

## Article

# Sustainability Science Communication: Case Study of a True Cost Campaign in Germany

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**Abstract:** The Anthropocene, marked by human-induced climate change, necessitates urgent action to address climate goals and respect planetary boundaries. While sustainability research provides knowledge, the first challenge lies in communicating the findings in an adequate manner to the public and several stakeholders, such as economic and political actors. Therefore, this study explores the significance of science communication in sustainability science, focusing on a case study—the True Cost Accounting (TCA) campaign by the University of Greifswald, Technical Institute of Nuremberg, and German retailer PENNY. TCA herein serves as a transparency tool, economic incentive, and discussion basis for sustainable consumption. This study investigates consumer perceptions of ecological prices of foods through a face-to-face survey during the 2023 PENNY campaign, comparing results to an informational campaign carried out in 2021. Findings indicate a high awareness of the true cost campaign in 2023, with 50.8% of participants hearing about it. Consumers' willingness to pay true costs and potential behavior changes were explored. In comparison to results from the informational campaign of 2021, customers showed a decrease in this WTP when the true prices would actually impact their spending, indicating an attitude–behavior gap. In addition, a willingness to reduce the consumption of animal foods—if TCA was implemented—of 60.5% was determined, which suggests that TCA has the potential for sustainable behavior change. This study highlights factors that influence consumer attitudes and preferences regarding the inclusion of TCAs, such as environmental, social, and animal welfare costs. Customers' understanding of increased prices—like, in this case, the compensation for environmental and social costs—is an argument in favor of true prices. The results emphasize the need for differentiated scientific communication strategies to bridge knowledge and action gaps in sustainability science.

**Keywords:** true cost accounting; survey; awareness; food; dietary behavior; science communication



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## 1. Introduction

The era of the Anthropocene, marked by human-induced climate change [1–3], noticeable and visible to humans [4–6], demands urgent action at both national and international levels to address climate goals [7–10] and the imminent breach of planetary boundaries [11]. However, the challenge lies not in a lack of knowledge within the realm of sustainability research but in the implementation of its findings through political and economic frameworks and in linking knowledge with action [12].

Therefore, the relevant literature on science communication must be considered in this context: Science communication plays a pivotal role in bridging the gap between scientific insights and actionable steps [13–16]. Science communication promotes public awareness, understanding, competence and culture by increasing interest, trust, and engagement in science. It equips the public, communicators and scientists with skills, media, activities, and

dialogues to interact more effectively, making it a significant and ongoing area of business and research [17,18].

Consequently, communicating scientific findings to society, political actors, and multiple stakeholders outside the science realm is an important challenge [19–22]. Especially in the domain of sustainability science, effective science communication is more crucial than ever [2,23]. According to Bucchi and Trench, science communication should be rethought as a “social conversation about science” [24].

In addition, science communication needs to be contextualized in the literature on current developments (e.g., the role of the media in the dissemination of scientific knowledge and the use of social media) and crises. During the COVID-19 pandemic, there were commendable instances of how complex scientific issues could be effectively communicated to society through media channels and by scientists themselves [25,26], even though there were also negative examples. At the same time, however, expectations of science as a problem solver have increased [26].

As Fischhoff and Scheufele [27] highlighted, realizing the potential of science requires effective two-way communication with the public, ensuring that information is relevant, credible, and comprehensible. This importance of science communication is particularly pronounced in the interdisciplinary field of sustainability science [28], where interactions between diverse stakeholder groups necessitate clear communication strategies [29].

However, even beyond global crises, the media is foremost responsible for communicating scientific findings to society in a neutral and technically correct form [30,31]. Reporting on the climate crisis and sustainability topics has increased [32] despite not being constant and being very dependent on certain (weather) events [33]. Regrettably, reporting on issues like the climate crisis often lacks concrete action options and proposals despite their existence in scientific research [34,35].

Generally, media reporting on climate protection has become more intensive and differentiated in recent years [36]. A long-term analysis of the Austrian media landscape showed that there has been a great increase in reporting since 2016 [32]. According to Hase et al. [37], global differences can be identified in the manner of reporting. Although there is more reporting on climate change in the Global North, there is more reporting on the challenges and impacts at a social level in the Global South. However, a study by IFAK [38] showed that reporting does not necessarily go hand in hand with trust in it. Only 46% of respondents “completely/rather” trust the reporting on climate change (38% “partly” and 18% “rather not/not at all”). Social media is playing an increasingly important role in science communication: On the one hand, social media can be a great opportunity for science communication, making science accessible to a large audience through short and comprehensible articles [39]. Dernbach et al. [15] even saw this as “democratizing science” or “science communication 2.0” and highlighted that cooperative use of social media can transform scientific work through public debates. On the other hand, the positive effects are also countered oftentimes in relation to “fake news” [40–42] or hatred toward the communicators of facts—in this case, the scientists or science journalists [43].

This paper addresses the significance of science communication in sustainability science, emphasizing the role of True Cost Accounting (TCA) as a case study: a project by the University of Greifswald and Technical Institute of Nuremberg in cooperation with the German food retailer PENNY executed a campaign week on the “true cost” of food in 2150 PENNY markets in Germany. This campaign focused on the communication of scientific knowledge in the agri-food sector. Food price calculations along TCA principles that consider the environmental and social impacts of the foods’ production process and value chain can ensure transparency and are, therefore, in the interest of various stakeholders [44]. Not only (1) agriculture and the food retail trade but also (2) the general public and (3) political decision-makers need to be the target of science communication. TCA, exemplified by the PENNY campaign, could accordingly serve as (1) a transparency tool in agri-food systems, (2) an economic incentive toward more sustainable consumption patterns, and (3) a discussion basis for political and economic framework conditions in the

current system. Additionally, it is important to recognize greenwashing as a possible negative effect of communicating TCA [44,45]. The diverse existing TCA approaches [46–49], as well as its recognition as a method and communication tool by the Food and Agriculture Organization (FAO) [50], underscore its relevance in the pursuit of sustainability goals [51].

