Green production information transparency and online purchase behavior: Evidence from green agricultural products in China

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The "lemon effect," which is the result of information asymmetry and barriers to trust, poses serious challenges to the sustainable development of green agricultural products. Therefore, enhancing consumers' trust is critical to maintain sustainable purchasing behavior. Information transparency has been widely attention as a marketing tool, and previous research related to agricultural products has focused on the visible information. Based on signaling theory, this study takes an invisible information perspective and empirically investigates how production information transparency of green agricultural products affects consumer trust and online purchasing behavior. The results of structural equation modeling analysis show that production technology information transparency and production means information transparency have different effects on the dimensions of consumer trust (in competence and benevolence). Moreover, trust in competence has a significant positive impact on trust in benevolence; they both have significant impacts on consumers' online green purchase behavior. The results of this study contribute to signaling theory and the product transparency literature, and offer significant implications to practitioners of the green agricultural sectors.

KEYWORDS

green production information transparency, online green trust, online green purchase behavior, green agricultural products, sustainable consumption, signaling theory

Introduction

Sustainability is an emerging paradigm in the circular economy. It is a concept that can provide long-term vision, making it possible to achieve environmental and social goals in line with the UN's sustainable development requirements. In recent years, there has been growing interest in sustainable development and circular economy research (Aman et al., 2021; Li et al., 2022; Awan and Sroufe, 2022; Li et al., 2022; Geng et al., 2022). Nevertheless, studies in this area are largely scattered and research on sustainable development and environmental protection in agriculture is still in its infancy. The

COVID-19 epidemic increased public concerns about health (Li et al., 2021) and environment (He et al., 2022; Singh et al., 2022; Wang et al., 2022), thereby the consumers' willingness to buy green or environmentally friendly products has grown rapidly in both developed and developing countries (Kumar et al., 2021; Chen et al., 2022). The COVID-19 pandemic developed new challenges for global consumers by leading to online shopping (Al Halbusi et al., 2022). Against this background, online consumption of green agricultural products has flourished in China, especially through e-commerce platforms. Consumers can easily choose a variety of green, healthy agricultural products, from natural, pollution-free organic fruits, vegetables, fresh meat, poultry, seafood, green grain, oil, and dry goods. However, the "lemon principle," resulting from information asymmetry and betrayal of trust has seriously damaged consumers' trust and inhibited their purchase intentions in the online shopping environment. Therefore, enhancing consumer trust and stimulating online purchase behavior remain important subjects for both academia and the industry.

Previous studies have reported that information transparency can reduce information asymmetry between consumers and sellers, improve consumer trust, and promote purchase behaviors (Kraft et al., 2020; Mohan et al., 2020). However, in practice, information transparency is a double-edged sword (Zhu, 2004), and sellers may not always benefit from it (Zhu, 2002; Li and Zhu, 2021). Therefore, further exploration of the mechanisms through which information transparency affects consumer purchase behavior is necessary. In addition, the degree and effect of information transparency are closely related to the quality of the information disclosed. Generally, information transparency regarding the production of green agricultural products can be divided into visible information and invisible information. In China, sellers are legally required to disclose information related to the origin of the product and all ingredients; this is one form of visible information. However, disclosure of invisible information such as the production process is left up to the seller. Compared with other agricultural products, green agricultural products have a premium of 20%–47% (Abraben et al., 2017; McFadden and Huffman, 2017; Lang and Rodrigues, 2022), and that for organic agricultural products is even higher at 109%–210% (Gschwandtner, 2018; Ha et al., 2019). To justify the higher price of such products, consumers must be given more information about them, including whether the production process meets green production standards.

Thus, information transparency needs further investigation in the context of green agricultural products, especially how it can be used to encourage consumer purchases. Drawing upon signaling theory, this study aims to build a conceptual framework of "green production information transparency–online green trust–online green purchase behavior" and empirically validate it through a large-scale survey of Chinese consumers. Specifically, our study seeks to answer three research questions: 1) What are the key elements of production information transparency and how do they affect online green trust? 2) How does online green trust affect online green purchase behavior? 3) What are the interrelations between the dimensions of online green trust? Through answering these questions, we contribute to the signaling theory literature by extending its application to the emerging field of online shopping for green agricultural products. Our study also clarifies the dimensions of production information transparency and provides empirical evidence on how they affect consumer trust and purchase behavior from a developing country perspective. Our findings also offer important insights for practitioners.

