all, 100 = completely sustainable

Fig. 1. The mean values of the environmental, social and economic sustainability perceptions with 95% confidence intervals for the four measures.

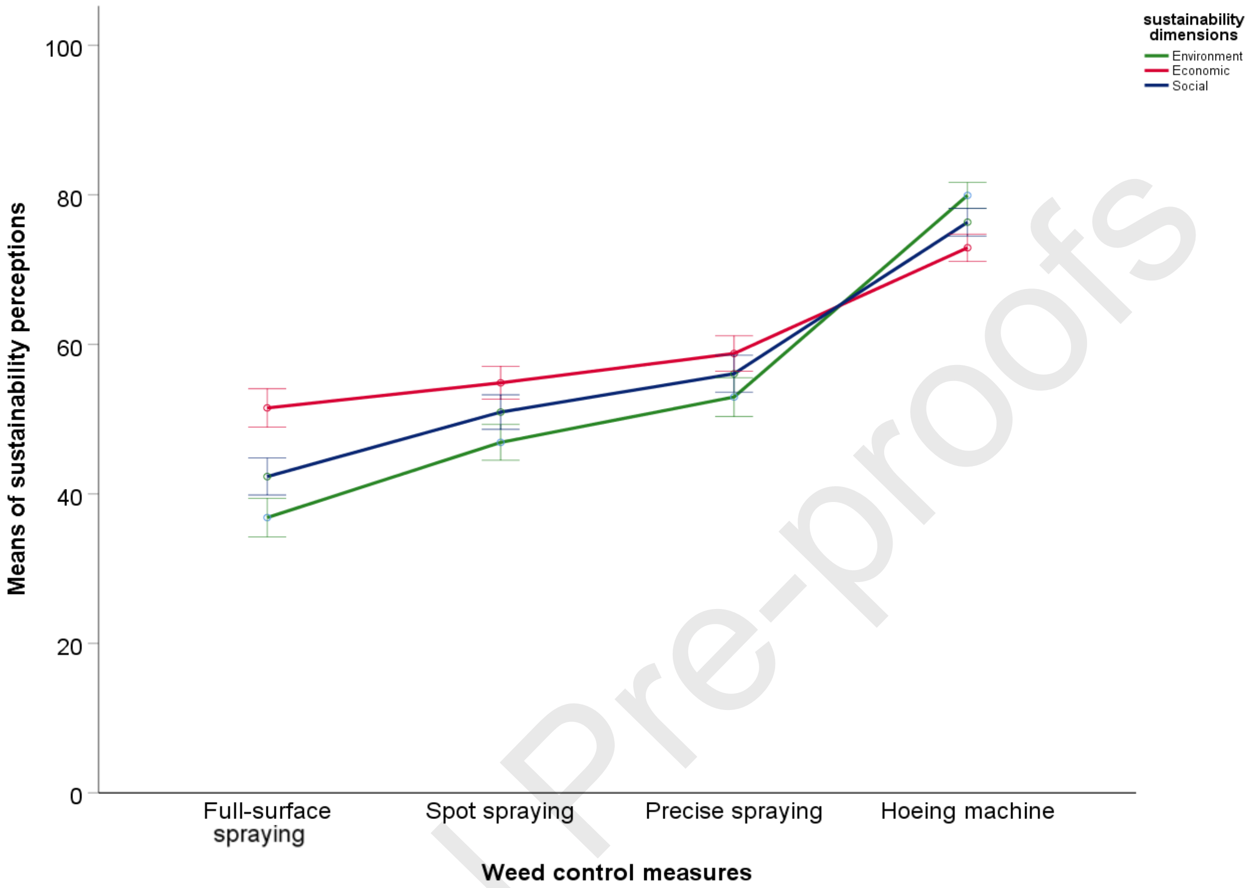


Table 3. Regression analysis on the acceptance of food produced using the four different measures.

	Measures											
	Full-surface spraying			**Spot spraying**			**Precise spraying**			**Hoeing machine**		
Predictors	*β*	*p*	95% CI	*β*	*p*	95% CI	*B*	*p*	95% CI	*β*	*p*	95% CI
Constant	-1.46	.85	[-16.30, 13.39]	-1.03	.87	[-13.88, 11.82]	*6.03*	.37	[-7.13, 19.19]	15.29	.01	[4.24, 26.33]
Age	-0.03	.31	[-0.17, 0.05]	**-0.05***	**.05**	**[-0.19, 0.00]**	**-0.05***	**.04**	**[-0.21, -0.01]**	-0.00	.93	[-0.08, 0.08]
Gender	**0.08****	**.01**	**[1.10, 7.95]**	**0.09****	**.00**	**[1.93, 7.88]**	0.03	.20	[-1.06, 5.03]	0.05	.16	[-0.71, 4.19]
Language	0.01	.82	[-3.01, 3.81]	0.05*	.06	[-0.08, 5.86]	**0.06***	**.02**	**[0.71, 6.77]**	0.03	.41	[-1.40, 3.47]
Education	0.02	.53	[-0.70, 1.37]	-0.03	.36	[-1.32, 0.48]	-0.00	.96	[-0.95, 0.90]	**0.11****	**.00**	**[0.50, 1.99]**
Location	-0.01	.78	[-1.57, 1.18]	0.02	.49	[-0.78, 1.61]	0.02	.43	[-0.73, 1.72]	**-0.07***	**.05**	**[-1.96, -0.00]**
Political orientation	**0.07***	**.03**	**[0.01, 0.17]**	**0.07****	**.02**	**[0.02, 0.16]**	0.02	.44	[-0.04, 0.10]	-0.03	.41	[-0.08, 0.03]