There have been two campaigns in Germany in which the scientifically calculated “true costs” of food were communicated in supermarkets. In (1) 2020, an informational campaign with second price tags on true costs was carried out in one PENNY store in Berlin. In (2) 2023—also by PENNY and based on scientific calculations [49]—a Germany-wide campaign week was carried out in all 2150 PENNY stores in Germany, in which the “true costs” for selected foods were called up at the checkout. Accompanying research was conducted for both campaigns. For the informational campaign (1), Michalke et al. [44] found great public interest and how a change in consumption toward more sustainable products in conjunction with the price incentives through TCA would be conceivable for many consumers. As part of the Germany-wide campaign in 2023 (2), a face-to-face survey was also conducted as accompanying research (cf. methods). This survey, its data, and its results are presented here. Additionally, this study compares the results of the accompanying research of the two campaigns.

Apart from the above-mentioned study by Michalke et al. [44], there are as yet no publications worth mentioning in the current literature that have carried out detailed investigations into the acceptance of true food costs. Beyond the studies with PENNY, however, it is worth taking a detailed look at a recent study by Taufik et al. [52], who conducted two surveys on true costs in the Netherlands. Their results are, therefore, taken into account in this paper and can serve as a valuable reference, especially in the discussion section. Purchase transactions prompted customers to participate in a survey assessing their perceptions of green value, social status, and beliefs in remedial actions. The results revealed positive correlations between these factors and an intention to buy products with true prices. Their findings suggest that communicating the environmental and social values associated with true pricing positively influences consumer intentions to purchase such products. One important remark needs to be mentioned here, however: the true costs in the survey by Taufik et al. [52] could only be paid for fruit and vegetables, and these markups are always significantly lower than for dairy and meat products [45,49].

The findings of Taufik et al. [52] align with the broader literature on sustainable consumer behavior. Notably, Zander and Feucht (2018) [53], who, in contrast to Taufik et al. [53], referred primarily to fish and meat, emphasized that consumers exhibit a higher willingness to pay for organic production compared with other sustainable attributes, such as animal welfare and local sourcing. Additionally, Luomala et al. [54] shed light on the prosocial signaling embedded in everyday consumer behaviors, illustrating how purchasing organic foods serves as a marker of social responsibility. Overall, a research gap that includes both the investigation of a pioneering study with actual retrieval of the true costs in Germany and the corresponding survey of customers on site, as well as the integration of this campaign in the context of science communication, can be identified.

This leads to the following research questions: (1) What is the customer’s perception of the true cost campaign and true costs in general? (2) How has the perception of true cost from informational campaigning to real prices changed? (3) What influenced these developments? Furthermore, (4) what can be learned from this case study for (sustainability) science communication in general?

Subsequently, we will delve into this paper’s methodology, results, and implications, offering a holistic understanding of the intricate interplay between consumer perceptions, trust, and the true price paradigm. Furthermore, we analyze this topic in the context of science communication.

## 2. Materials and Methods

This chapter briefly explains the (1) scientific background to the TCA calculations and describes the framework of the Germany-wide true cost campaign conducted in 2023, as well as the (2) methodological approach of the face-to-face survey and its sample.

### 2.1. True Price Campaign 2023

In August 2023, the discounter PENNY executed the true cost campaign, revealing the externalities of food (i.e., a surcharge of additional external environmental costs due to the foods' production), and also charged customers this true price for nine selected products (cf. Table 1). Scientists from the University of Greifswald and the Technical Institute of Nuremberg provided the price calculations (based on Michalke's methodology) [50] for the true price markups in order to present findings and, more generally, the topic of TCA to broad society and to facilitate discourse on the current conditions of the agri-food system. For the calculation of true costs, data from life cycle assessment (LCA) are combined with impact monetization. This approach is called True Cost Accounting (TCA). The TCA approach by Michalke et al. [45,49] was used and extended according to PENNY's use case, where the systems' boundaries are expanded to include the processing stages of food products, in addition to the foods' agricultural stages. The calculation was conducted on a product-specific basis with TCA, which primarily involves two steps.

#### 2.1.1. Quantification of Environmental Impacts

In the first step, the quantities of emitted pollutants and emissions, as well as resource consumption, are assessed, and their effects are categorized into impact categories. Life cycle assessments (LCAs) are conducted for the food products. This involves examining all stages leading up to the product's processing, such as the production on the farm and the processing of milk to cheese, for example. The life cycle assessment methodology aids in categorizing diverse emissions, pollutants, and resources into 18 impact categories. These are, for the purpose of easier communication, grouped into four areas:

- Health (ozone depletion, formation of photochemical oxidants, ionizing radiation, human toxicity, particulate matter formation): Health damage is measured not by the consumption of unhealthy foods but by the emission of health-hazardous substances during production;
- Water (marine ecotoxicity, freshwater eutrophication, freshwater ecotoxicity, marine eutrophication);
- Soil (urban soil use, agricultural soil use, terrestrial ecotoxicity, terrestrial acidification);
- Climate (climate change: carbon dioxide, nitrous oxide, and methane are converted into CO<sub>2</sub>e).

Distinctions are made between organic and conventional foods in this quantitative measurement. For example, organic farming prohibits the use of synthetic fertilizers or pesticides, positively impacting the ecological consequences that arise during production.