Literature review and research hypotheses

Signaling theory

Signaling theory grows out of the problem of information asymmetry. In a transactional market, the buyer is often in a more advantageous position in terms of access to information and relies heavily on any signals sent out by the seller when making purchase decisions (Kirmani and Rao, 2000). A thorough review of the recent literature on signaling theory indicates that it has rarely been applied to the context of green agricultural products. There are some exceptions: for instance, Berger. (2019) found that signals can increase consumers' willingness to purchase green products. Khan et al. (2022) confirmed that consumer trust can be enhanced by signals regarding green product attributes. Chang et al. (2021) argued that environmental signals such as the avoidance of excessive packaging significantly motivate consumers' green purchase behavior. Therefore, ensuring the sustainable development of green agricultural products and gaining long-term support from consumers requires continuous signaling of the products' value by the producer and seller. In the e-commerce context, where the producer and consumers are typically distant from each other, green production information transparency is a key method of signaling that is central to consumers' online trust and decision-making.

Green production information transparency

Information transparency is a central topic in the customer relationship management literature, as it is a key tool for companies to secure a competitive advantage. From information delivery perspective, it is defined as the level of availability and accessibility of market information to its

participants (Zhu, 2004; Granados et al., 2010). From the product perspective, it refers to the degree to which consumers can easily access and understand the information needed to assess a product's performance, including information on its price, quality, and characteristics (Zhou et al., 2018). From a production process perspective, information transparency is the extent to which information about product quality and sustainability is disclosed throughout the whole process (Mol, 2014). The three dimensions of information transparency are product transparency, supply chain transparency, and transaction transparency (Zhou et al., 2018). Studies of information transparency focus on information disclosure in capital markets (Zadeh et al., 2021), information sharing in supply chains (Rao et al., 2021), corporate social responsibility disclosure (Sendlhofer and Tolstoy, 2022), environmental information disclosure (Teubner et al., 2020; Du et al., 2022; Lin, 2022), and product information disclosure (Peschel and Aschemann-Witzel, 2020).

In recent years, with the rise of online shopping, studies have begun to address information transparency issues in online marketplaces (Liu et al., 2022). While theoretically, information transparency benefits all parties involved in the online transaction, a number of scholars question whether sellers are always beneficiaries (Li and Zhu, 2021). It is widely accepted that transparency can increase consumer trust and subsequent willingness to buy (Kang and Hustvedt, 2014). However, the cost associated with disclosing more information and the potential negative effect of information disclosure require more in-depth investigation (Peschel and Aschemann-Witzel, 2020). Therefore, by exploring the context of online shopping for green agricultural products, this study aims to shed light on how green production information transparency in the form of information on production means and production technology affects consumer online purchase behavior through their online green trust.

To achieve sustainable production, it is necessary to improve transparency in all segments, as a lack of information is associated with uncertainty and doubt. However, lack of transparency will be one of the most important factors affecting consumers' purchasing decisions (Wiederhold and Martinez, 2018). Further, some scholars indicate that cost transparency promotes trust, and trust in turn enhances consumers' willingness to purchase goods (Mohan et al., 2020). Buell and Kalkanci. (2021) found that operational transparency increases sales. And Shao and Ünal. (2019) showed through structural equation modeling results that environmental impact information has a significant influence on green purchasing. In addition, consumers are even willing to pay premium prices for products with complete product information transparency. Cheung and To. (2019) expressed that green product information is a crucial determinant of consumers' green purchase behavior.

Online green trust

Researchers identified customer trust as a key determinant of customer purchase intentions (Schlosser et al., 2006). Because of exaggerations and vagueness in marketing communications, consumers tend to lack trust in green products (Kalafatis et al., 1999). Green trust is defined as "the willingness to rely on beliefs or expectations based on trustworthiness, benevolence, and competence in environmental performance of a product or service," which is generally believed to influence customers' green purchase intentions and behavior (Chen, 2010, p. 309). Empirically, especially in the context of green agricultural products, studies focus on the antecedents of green trust and its outcomes. For instance, Chen and Huang. (2021) found that consumer-oriented drivers are critical in forming consumer trust in green products. Ahmad et al. (2022) confirmed a positive effect of green trust on green product purchase intention and behavior. However, whether these relationships and effects hold in an online shopping setting are unclear. Trust is believed to be decisive for consumers' decision-making in uncertain environments such as online marketplaces (McKnight et al., 2002); however, more empirical evidence is needed, and providing such evidence is one goal of our study. Based on studies by Singh and Sirdeshmukh. (2000) and Ba and Pavlou. (2002), we divided green trust into competence and benevolence. Green trust competence refers to consumers' confidence in the online seller's ability to execute the green production process effectively and reliably, and green trust benevolence is consumers' belief that the online seller has the intention and motivation to benefit the consumer.

Research hypotheses

Transparency has been observed to be a crucial parameter for creating trust (Robinson, 2020; Sukma and Leelasantitham, 2022). As a signal that conveys information related to the quality of green agricultural products, production information transparency provides consumers with rich information on how the product is made and what measures have been taken to ensure its quality, which causes consumers to form a positive image of the product. This positive image will increase trust in the seller and the product will ultimately lead to greater willingness to purchase the product and actual purchase behavior.