Sustainability perceptions	**0.69*** **	**.00**	**[0.74, 0.88]**	**0.73*** **	**.00**	**[0.80, 0.93]**	**0.76*** **	**.00**	**[0.82, 0.95]**	**0.71*** **	**.00**	**[0.70, 0.84]**
Chemophobia	**-0.15*** **	**.00**	**[-5.07, -2.21]**	**-0.13*** **	**.00**	**[-4.19, -1.68]**	**-0.13*** **	**.00**	**[-4.49, -1.93]**	-0.03	.44	[-1.40, 0.61]
Perceptions of farmers	**0.08** **	**.01**	**[0.59, 4.34]**	0.05*	.06	[-0.06, 3.20]	0.05*	.06	[-0.07, 3.30]	0.05	.11	[-0.24, 2.41]

N = 485; gender: 0 = man, 1 = woman; education: 1 = basic, 7 = advanced; language: 0 = German, 1 = French; location: 1 = rural, 5 = urban; political orientation: 0 = very left, 100 = very right); acceptance of food produced using the weed control measures measured with willingness to eat the respective food: 0 = not willing at all, 100 = completely willing; sustainability scale: 0 = not sustainable at all, 100 = completely sustainable; chemophobia scale: 1 = completely disagree, 6 = completely agree; perceptions of farmers scale: 1 = completely disagree, 7 = completely agree; *p < .05, **p < .01, ***p < .00

Appendix A.

The first description respondents read related to the weeds problem:

Weeds are undesirable plants that grow next to crop plants in the same plot. They limit the growth of crop plants by competing with them for nutrients, water and light. To limit the growth of weeds, farmers use many preventive and curative measures. Among these measures, there are four that are used in Switzerland, and we would like to know what you think about each one.

The descriptions and images of the weed control measures respondents saw.

Full-surface spraying

The application of herbicides with the traditional sprayer is a chemical weed control measure. Herbicides are applied to the entire field surface, without distinguishing between weeds and crops. Herbicides only act on weeds.

Spot spraying

The targeted application of herbicide by section cutting on the sprayer is a digitally controlled weed control measure. Cameras in the tractor detect weeds, and the information is transmitted to the sprayer using artificial intelligence. In areas where weeds are identified, only one section of nozzles delivers a precise amount of herbicides. The crop plants also receive the herbicides, but the latter does not have an effect on them.

Precise spraying

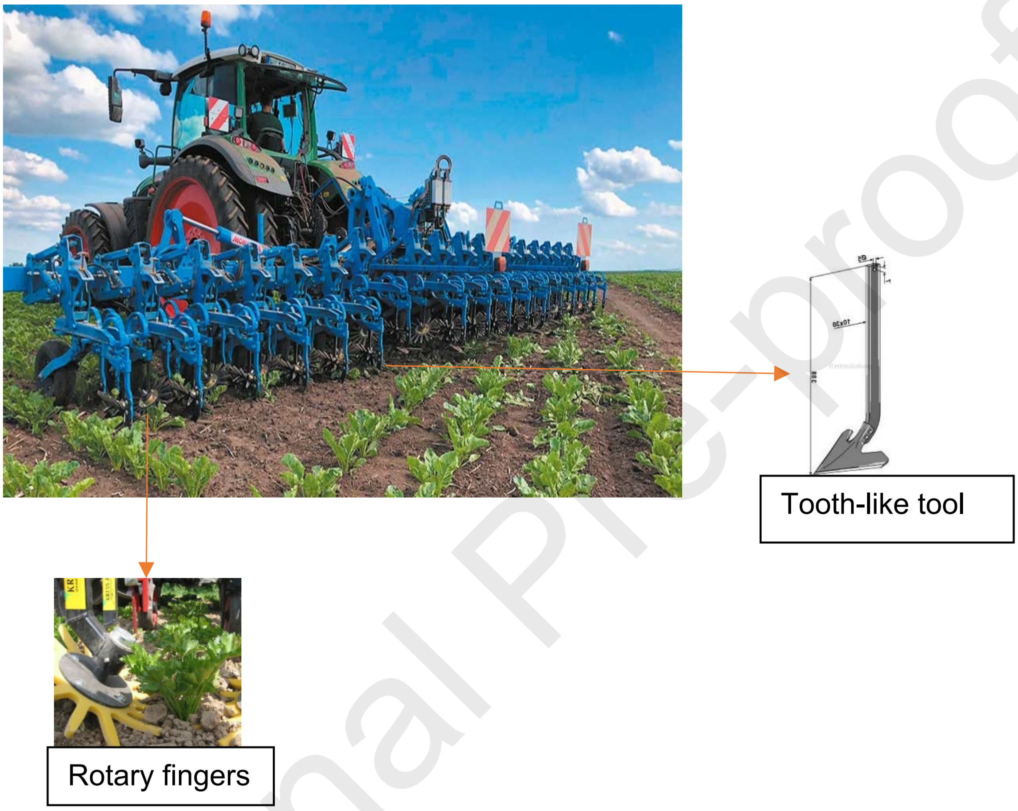
The application of herbicides with a precision sprayer is a digitally controlled measure of weed control. The machines used for application distinguish between crop plants and