#### 2.1.2. Monetary Evaluation of Quantified Impacts

In the second step, these quantified environmental impacts are monetarily assessed, translating them into monetary values. Damage costs within the four damage categories—water, soil, climate, and health—are evaluated using damage cost factors that describe the economic impacts. These factors are, for instance, collected by the Environmental Protection Agency.

The true costs of the nine campaign products calculated using the TCA methodology described here are shown in Table 1.

It is essential to note that this methodology while bringing us closer to the "true price" of food, does not comprehensively cover it. Both life cycle assessments (1) and cost calculations (2) are associated with uncertainties and assumptions. Not all hidden costs are known, which could lead to additional parameters influencing pricing. Therefore, TCA

serves as an approximation of true prices, intending to highlight areas where negative effects need to be avoided or compensated.

**Table 1.** True costs of campaign products. Method based on Michalke et al. (2023) [44].

Product Name	Meat/Dairy/ Plant-Based	Package [Size]	Regular Price [EUR]	True Costs [EUR]	Campaign Price [EUR]	Price Increase [%]
Fruit yoghurt (organic)	dairy	400	1.19	0.37	1.56	31
Cheese slices <sup>1</sup> (organic)	dairy	180 or 200 <sup>1</sup>	2.19	1.51	3.70	69
Mozzarella (organic)	dairy	200	1.29	0.63	1.92	49
Sausages <sup>2</sup> (organic)	meat	160 or 200 <sup>2</sup>	3.29	2.07	5.36	63
Fruit yoghurt (conventional)	dairy	450	1.19	0.45	1.64	38
Cheese slices (conventional)	dairy	300	2.49	2.35	4.84	95
Mozzarella (conventional)	dairy	200	0.89	0.66	1.55	74
Sausages (conventional)	meat	400	3.19	2.89	6.01	88
Vegan schnitzel (conventional)	plant-based	200	2.69	0.14	2.83	5

<sup>1</sup> The cheese slices were sold in mixed cartons with three different meat types. Two products had 200 g (Emmental and mountain cheese), and the other cheese slices had 200 g (Gouda and Maasdammer) packaging. The true cost was, therefore, the average of the previously calculated true costs of the different cheeses, as this could not be calculated differently at checkout. <sup>2</sup> The sausages (organic) were sold in mixed cartons with four different cheese types. Two products had 180 g (Wiener sausages pork and Wiener sausages poultry), and one sausage type had 160 g (beef sausages) packaging. We, therefore, determined the true price for poultry, pork, and beef sausages and again calculated an average weighted according to the proportions in the carton. It should be noted that beef, in particular, increases the average price.

## 2.2. Consumer Survey

The true price campaign described above, which was rolled out in all German PENNY stores with extensive point-of-sale and media campaigns, was also examined in terms of consumer perception. For this purpose, a standardized questionnaire [55], which was intended to examine, among other things, customers' perception of the campaign, the attitude toward true costs, the willingness to pay, and the possible effects of implementing true costs on individual food consumption behavior, was developed. A face-to-face survey [55] that primarily collected quantitative data but also included qualitative statements as supplements was chosen as the survey technique. In the scope of the campaign week, 120 persons were interviewed. The survey was conducted throughout the campaign week, from 31 July to 5 August 2023.

The survey was divided into different sections. It began with investigating the participants' typical grocery shopping locations, shedding light on the primary venues of their food procurement. Following this, the survey delved into participants' awareness of the campaign and their perception of its presence within the retail environment, gauging the effectiveness of the campaign in influencing consumer behavior. A crucial component of the survey focused on participants' willingness to pay the true costs for apples and cheese. This section aimed to assess the financial commitment individuals are willing to make to support sustainable and ethical agricultural practices. Additionally, the survey explored participants' opinions on the potential impacts of implementing TCA on their individual consumption patterns regarding organic and animal-based food. The question-

naire investigated which aspects of TCA are deemed essential by participants, including considerations such as animal welfare, social implications, and environmental factors. Furthermore, demographic aspects were included (cf. Table 2). Overall, the survey methodically examined various dimensions of consumers' perspectives, contributing valuable insights to the broader understanding of the implications of True Cost Accounting on food consumption practices.

**Table 2.** Structure of survey participants.

	Survey Participants (N = 120)	German Population (Average)
Average age [years]	51.83	43 [56]
Min	18	n/a
Max	90	n/a
Gender [%]		
Female	60.5	50.72 [57]
Male	39.5	49.3 [57]
Person/household [average]	1.91	2.03 [58]
Min	1	n/a
Max	6	n/a
Monthly budget grocery shopping [average EUR/month]	91.59	402.00 [59]
Min	15.00	n/a
Max	400.00	n/a

In this sample, 60.5% (N = 72) were female and 39.5% (N = 47) were male. The average age of the sample is 51.8 years (only persons over 18 were interviewed). This is higher than the German population average, which could, for example, have had an influence on the available income or the general preference for nutrition and, thus, also on the purchase of organic or meat products. The survey was conducted in Greifswald, a small university town in the Northern German state of Mecklenburg-Vorpommern. Thus, the sample cannot be considered representative of the entire German population—nevertheless, assumptions can be made with the corresponding limitations described here.

Furthermore, the findings of this survey were compared to those of a prior survey conducted by Michalke et al. [44]. Here, a survey was carried out surrounding a campaign where the true costs of selected products were presented as a second price tag in a single designated PENNY store in Berlin, as part of a comprehensive information campaign initiated in 2020.