Consumers increasingly prioritize quality of products over other factors such as price, functionality, and availability. Therefore, there is high demand for production information transparency (Zhou et al., 2018). The use of means of production is one of the factors affecting the quality of green agricultural products. When the online seller fully discloses detailed information about how a green agricultural product is made (e.g., the use of fertilizers, pesticides, or growth regulators), consumers' perception of product quality will be greatly

enhanced, as this shows the producer's professionalism and expertise. During information exchange about the production process, consumers learn more about green products and develop trust in the producer and seller. Therefore, we propose the following:

H1a Green production means information transparency has a significant positive impact on consumers' green trust competence.

Making the production process more transparent, potentially enhances consumers' awareness of the wider aspects relevant to the value of products or services (Montecchi et al., 2021). The production process of green agricultural products is directly related to consumers' health and wellbeing. Consumers are especially concerned about whether legal and industrial standards are strictly followed during the production process. When consumers can easily access such information, they tend to regard the company as a trustworthy one that sincerely cares about their wellbeing. Accordingly, we propose the following:

H1b Green production means information transparency has a significant positive impact on consumers' green trust benevolence.

Companies can earn consumers' trust by proactively disclosing information to consumers (Kalkanci et al., 2016). In the context of green agricultural products, disclosure of details about the information technologies used in the production process, from the purchase of seeds and other inputs to the harvest of primary products, reassures consumers about product quality and the producer's technological capabilities. Effective application of technologies requires support from skilled workers and other resources, and consumers tend to trust producers who have such support. Centobelli et al. (2022) reported that technology is a bridge to building trust. Therefore, we propose the following:

H2a Green production technology information transparency has a significant positive impact on green trust competence.

Production technology is one of the factors affecting product quality. If disclose information on the production technology of green agricultural products, indicates that the technical quality of green agricultural products in the production process meets the relevant green production standards, it will make consumers believe that the online sellers will strictly follow the production technology and quality standards of green agricultural products, which will in turn enhance consumers' trust benevolence of online sellers. And information sharing can enhance benevolent trust with customers (Barry et al., 2021). For instance, Wang et al. (2018) found empirical evidence that sharing green attribute information, such as emissions reductions and energy savings, and green certification information enhances consumer trust in the producer. Therefore, we propose the following:

H2b Green production technology information transparency has a significant positive impact on green trust benevolence.

The literature suggests two possible outcomes of consumers' trust in online shopping, namely purchase intention and

purchase behavior, and points out that the intention to buy does not necessarily result in actual purchase behavior. Therefore, our study focuses on the purchase behavior of consumers in business-to-customer (B2C) e-commerce as a result of trust.

Online transactions generally involve a high degree of product uncertainty because buyers are concerned about potential product defects. Therefore, consumers tend to evaluate the seller's competence, which is regarded as a prerequisite for their purchase decision-making. In an online shopping environment, when consumers' trust in the producer's competence is established, they tend to believe that the producer's ability to provide safe, high-quality agricultural products and reliable product information; these beliefs are likely to result in online purchase behavior. The empirical results of Kim and Song. (2020) supported that consumers' trust in sellers' competence had a significant positive impact on consumers' purchase intention. Therefore, we propose the following:

H3a Green trust competence has a significant positive impact on online green purchase behavior.

When consumers have high trust in the producer's competent delivery of green products, they are more likely to believe that the producer/seller shares the same values, such as environmental protection and a healthy lifestyle, and to see them as a responsible organization. Based on this belief, consumers expect the seller/producer to put the consumers' interests first and voluntarily protect their rights and interests during and after the transaction. Di Battista et al. (2021) confirmed that competence trust promotes benevolent trust. Therefore, we propose the following:

H3b Green trust competence has a significant positive impact on green trust benevolence.

Consumers' trust in the producer's/seller's benevolence can reduce transaction uncertainties and establish a positive emotional connection, thereby stimulating consumers' purchase behavior. In an empirical study of Australian companies, Mohan et al. (2021) found that benevolent trust is significantly related to consumers' purchase intention, which is a crucial antecedent of purchase behavior (Wang et al., 2021; Xu et al., 2022). On this basis, we propose the following:

H4 Green trust benevolence has a significant positive impact on online green purchase behavior.

The conceptual framework including all of the hypotheses is depicted in Figure 1.