unwanted weeds using cameras and artificial intelligence directly in the sprayer. A precise amount of herbicides is accurately sprayed by individually controlled nozzles only on the identified weeds. Crop plants do not receive the herbicides.

Hoeing machine

The hoeing machine is a mechanical weeding measure. The hoeing machine's crowfoot shares pull weeds between the crop rows by penetrating the soil at the roots. At the same time, the softer rotating fingers prune the weeds in the row without damaging the crops.

The



definitions of the sustainability dimensions used:

Economic sustainability in agriculture refers to managing a farm in a way that ensures long-term profitability.

Environmental sustainability in agriculture refers to the good stewardship of natural resources to avoid or reduce negative impacts on the environment.

Social sustainability in agriculture refers to good farm work conditions in terms of health and acceptable labour in a way that ensures the farmers' long-term work and livelihood satisfaction.

Appendix B. Pearson's correlations

Table B1. Pearson's correlations between the perceptions of the three sustainability dimensions for each of the weed control measures.

	Weed control measure							
	Full-surface spraying		**Spot spraying**		**Precise spraying**		**Hoeing machine**	
Perceptions of the sustainability dimensions	1	2	1	2	1	2	1	2
1. Environmental sustainability	-		-		-		-	
2. Social sustainability	.76***	-	.78***	-	.81***	-	.64***	-
3. Economic sustainability	.56***	.68***	.64***	.71***	.67***	.76***	.54***	.66***

***$p < .001$

$N = 485$; sustainability scales: 0 = not sustainable at all, 100 = completely sustainable

Table B2. Pearson correlations between the dependent variable (acceptance of food produced using the respective measure) and the following independent variables: sustainability perceptions, naturalness perceptions, farmers' perceptions, chemophobia, and importance of the naturalness of food.

	Weed control measures																			
	Full-surface spraying					Spot spraying					Precise spraying					Hoeing machine				
Predictors	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1. Acceptance of food produced using the respective measure	-					-					-					-				
2. Sustainability perceptions	.76**	-				.80**	-				.82**	-				.71**	-			
3. Naturalness perceptions	.75**	.78**	-			.75**	.80**	-			.81**	.83**	-			.71**	.68**	-		
4. Perceptions of farmers	.23**	.22**	.16**	-		.24**	.24**	.23**	-		.26**	.26**	.22**	-		.16**	.17**	.17**	-	

5. Chemophobia	-.31**	-.21**	-.25**	.03	-	-.31**	-.23**	-.17**	.03	-	-.31**	-.23**	-.23**	.03	-	.01	.07	.04	.03	-
6. Importance of food naturalness	-.30**	-.21**	-.26**	.05	.62**	-.31**	-.24**	-.17**	.05	.62**	-.25**	-.16**	-.18**	.05	.62**	.07	.10*	.03	.05	.62**

**$p < .01$, *$p < .05$

N = 485; acceptance of food produced using the weed control measures measured with willingness to eat the respective food: 0 = not willing at all, 100 = completely willing; sustainability scales: 0 = not sustainable at all, 100 = completely sustainable; naturalness perception scale: 0 = not natural at all, 100 = completely natural; perceptions of farmers scale: 1 = completely disagree, 7 = completely agree; chemophobia scale: 1 = completely disagree, 6 = completely agree; importance of food naturalness: 1 = not important at all, 4 = completely important

Declaration of Interest Statement

The authors declare that they have no conflicts of interest. This study did not receive any third-party funding.

Author Statement

Rita Saleh: Conceptualization, Methodology, Software, Data Curation, Formal analysis, Visualization, Writing-Original draft**. Nadja El Benni:** Conceptualization, Methodology, Validation, Writing- Reviewing and Editing. **Sandie Masson:** Conceptualization**,** Writing- Reviewing and Editing. **Jeanine Ammann:** Conceptualization, Methodology, Writing- Reviewing and Editing

Highlights

- The way weeds are controlled influence peoples' sustainability evaluations of food.
- Precise spraying is perceived as more sustainable than spot spraying.
- The quantity of herbicide and the way of spraying impact public acceptance.
- Food produced with mechanical weed control measures is highly accepted.