### 3. Results

This section presents the results of the face-to-face survey about the true cost campaign of 2023. Additionally, we evaluated the willingness to pay (WTP) for the true costs of food and explored the potential effects on consumption behavior resulting from the implementation of true prices. Lastly, perceptions of the implementation of true prices and associated reasons for those perceptions were investigated. These findings were then compared with an earlier survey conducted by Michalke et al. [44] about the informational true cost campaign of 2021.

In order to contextualize the results further, the preferred supermarkets and dietary habits were surveyed. The majority of respondents predominantly patronize PENNY for their grocery shopping (61.7%; N = 74). Following closely is the supermarket chain REWE, selected by 36.7% of respondents (N = 44). Analysis of the dietary habits within the sample revealed that 79% (N = 94) follow an omnivorous diet, 13.5% (N = 16) adhere to a vegetarian diet, less than 1% are vegan (N = 1), and the remaining 6.7% (N = 8) have specified alternative diets such as “flexitarian” or dietary restrictions due to illness or allergies.

### 3.1. Previously Heard from Campaign

We explored whether participants were aware of the true cost campaign before their visit to the supermarket and whether they noticed campaign products (cf. Table 3) or point-of-sale advertising materials.

**Table 3.** Awareness of true cost campaign.

Answers	Survey 2021 (Informational Campaign in Berlin)		Survey 2023 (Nationwide Campaign)	
	Absolute	Relative	Absolute	Relative
yes	84	77.1	61	50.83
no	25	22.9	59	49.17
not sure	0	0.00	0	0.00
overall (N)	109	100.00	120	100

A notable 50.8% (N = 61) of participants had heard about the campaign before shopping for groceries in that PENNY store (cf. Table 3). Television played a prominent role, with 40.3% (N = 29) citing reports in the leading German TV news show *Tagesschau* as a key source of information. Additionally, social media (18.1%, N = 13) and radio reports (13.9%, N = 10) informed participants about the ongoing true cost campaign. A smaller percentage referenced print magazines (11.1%, N = 8), information from family/friends or work (9.7%, N = 7), or digital advertising at the point-of-sale in the form of flyers and brochures (6.9%, N = 5). These findings are in line with the first study findings: 64% of the 2255 participants of an online survey knew that a PENNY true price campaign had been launched regardless of whether they were shopping at PENNY during that week or not [60].

In comparison, 77% of respondents in Michalke et al. [44] had encountered the informational campaign of 2021 before entering the store prior to being surveyed (refer to Table 4). However, the information campaign in Berlin had been on display in the market for several months, and customers could have shopped in the store multiple times before being surveyed. Therefore, it is difficult to draw a direct comparison with the previously mentioned results.

**Table 4.** Awareness of second price tags in PENNY stores.

Answers	Survey 2021 (Informational Campaign in Berlin)		Survey 2023 (Nationwide Campaign)	
	Absolute	Relative	Absolute	Relative
yes	61	55.96	35	29.17
no	48	44.04	85	70.83
not sure	0	0.00	0	0.00
overall (N)	109	100.00	120	100

### 3.2. Willingness to Pay for True Costs

Given that price is one of the pivotal factors influencing purchasing decisions, particularly in the emotionally charged realm of food consumption, it becomes imperative to delve deeper into customers' willingness to pay (WTP) for externalities. In exploring responses related to the willingness to cover additional true costs for apples (EUR 0.09 for 500 g) and Gouda cheese, noticeable disparities arose between the 2021 informational campaign and the 2023 campaign. To elucidate, participants were presented with two questions: (1) "Are you willing to pay additional true costs for apples (EUR 0.09 for 500 g)?" and (2) "Are you willing to pay additional true costs for Gouda cheese (EUR 2.35 for 300 g)?"

Regarding the first question pertaining to apples, the 2021 findings revealed that 94.50% (N = 109) expressed a willingness to pay additional true costs, with only 5.50% opposing the idea. In 2023, with a larger sample of 120 participants, 88.33% indicated a willingness to pay, 10.83% expressed opposition, and 0.83% were uncertain. The 2023 data indicate a marginal decline in the willingness to pay additional true costs for apples, accompanied by a slight uptick in opposition and uncertainty when compared to the 2021 results (refer to Table 5).

**Table 5.** Survey answers to the question, “Are you willing to pay additional true costs for apples (EUR 0.09 for 500 g)?”.

Answers	Survey 2021 (Informational Campaign in Berlin)		Survey 2023 (Nationwide Campaign)	
	Absolute	Relative	Absolute	Relative
yes	103	94.50	106	88.33
no	6	5.50	13	10.83
not sure	0	0	1	0.83
overall (N)	109	100.00	120	100.00

Shifting to the second question focused on Gouda cheese (EUR 2.35 for 300 g), the 2021 data showed that 43.12% were willing to pay, 56.88% opposed, and none were uncertain (N = 109). In 2023, 24.17% expressed willingness, 75.00% opposed, and 0.83% were uncertain. The 2023 findings underscore a substantial decrease in the willingness to pay for the externalities of Gouda cheese, coupled with a significant increase in opposition. This suggests a noteworthy shift in attitudes toward covering additional true costs for this specific product over the two survey periods (refer to Table 6). This shift may be attributed, in part, to the fact that the “true price” was effectively charged at the checkout this time, potentially reducing the influence of the attitude–behavior gap on the survey.

**Table 6.** Survey answers to the question, “Are you willing to pay additional true costs for Gouda cheese (EUR 2.35 for 300 g)?”.