Research methodology

Questionnaire design and data collection

To validate the conceptual framework, our study uses a survey research method targeting potential consumers of online
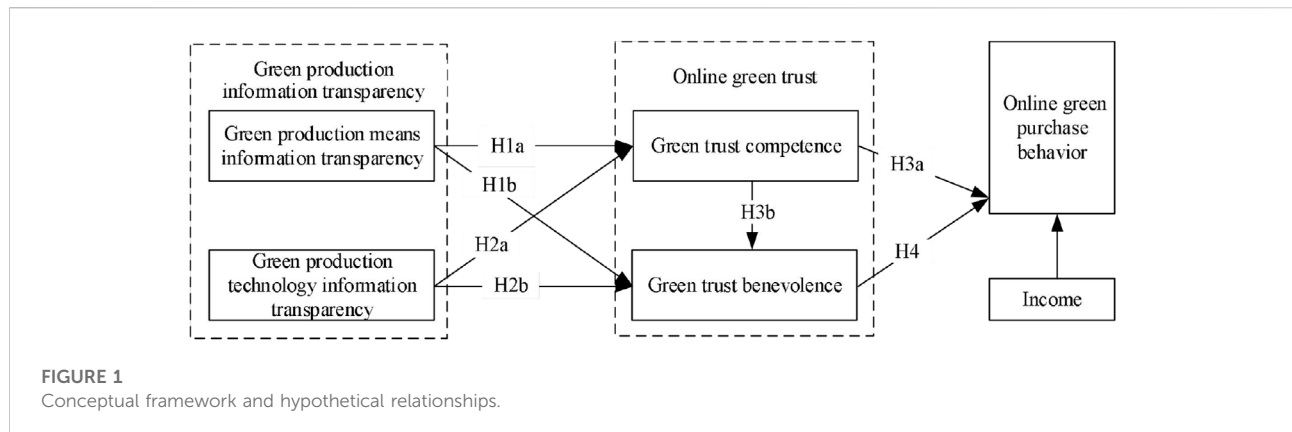
FIGURE 1
Conceptual framework and hypothetical relationships.

TABLE 1 Basic characteristics of respondents.

Variable	Value	Frequency	Percentage
Gender	Female	303	60.8
	Male	195	39.2
Age	18–24	109	21.9
	25–34	239	48
	35–44	99	19.9
	45–54	34	6.8
	55–64	16	3.2
	more than 65	1	0.2
Educational background	junior middle school or below	5	1
	senior middle school/polytechnic school/technical school	35	7
	junior college	58	11.7
	undergraduate course	344	69.1
	master's	52	10.4
	doctorate	4	0.8
Monthly income (CNY)	Below 3,001	88	17.7
	3,001–5,000	95	19.1
	5,001–8,000	109	21.9
	8,001–10,000	78	15.7
	10,001–15,000	77	15.4
	15,001–20,000	32	6.4
	Over 20,000	19	3.8

green agricultural products. The measurement items adopted in this study are based on established scales in the literature. To ensure the validity and reliability of the questionnaire, we invited potential respondents and academic experts, including university professors and research students in the field of agricultural product marketing and e-commerce, to take a pretest before we officially launched the survey. Based on their feedback, minor changes were made to the wording of some questions.

The questionnaire comprises three parts. The first part explains the purpose of the survey and key concepts such as green agricultural products. The second part gathers general information about the respondent's demographic characteristics (Yoosefi Lebni et al., 2020; Geng et al., 2022), including gender, age, highest education level, monthly income level, and occupation. The third part is the main part of the survey, presenting questions on the key constructs of the research model. A 7-point Likert scale is used for the questions in Part

TABLE 2 Common method bias detection.

	CMIN/DF	RMSEA	CFI	TLI	△RMSEA	△SRMR	△CFI	△TLI
Original model	1.313	0.025	0.993	0.989				
Models with common method factors	1.607	0.035	0.983	0.979	0.01	0.002	0.01	0.01

Note: if △RMSEA, △SRMR ≤0.05, △CFI, △TLI ≤0.1, that is, no serious common method bias is demonstrated.

Three, with 1 = "completely disagree" and 7 = "completely agree." The full questionnaire is provided in Supplementary Appendix A.

Because of the ongoing COVID-19 pandemic (Fu et al., 2021; Zhou et al., 2021; Farzadfar et al., 2022), the survey was launched online using two popular platforms in China. With the support of online shops selling green agricultural products, we collected 498 valid responses, a response rate of 87.3%. The administration of the survey fulfills the research ethics requirements of the lead researcher's institution.

The demographic characteristics of the sample are shown in Table 1. The survey targeted consumers who had experience with purchasing green agricultural products online. More than 60.8% of the respondents were female. There are two possible explanations for the disproportionate female–male ratio in the sample. First, women generally have a stronger preference for online shopping than men. While women often see shopping as fun activity, men usually view it as a chore (https://ecommerce-platforms.com/zh-CN/articles/male-shopping-habits-versus-female-shopping-habits). Second, during the COVID-19 epidemic, women's share of household income greatly increased after they engaged in work to cope with the risk (Ge et al., 2022). Further, women are more likely than men to spend money on household needs (Nichter and Goldmark, 2009). Therefore, it is reasonable for there to be a larger proportion of female respondents to our survey on online shopping for agricultural products.

In terms of age, people between 25 and 34 represent the largest proportion of the sample (48%). 79.5% of respondents hold an undergraduate degree or above. The sample covers a wide range of monthly income levels, of which the largest groups were 5,001–8,000 CNY (21.9%), 10,001–15,000 CNY (15.4%), and more than 20,000 CNY (3.8%). Thus, the sample is reasonably representative.

We used Harman's single factor test to detect potential common method bias (Podsakoff et al., 2003). Common method bias is not a serious issue in this study as shows in Table 2.

Measures

Production information transparency refers to the degree of disclosure of information about products, their quality, and the sustainability of the production process (Mol, 2014). In this study, two dimensions of production information transparency are captured, namely, production means information transparency and production technology information transparency; the measurement scales for these dimensions are adapted from Liu. (2013).

Online green trust is divided into two dimensions: trust in competence and trust in benevolence. In B2C e-commerce, trust in competence refers to consumers' belief that the seller can ensure the smooth progress of online transactions. Trust in benevolence refers to consumers' belief that the seller cares about their interests in online transactions, rather than focusing completely on their own economic interest. The scales used to measure both dimensions of consumer trust were adapted from McKnight et al. (2002), Mohan et al. (2021), and Xu et al. (2016) and consist of three items for competence and four for benevolence.

Online green purchase behavior for green agricultural products can be understood as consumers' prioritizing of green agricultural products over others when making online purchase decisions, and the measurement scale is adapted from Kang and Hustvedt. (2014), Suki and Suki. (2019), and Talwar et al. (2021). All of the measurement scales and items in the questionnaire are shown in Table 3.

Results

Reliability and validity analyses

SPSS 26.0 software was used for data analysis. The first step was to test the reliability of the scales, for which we used the widely accepted indicator of Cronbach's alpha. According to Table 3, the Cronbach's alpha values of all constructs are between 0.735 and 0.815, indicating high internal consistency of measurement items within each construct, and further analysis can therefore be carried out.

Following the reliability assessment, confirmatory factor analysis (CFA) was conducted using AMOS 26.0 to test the convergent validity and discriminant validity of the constructs. Convergent validity is established for a scale if the average variance extracted (AVE) is more than 0.5. As can be seen in Table 3, the AVE values of all of the constructs are in the range of 0.543–0.66, indicating sufficient convergent validity. In addition,

TABLE 3 Reliability and convergence validity.

Construct		Item	Factor loading	Cronbach's alpha	Average variance extracted (AVE)	Composite reliability (CR)
Green production information transparency	Green production means information transparency	This online seller publicly provides information on the means of production of their green agricultural products	0.865	0.789	0.66	0.854
		The information on the means of production of the green agricultural products provided by this online seller through various channels is basically consistent	0.799			
		This online seller provides objective information on the means of production of green agricultural products	0.775			
	Green production technology information transparency	This online seller publicly provides online information on the technical quality of green agricultural products	0.827	0.788	0.654	0.85
		The information on the technical quality of green agricultural product production provided by this online seller on various channels is basically the same	0.811			
		This online seller provides objective information online about the technical quality of green agricultural products	0.788			
Online green trust	Green trust competence	I believe this online seller is a reputable merchant	0.786	0.735	0.606	0.821
		I believe this online seller has a good understanding of the market in which it is located	0.761			
		I believe this online seller is a competent online supplier of green agricultural products	0.635			
	Green trust benevolence	I believe this online seller puts the interests of customers first	0.874	0.815	0.543	0.777
		I believe this online seller has my interests in mind	0.680			
		I believe this online seller will voluntarily protect consumer rights	0.760			
		I believe this online seller will genuinely care about customers	0.735			
Online green purchase behavior		I have already purchased green agricultural products from this online seller	0.796	0.765	0.645	0.845
		I will also buy green agricultural products from this online seller	0.797			
		I would recommend that others buy green agricultural products from this online seller	0.817			

TABLE 4 Analysis of discriminant validity.