Answers	Survey 2021 (Informational Campaign in Berlin)		Survey 2023 (Nationwide Campaign)	
	Absolute	Relative	Absolute	Relative
yes	47	43.12	29	24.17
no	62	56.88	90	75.00
not sure	0	0	1	0.83
overall (N)	109	100.00	120	100.00

### 3.3. When Implementing TCA: Increase of Organic Products and Reduction of Meat Consumption?

In addition, we explored potential shifts in consumption behavior resulting from the implementation of True Cost Accounting (TCA), considering specifically a possible increase in organic product adoption and the potential reduction in meat consumption. Animal products, including meat and dairy, generally entail higher externalities compared with plant-based alternatives. Moreover, organic foods typically exhibit lower externalities compared with conventional substitutes, owing to divergent legal requirements for fertilizers and pesticides (refer to Table 2 and cf. [49]). Hence, the theoretical assumption posits that integrating true costs into market prices could lead to a decrease in the consumption of animal-based foods and an increase in the consumption of organic foods.

By comparing survey responses from the 2021 informational campaign (N = 109) and the 2023 nationwide campaign (N = 120) regarding potential implementations for

the true costs of food, notable shifts in participant attitudes were evident. Regarding the question of reducing consumption of animal-based food if true costs were implemented, the 2021 responses indicated that 60.55% affirmed a willingness to reduce consumption, while 39.45% opposed the idea (see Table 7). In 2023, a similar percentage of participants (60.50%) expressed a willingness to reduce consumption, 33.61% opposed the idea, and 5.88% remained uncertain. The reasons stated by respondents for not considering reducing their consumption of animal products in the case of rising prices included “taste” (18%; N = 7), “already reduced meat consumption” (33%; N = 13), “existing eating habits” (25%; N = 10), or the “need to consume meat” (18%; N = 7).

**Table 7.** Survey answers to the question, “Would you reduce the consumption of animal products, if true costs were implemented and prices for animal products increased?”.

Answers	Survey 2021 (Informational Campaign in Berlin)		Survey 2023 (Nationwide Campaign)	
	Absolute	Relative	Absolute	Relative
yes	66	60.55	72	60.50
no	43	39.45	40	33.61
not sure	0	0	7	5.88
overall (N)	109	100.00	119	100.00

Turning to the question of increasing the consumption of organic food with the implementation of true costs, the 2021 responses demonstrated that 76.15% favored an increase, 22.94% opposed the idea, and 0.92% were unsure. In 2023, 59.32% favored an increase, 28.81% held a negative stance, and 11.86% remained uncertain. Reasons given by the study participants for not increasing organic consumption by equalizing the prices of conventional and organic products through the implementation of true prices included the following: “skepsis toward organic” (62%; N = 23), “habit” (13.5%; N = 5), or “no impression of added value through organic” (13.5%; N = 5). Notably, the 2023 responses indicated a decrease in the willingness to increase organic food consumption compared with the 2021 results, suggesting evolving attitudes toward organic food within the context of TCA implementation (see Table 8).

**Table 8.** Survey answers to the question, “Would you increase your consumption of organic products if the price differences between organic and conventional products were minimized through the implementation of TCA?”.

Answers	Survey 2021 (Informational Campaign in Berlin)		Survey 2023 (Nationwide Campaign)	
	Absolute	Relative	Absolute	Relative
yes	83	76.15	70	59.32
no	25	22.94	34	28.81
not sure	1	0.92	14	11.86
overall (N)	109	100.00	118	100.00

### 3.4. Considered Factors for Inclusion in True Cost Accounting (TCA)

In the survey addressing the components to be encompassed within True Cost Accounting (TCA), participants were probed regarding the inclusion of three distinct categories: environmental costs, social costs, and animal welfare costs. A total of 70.83% of respondents expressed support for integrating environmental costs, while 79.17% endorsed the inclusion of social costs, and 80.83% advocated for the integration of animal welfare costs (N = 120; see Table 9). These findings underscore the varied perspectives among respondents con-

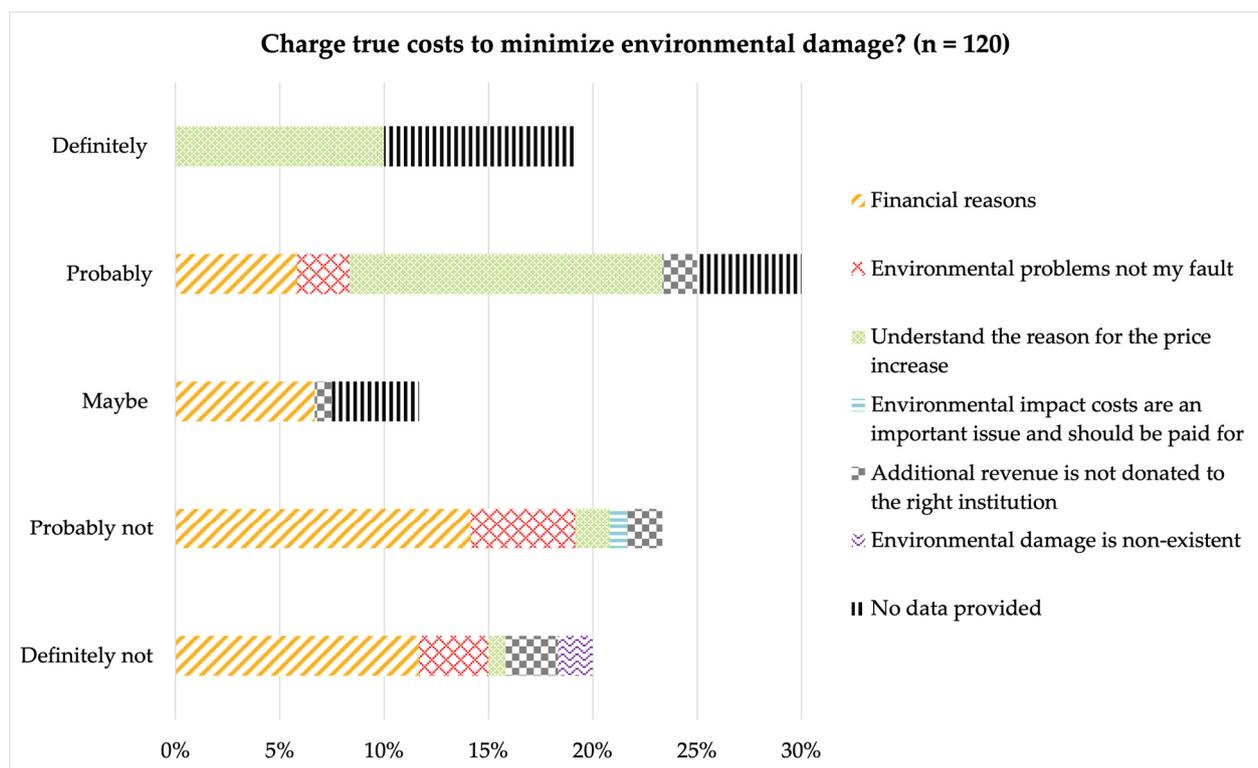
cerning the inclusion of specific cost categories, thereby offering valuable insights into the considerations and priorities of the surveyed individuals within the broader context of comprehensive True Cost Accounting.