	1	2	3	4	5
1 Green production means information transparency	0.812				
2 Green production technology information transparency	0.597	0.808			
3 Green trust competence	0.452	0.433	0.778		
4 Green trust benevolence	0.489	0.398	0.482	0.736	
5 Online green purchase behavior	0.432	0.430	0.516	0.452	0.803

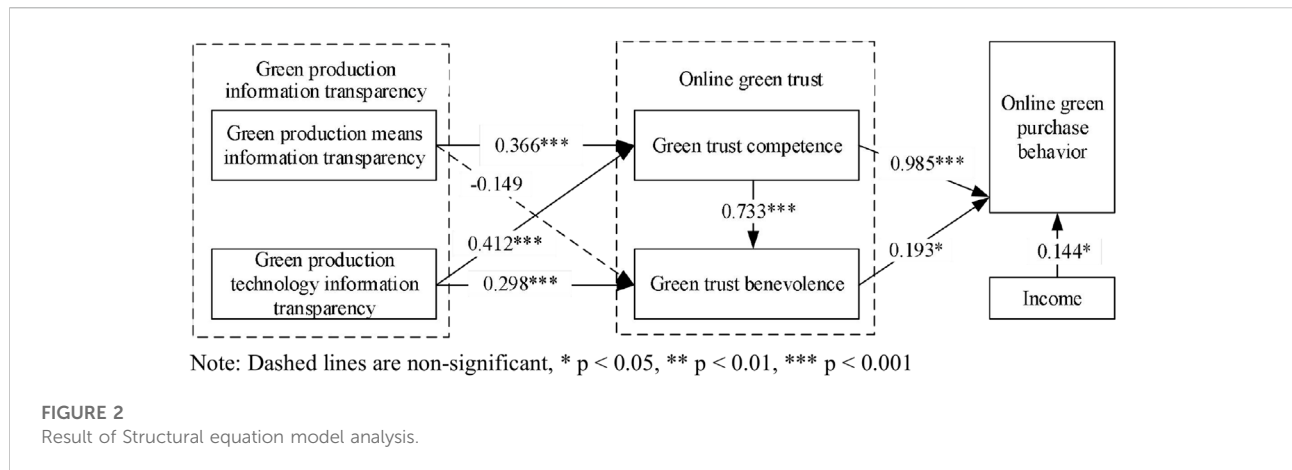Note: The diagonal in the table is the square root of the corresponding AVE value.

FIGURE 2
Result of Structural equation model analysis.

TABLE 5 Results of the hypothesis tests.

Hypotheses	Standardization path coefficient	SE.	p-value	Outcome
H1a: Green production means information transparency → Green trust competence (+)	0.366	0.077	***	Supported
H1b: Green production means information transparency → Green trust benevolence (+)	-0.149	0.077	0.077	Rejected
H2a: Green production technology information transparency → Green trust competence (+)	0.412	0.074	***	Supported
H2b: Green production technology information transparency→ Green trust benevolence (+)	0.298	0.079	***	Supported
H3a: Green trust competence → Online green purchase behavior (+)	0.985	0.155	***	Supported
H3b: Green trust competence → Green trust benevolence (+)	0.733	0.076	***	Supported
H4: Green trust benevolence → Online green purchase behavior (+)	0.193	0.084	*	Supported
Income → Online green purchase behavior (+)	0.144	0.058	*	

Note: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

TABLE 6 Analysis of mediation effects.

Paths	Bias corrected bootstrapping 95% CI	
	Lower	Higher
Total Indirect Effects: green production means information transparency → online green purchase behavior	0.132	0.577
Specific Indirect Effects: green production means information transparency → trust competence → online green purchase behavior	0.491	1.219
Specific Indirect Effects: green production means information transparency → green trust competence → green trust benevolence → online green purchase behavior	0.132	0.577
Specific Indirect Effects: green production means information transparency → green trust benevolence → online green purchase behavior	-0.449	0.017
Total Indirect Effects: green production technology information transparency→ online green purchase behavior	0.093	0.482
Specific Indirect Effects: green production technology information transparency → green trust competence → online green purchase behavior	0.126	0.440
Specific Indirect Effects: green production technology information transparency → green trust competence → green trust benevolence → online green purchase behavior	0.088	0.178
Specific Indirect Effects: green production technology information transparency → green trust benevolence → online green purchase behavior	0.102	0.530

the composite reliability (CR) values of all of the constructs are greater than 0.6, between 0.777 and 0.854. Therefore, the internal consistency of each construct is confirmed. To assess the discriminant validity of the constructs, the square root of each construct's AVE value is extracted and compared with the correlation coefficient with other constructs. As Table 4 shows, discriminant validity is established for all variables, as the square roots of the AVE values of the five constructs are greater than the correlation coefficients between all of the constructs.

Structural equation modeling and results

SmartPLS 3.3.2 was used to test the hypotheses; the results are presented in Figure 2 and Table 5.

As shown in Table 6, a bootstrap procedure shows that all of the indirect paths are statistically significant except for "green production means information transparency → green trust benevolence → online green purchase behavior," where the lower and the upper bounds of the 95% confidence interval include zero.

Discussion

The effect of green production information transparency on online green trust

Figure 2 shows the different effects of the two dimensions of green production information transparency on the two dimensions of online green trust.

(1) Green production means information transparency has a significant positive impact on trust competence ($\beta = 0.366$, $p < 0.001$); thus, H1a is supported. According to signaling theory, making the production means transparent reflects the producer's/seller's competence and confidence, which creates a positive image in consumers' minds. This is consistent with the research of Sukma and Leelasantitham. (2022), transparency promotes consumer confidence in the organization. Similarly (Arshad and Khurram, 2020), government agencies provision of quality information on social media is positively related to citizens' trust in the agency. It may be that transparency allows citizens to see the work and efforts of the government. As a result, citizens trust their government to translate these efforts into practical results. Therefore, consumers tend to trust that the seller/producer can deliver what they promise.

Interestingly, the effect of green production means information transparency on trust benevolence was not found

to be significant ($\beta = -0.149$, $p > 0.05$); thus, H1b was not supported. This result is consistent with Garbarino and Lee. (2003), who found that consumers' perceptions of the dynamic pricing of companies under information transparency reduced their trust in the companies benevolence. A possible reason is that trust in sellers' benevolence is primarily a result of the seller's genuine concerns, knowledge, and interest in consumer welfare, which are difficult to strengthen directly by disclosing how a product is made. Peschel and Aschemann-Witzel. (2020) showed that a higher degree of transparency increases product choice only to a minor degree or even affects it negatively. Therefore, it is reasonable that production means information transparency does not directly impact on consumer trust in the benevolence of the organization.

(2) Green production technology information transparency has a significant positive effect on online green trust; thus, H2a ($\beta = 0.412$, $p < 0.001$) and H2b ($\beta = 0.298$, $p < 0.001$) are both supported. The results show that the high availability of green production technology information can promote both dimensions of online trust. Effective sharing of production technology information with consumers is conducive to increasing their trust in the producers' production technology capacity. The use of clean technologies also shows the organization's commitment to the environment. Therefore, production technology information transparency can promote consumer trust in both the capability and benevolence of the organization. However, despite clear evidence that transparency can enhance consumer trust, more information on the production process also enhances consumers' expectations of the product, which plays a key role in their perceptions of product quality and subsequent satisfaction (Al Sulaiti et al., 2005; Al-Sulaiti et al., 2021). Moreover, Azadi et al. (2021) indicated that effective information sharing could enhance the perception of the other party while potentially promoting positive behavior.

Improving online purchase behavior in connection with green agricultural products through online green trust

As shown in Figure 2, green trust in competence has a significant positive effect on online green purchase behavior ($\beta = 0.985$, $p < 0.001$), and green trust in benevolence has a significant positive effect on online green purchase behavior ($\beta = 0.193$, $p < 0.05$); thus, H3a and H4 are supported. The results indicate that consumers' online trust in both the competence and benevolence of an organization can effectively improve their online purchase behavior. This is consistent with Ahmad and Zhang. (2020) reported that green trust has a significant positive effect on green online purchase intention. In addition, trust in benevolence has a

stronger effect on online purchase behavior than trust in competence. A possible reason is that benevolence focuses on the organization's attentiveness to consumers' interests, which can lead to an emotional connection with consumers. Therefore, when consumers believe that an organization has high benevolence, they are more likely to make positive purchase decisions.

The survey also revealed a direct effect of trust in competence on trust in benevolence ($\beta = 0.733$, $p < 0.001$), which supports H3b. This agrees with the results of Di Battista et al. (2021), participants perceived that more competent professors were also caring. This is reasonable, as if the organization is believed to be capable of producing and delivering green products, it is also likely to be seen as a responsible organization concerned about consumer health and welfare. Also, competence is a more important symbolic organizational attribute than benevolence (Wilhelmy et al., 2019). Although we acknowledge that all types of organizations can have high benevolence, those with more capabilities are more likely to actually obtain goodwill. Therefore, consumers' trust in benevolence can be enhanced by their trust in competence.

Conclusion

This study empirically explores the mechanisms through which production information transparency can affect consumers' online purchase behavior for agricultural products. A conceptual model linking transparency, trust, and purchase behavior is constructed based on signaling theory and validated through structural equation modeling. The results showed that the two dimensions of green production information transparency (means and technology) have different effects on online green trust, which comprises trust in competence and trust in benevolence. While production transparency in means was found to be positively related to trust in competence although, its effect on trust in benevolence was non significant. However, production transparency in technology has a significant effect on both dimensions of trust. Both dimensions of online green trust were found to positively correlated to consumer online green purchase behavior. Further, the two dimensions of trust were found to be interrelated, i.e., trust in competence can lead to trust in benevolence.