**Table 9.** Survey answers to the question, “Which of these categories should be included in the true prices?” (All categories were asked individually).

Answers	Environmental Costs		Social Costs		Animal Welfare Costs	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
yes	85	70.83	95	79.17	97	80.83
no	35	29.17	25	20.83	23	19.17
overall (N)	120	100.00	120	100.00	120	100.00

### 3.5. Perceptions of True Prices: An Evaluation

We further investigated participants’ overall attitudes toward the implementation of true costs. Approximately half of the respondents (47.5%; N = 57) expressed a positive inclination, with 26.7% (N = 31) considering the idea “rather positive”, and 20.8% (N = 25) welcoming it. A total of 11.7% (N = 14) maintained a neutral stance, while 20.8% (N = 25) were hesitant to embrace the concept, and 19.1% (N = 23) outright rejected it. Consequently, a diverse spectrum of consumer perspectives emerged. Notably, this study delved into the nuanced reasons behind these assessments, as detailed in this investigation (see Figure 1).



**Figure 1.** Relative frequencies (subdivided by reason) of given answers to the question, “Would you charge true costs to minimize environmental damage?” (N = 120).

A predominant argument in favor of true prices was the understanding of the rationale behind the price increase. Conversely, commonly cited reasons against the implementation of true prices included concerns related to “financial aspects” and the perception that “environmental damage is not my fault.” Notably, reasons such as “additional revenue is not used in the right place” or the assertion that “environmental damage does not exist” were

infrequently mentioned, offering valuable insights into the multifaceted considerations shaping consumer opinions on true prices.

#### 4. Discussion

Effective science communication is crucial for bridging the gap between scientific research and public understanding, fostering informed decision-making and driving societal change [21]. This discussion section explores key aspects of the true cost campaign, evaluating its impact on consumer behavior, assessing changes in acceptance and awareness over the last years, drawing implications for future research and communication strategies (e.g., focusing on health and animal welfare costs), and considering the potential use of TCA in engaging relevant stakeholders at policy and company levels, as well as the role of science communication in this field.

The integration of further aspects in TCA is of great importance in the context of science communication. The findings of this study (79.17% support the inclusion of social costs, and 80.83% support the integration of animal welfare costs (N = 120)) underscore the need for future research to delve deeper into specific aspects of TCA, such as health costs and animal welfare. As consumers become more conscientious about the true costs associated with food production, exploring the impact on health-related behaviors and attitudes toward animal welfare could provide valuable insights. Communication strategies should, therefore, consider highlighting these dimensions to enhance the effectiveness of future campaigns. In particular, the level of individual human health, which is linked to nutrition, could be an important lever [61,62]. The first TCA approaches, including human health costs, have been developed in recent years. Seidel et al. examined the healthcare costs for diseases attributable to nutrition and included type 2 diabetes mellitus, cardiovascular diseases, and neoplasms [63]. Hendriks et al. [64] put the total global costs for human health at USD 11 trillion—in comparison, the environmental impact costs amount to approximately USD 7 trillion, and the economic impact costs amount to approximately USD 1 trillion [65].

Another finding of the survey is that participants wish for transparency in the area of animal welfare through TCA. This is in line with research results by Perino and Schwickert [66], who, in a representative survey for Germany, identified animal welfare as the strongest determinant for approval of an extra tax (in this case, the “meat tax”) in the food sector. Furthermore, there are already proposals from the “Competence Network for Livestock Farming”, also known as the “Borchert Commission” [67], who suggested an animal welfare tax of EUR 0.40 per kilogram of meat as a political initiative in Germany. To date, however, no corresponding political implementation has taken place, and the commission disbanded in 2023 [68]. For this purpose, studies have examined the willingness to pay for animal welfare: Lagerkvist et al. [69] found that providing information on the living conditions of farm animals significantly changes, and Frey and Prischer [70] identified a correlation between willingness to pay for animal welfare and environmental concerns, as well as altruism. Rasidovic et al. [71] calculated the costs of animal welfare using TCA and differentiated between animals and husbandry systems: the price premiums for conventionally reared chickens amount to EUR 0.3 to EUR 0.4/kg, while the animal welfare levies for organically reared broilers average EUR 0.18/kg. Extrapolated to the total annual amount, the social externalities in Germany amount to around 450 million euros.

These many facets of TCA consequently need to be further developed scientifically but also communicated in a differentiated and understandable way by scientists and the media. In 2023, the German newspaper *Die Zeit* [72] presented the true costs in a detailed article with sample products and current research results from various studies, differentiating between the externalities of “animal welfare”, “environmental costs”, and “social costs”. In this article, the positive effects of diets on human health were also presented, and the narrative “this apple is too expensive” could be chosen as the headline: if true costs and, therefore, also healthcare costs—which have a positive impact on total costs—are included, the apple would actually cost less. In most cases, TCA is otherwise communicated with

drastic price increases. The positive narrative could represent a possible approach for future science communication [73].

#### 4.1. Changes in Acceptance and Awareness of TCA

This study observed a notable level of awareness among consumers during the true cost campaign. However, to gauge its lasting impact, it is essential to examine how acceptance and awareness have evolved over the past years. The broader context of inflation during multiple crises, like COVID-19, the Russian invasion in Ukraine, and the associated shortages in supply changes, may have influenced these dynamics [74,75]. Understanding the long-term effects is critical for assessing the sustainability of TCA-driven behavioral changes and shaping future communication strategies.

A large majority (88.3%) would be willing to pay a small true cost premium for a plant-based product (conventional apples with a price premium of EUR 0.09—in the survey of Michalke et al. [44], 94.5% were still in favor). Around 1/4 (24.2%) would be willing to pay the true price for Gouda cheese (EUR 2.35 price premium). There is a drastic decline in the willingness to pay compared with the 2021 survey. At that time, 43.1% agreed to pay for the higher true price [44]. This decline could be due to the actual confrontation with the higher prices (as well as the aforementioned multiple crises)—not only with information on it—and, thus, a reduction in the attitude–behavior gap. On the other hand, the rising above-mentioned food prices due to multiple crises and the general availability of income for food could also play a role. The great media response to the campaign in 2023 could also have influenced respondents' answers. It is interesting to note, however, that when the willingness to reduce animal consumption was in question, the actual implementation of TCA and, therefore, an increasing price did not result in changed responses: in both surveys, 60.5% stated they would reduce their consumption of animal products [44]. This is in line with the general declining trend of meat consumption in Germany [76].

#### 4.2. TCA Campaign as Science Communication Approach

Based on the question, “Would you calculate the true cost of minimizing environmental damage?” (cf. Figure 1), and the associated conclusion that the majority of respondents (“definitely”, “probably”, or “maybe”) see true costs as a lever to reduce externalities and environmental damage but only less than 1/3 of respondents have seen the information materials in the shop (cf. Table 4), the question arises as to the best possible approach to TCA—in the most target group-appropriate form possible.

With regard to the true cost campaign 2023 and the public communication of TCA generally, the following target groups for communicating TCA can be defined: (1) cross-section of society, (2) political decision-makers, and (3) business practice. After all, for a sensible and sustainable transformation of agri-food systems, these contributions are useful: (1) understanding and awareness of the necessary change processes, (3) political courage to set the course accordingly, and (4) companies that lead the way and translate and integrate the approaches into their business practice [18].

The cross-section of society can be addressed with understandable language [77,78]. In order to reach the majority of people, they should be targeted directly at their point of contact with the issue, e.g., when shopping for groceries in the supermarket. In our project, the campaign focused on communication of the true costs directly at the point-of-sale and on individual products from different product groups (meat, dairy, and plant-based), as well as different production processes (organic and conventional), so that customers could compare the differences in product prices.

The reporting of environmental impact costs with TCA has been well-researched in recent years. TCA approaches are able to differentiate between organic and conventional production [49], and calculations can be carried out for a multitude of different products. These TCA findings are communicated to (1) the cross-section of society in the form of science communication at the point-of-sale—as in the PENNY 2020 informational campaign [44], the nationwide PENNY campaign [79] in Germany, or similar approaches by

Albert Heijn in the Netherlands [80]. The presentation of TCA findings in campaigns and, thus, beyond the scientific community has led to a significant leap toward greater transparency. However, stakeholders have criticized—also in public discourse—that, for example, no distinction is made at the operational level (which is due, in particular, to the availability of data and also the willingness to participate in pioneering projects from the field). Nevertheless, there are approaches and companies that are already able to implement TCA at a company level [81,82].

Furthermore, in addition to the negative externalities displayed by TCA, there are also approaches to the positive added value of agriculture, which are, e.g., presented in projects at the farm level in Germany using the methodology of Sustainable Performance Accounting (SPA) of regional value services: aspects like humus formation and social benefits of agricultural enterprises are considered [83,84]. Consequently, the integration of further aspects of transparency in TCA is of great importance in the context of science communication.

#### *4.3. Greenwashing as Challenge in Communicating TCA*

Trust in True Cost Accounting plays an important role in the survey results. For example, the argument “additional revenue is not donated to the right institution” was raised by some respondents. The media also often spoke of “greenwashing” in this context and in relation to the campaign [85,86]. The results of a survey conducted by the University of Greifswald (2024) [60] also confirmed this: 46% (N = 2255) agree with the statement “the campaign was greenwashing”. Consequently, trust plays a major role in the (science) communication of TCA. In this context, Taufik et al. [52] defined the correlation of “green value”, social status, and remediation beliefs as “green trust”. According to this, “green trust”, in turn, influences the purchase intention for true-price food products. In addition, Taufik et al. [52] pointed out that trust in the calculation of the true prices, as well as in the integrity of the organization that retrieves the prices, has an impact on consumer trust.