Theoretical contributions

This study makes two theoretical contributions.

First, our study applies signaling theory to the context of consumers' online purchases of green agricultural products. Regarding production information transparency as a key signal that producers send to potential consumers, we confirm that it has a positive impact on consumers' online purchase decision-making for green agricultural products. Our study also contributes to the literature on the country-of-origin effect, which posits that the country where a product is produced

affects consumers' perception of product quality (Al-Sulaiti and Baker, 1998). The result showed that consumers' trust and confidence in products made in China have been significantly enhanced through increased transparency of the production process. Thus, our study validates and extends the application of the signaling theory to the emerging field of e-commerce and green agricultural products in China.

Second, this study focuses on the role of invisible information disclosure of green agricultural products in the Chinese context. It is a complement to previous research on the value of visible information on green products and provides new insights into green product information concerns. Further, it enriches the research on the transparency of information on green agricultural products in developing countries. Previous studies on production information transparency have mainly focused on non-agricultural products. This study aims to explore the transparency of information on green agricultural products, thus complementing the existing studies on production information transparency. Production information transparency is divided into production means information transparency and production technology information transparency, which is an expansion of the production information transparency dimension. This extension facilitates better understanding of which dimensions of production information transparency of green agricultural products have a positive impact on consumers' behavior. The results also show that different types of green production information transparency have different effects on different dimensions of online green trust, thus providing theoretical evidence for understanding the mechanisms behind influencing the online purchasing behavior of green agricultural products. This study provides new insights into how to promote green agricultural products to Chinese consumers from the perspective of product transparency.

Managerial implications

For the government, it is crucial to further promote agricultural enterprises' green and low-carbon "Internet +" development. The implications for the policy include the following.

The government should encourage agricultural enterprises to disclose information on green agricultural products, which can cultivate consumers' trust of green agricultural products. For example, by providing corresponding subsidies, project financial support, and establishing the signpost of key enterprises, *etc.* The government can lead enterprises to actively build and develop infrastructures and platforms for product information transparency, and provide financial support and technical guidance. Moreover, by government media, which publicizes the advantages of green agricultural production information transparency, typical enterprise representatives, *etc.*, would guide enterprises to disclose related information actively.

In areas where green agricultural products are grown on a large scale, the government can take the lead in establishing a

traceability platform for green agricultural products, and connect with agricultural production enterprises to monitor the production process of green agricultural products throughout the process, to make production information transparent, maintain the order of the green agricultural product market, and promote the sustainable development of the online consumer market for green agricultural products.

The management implications for agricultural enterprises to promote sustainable consumption of green agricultural products are as follows.

Strengthening consumer trust is vital for maintaining the sustainable consumption of green agricultural products. Trust significantly motivates consumers to buy green products online. Therefore, online shops are encouraged to disclose more information about how their products are made, such as the production process and the technologies used. Information about the green product should also be made accessible to consumers. In addition, shops can also share their values and missions to establish a strong emotional connection with potential consumers who hold the same values. With the help of modern digital technologies, online shops can establish communication channels where consumers can interact with them. Through frequent exchange of ideas, information asymmetry is reduced, and consumers' trust in the shop's competence and benevolence is strengthened.

Consumers with higher trust in an online shop are more likely to engage in continuous transactions with that shop. Therefore, after trust is established through transparency, it should be properly managed and maintained. Therefore, online shops should have channels for consumer reviews and feedback, and consider a proactive attitude toward improving information sharing and product and service quality. At a macro level, government interventions such as subsidies to producers of green agricultural products are needed to help organizations through difficult times such as the COVID-19 pandemic.

Limitations and future research directions

Although the findings in this study are helpful for increasing the sustainable consumption of green agricultural products, there are some limitations. 1) Cross-sectional data are used to verify the proposed theoretical model. Longitudinal data could provide a more in-depth perspective on the relationship between production information transparency and online purchase behavior, which would make the results more reliable. Consumer demand is constantly changing; thus, in the future, a follow-up survey could be considered, and new findings and conclusions could be obtained. 2) The empirical results show that information transparency can promote online purchase behavior by cultivating consumer trust. However, whether the production information shared online is always true remains questionable. A comprehensive study of whether blockchain technology will

affect consumers' purchase behavior could be conducted. Such a study would have strong academic and practical value by accelerating the development of agricultural blockchain core technology, strengthening research on agricultural blockchain standardization, and promoting the innovative application of blockchain technology to ensure the quality, safety, traceability, and transparency of the supply chain.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding authors.

Author contributions

Conception and design: SF. The provision of materials (i.e., questionnaires): XL. Data analysis and hypotheses: HL, YH. Article revision and proofreading: AL and YH.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fenvs.2022.985101/full#supplementary-material

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