In order to achieve this “green trust”, de Sio et al. [87] recommend that retailers should educate consumers about the benefits of buying sustainable products through environmental facts and the corresponding sources in advertising and/or on product packaging. Of the 2255 respondents to the online survey following the true price campaign, only 29% realized that the calculations were carried out by scientists [60]. Hence, nearly half of the participants who were familiar with the campaign were not aware of its scientific background. Consequently, there is still great potential for science communication.

#### *4.4. Communicating TCA at Company and Policy Level*

The survey results once again address consumers’ strong desire for transparency. For example, in the question on the inclusion of environmental costs, social costs, and animal welfare costs in TCA, 70.83% of respondents were in favor of the integration of environmental costs, while 79.17% were in favor of the inclusion of social costs, and 80.83% were in favor of the integration of animal welfare costs (N = 120). The implementation of these transparency wishes would have to be tackled at both a political and a company level. However, the discourse to date shows that one of the biggest challenges within science communication seems to be tackling the discourse on actual measures. For example, the true cost campaign received a lot of media coverage (>1200 articles during the campaign week), but only a small proportion of these reports discussed possible measures for transforming the current agricultural system in more detail, thus driving no social discourse on the subject.

However, this is an example that applies to many areas of science communication. In nature documentaries or reports on the climate crisis, reference has been made to scientific results and the presentation of changes in biodiversity, climate, or sea levels, but the necessary and, in some cases, already scientifically investigated possible measures for implementing these are often neglected [88]. According to Constantino and Weber [89] and

Strand et al. [90], this requires new narratives—especially those involving action—which can also have an impact on political perception and action.

In the context of science communication and, therefore, also for TCA, several strategies are required to address political decision-makers: awareness-raising through media coverage and press conferences [91]. In addition, informal meetings and participation in round tables with politicians are necessary [92]. The latter, in particular, provides decision-makers with the impetus for a necessary change of perspective in order to be able to advocate for a transformation of the agricultural and food system. The true cost campaign has the potential to extend beyond consumer awareness to influence relevant stakeholders at the policy level. TCA could be a valuable tool for policymakers seeking to address environmental and social externalities in the food industry. Generally, by integrating TCA into policy discussions, governments can work toward creating regulatory frameworks that incentivize sustainable practices and responsible consumption. In terms of science communication, it is becoming increasingly important to talk about actual solutions and action plans in the field of agri-food systems. For example, a current study by FÖS [93] shows that EUR 6.1 billion is currently being spent in this sector with an environmentally harmful effect on the state. A reduction in these subsidies could, therefore, represent a lever for transformation.

On the one hand, it is important to approach politicians with well-founded and concrete proposals for action measures but also for the media to take these into the discourse instead of solely reporting on the current status quo. In the area of TCA, for example, Oebel et al. [94] examined the possibilities of the value-added tax as a possible lever for transforming the agri-food system. In addition, the animal welfare levy has already been discussed and is being called for by various institutions (Citizens' Council on Change 2024; Borchert Commission 2020) [67,95], which could be considered a further measure. The BMEL (2024) [96] also sees out-of-home catering as a major lever and calls for free lunches for children as the key to educational opportunities and health. As a socio-political measure, this could go hand in hand with the conversion of public catering to plant-based, organically produced foods.

For businesses, a transformation could take place, in particular, at the accounting level and with the help of the new ESRS (European Sustainability Reporting Standards; cf. [97]), the German Supply Chain Due Diligence Act, and the current discussions and negotiations on the EU directive on corporate sustainability due diligence (CSDDD; cf. [98]). As a result, companies in the food sector would have to take more and more responsibility for their supply chains and their business activities. At this point, the aspiration formulated in the coalition agreement of the current German government to expand corporate accounting, which proposes “integrating ecological and, where appropriate, social values [...] into existing accounting standards in dialogue with the business community” [99], should be implemented. This needs to be addressed in dialogue with companies and policymakers based on more targeted scientific communication and discourse about TCA.

## 5. Conclusions

Overall, this paper shows that science communication can play a key role and, thus, also have a leverage effect in the area of TCA toward various target groups. The face-to-face survey conducted as part of the true cost campaign in 2023 showed, on the one hand, that an awareness of this topic has developed within the survey participants and that the campaign has been recognized. There is a certain willingness to pay for the true costs, although this is significantly higher for plant-based products with lower externalities—even though the survey showed a decrease in willingness to pay compared with a former study. This signals a potential shift toward more sustainable consumption patterns (with fewer externalities), characterized by reduced reliance on animal products and an increased preference for organic alternatives.

Furthermore, this study highlights a growing demand for transparency, particularly concerning human health and animal welfare. Future research endeavors, coupled with

effective science communication strategies, are poised to address these concerns and elucidate the correlations between consumer choices and broader socio-environmental impacts. However, it should be noted that this is not a representative sample for Germany so that only assumptions can be made for the population as a whole.

Importantly, this study identifies the need for science communication approaches tailored to different target groups. Engaging consumers in everyday contexts, such as during supermarket visits, and fostering positive narratives in media coverage is integral to cultivating informed decision-making. Moreover, constructive dialogues with policymakers and industry stakeholders are essential for devising and implementing evidence-based measures at fiscal and regulatory levels.

By integrating these diverse strategies, science communication initiatives on TCA can catalyze transformative changes within the agri-food system, fostering sustainability and resilience in the face of emerging challenges. Future research should focus on expanding the scope of inquiry and refining communication strategies to ensure broader engagement and impact.

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