Introduction

Food produced through conventional agriculture has raised concerns among consumers due to the utilization of synthetic chemicals like fertilizers, herbicides, and pesticides (Hsu & Chen, 2014; Koch et al., 2017), which has been viewed as the most significant threats to food quality and safety (Koch et al., 2017; Ruth et al., 2020). Consequently, many consumers are shifting toward a preference for organic food (Bourn & Prescott, 2002; Hsu & Chen, 2014; Rana & Paul, 2017). However, growing organic food can be costly due to intensive physical labor and low yield per acre (Ramankutty et al., 2019), which may not be sufficient to meet the challenges of food shortage and feed the growing world population. Thus, the exploration of an alternative farming approach becomes crucial (Leifeld, 2012).

In response, scientists are actively cultivating an array of sustainable farming technologies, among which precision technologies are gaining prominence within the ongoing agricultural revolution (Said Mohamed et al., 2021; Walter et al., 2017). Current precision agriculture employs advanced technologies such as artificial intelligence (AI), the Internet of Things (IoT), and mobile internet to enhance spatial management practices. This aims to increase crop production while using targeted application to mitigate concerns such as over-irrigation and the excessive use of synthetic chemicals (Krampe et al., 2021; Kutter et al., 2011; National Institute of Food and Agriculture (NIFA), 2022; Said Mohamed et al., 2021). These practices are expected to bring about significant changes in agricultural production, including increasing yield quantity and quality, reducing input costs, and minimizing potential environmental impacts (Krampe et al., 2021; Kutter et al., 2011; Said Mohamed et al., 2021), and generally exhibit greater economic and ecological sustainability compared to conventional farming methods (Silva et al., 2007; Sylvester-Bradley et al., 2006; Takács-György, 2008). According to a report from the Economic Research Service of the United States Department of Agriculture (USDA) (McFadden et al., 2023), adoption rates of precision technologies have rapidly increased on U.S. farms. For example, auto-steer guidance systems were used on only 5.3% of planted corn acres in 2001, but by 2016, their usage had surged to 58%.

Nevertheless, a gap exists in understanding consumers' viewpoints regarding precision-grown food (Califano, et al., 2024; Krampe et al., 2021), leading to a disconnect between food production and the consumer market. Consumers rarely encounter labels or packaging indicating that a food product originates from a farm practicing precision agriculture. This may result in missed opportunities for increasing demand for precision-grown food. To bridge the gap, the present study delves into how the processing of information about production methods influences consumer acceptance (i.e., beliefs, attitudes, and purchase intentions) toward precision-grown food in comparison to both conventionally and organically grown food.

First, we investigate whether providing comprehensive insights into production methods could substantially impact consumers' openness to precision-grown food. Consumers tend to closely scrutinize information about new food technology, primarily because food plays a vital role in their daily lives (Lucht, 2015). However, in food markets, information frequently exhibits asymmetry, with sellers often possessing more knowledge than consumers about factors such as the production process, nutritional content, and safety concerns. This information gap can lead to market inefficiencies when consumers struggle to accurately assess product quality or safety (Schrobback et al., 2023; Teisl & Roe, 1998; Verbeke, 2005). To reduce uncertainty, consumers exhibit a strong interest in tracing food information such as the production method, certification of the production method, and the use of pesticides and fertilizers during the production process (Jin & Zhou, 2014). Drawing on theories concerning the formation of beliefs, attitudes, and intentions (Fishbein & Ajzen, 1975), we advance the notion that production method information can serve as cues for assessing food quality and safety (Tsakiridou et al., 2011). These cues aid consumers in deducing and reinforcing beliefs regarding the quality and safety of precision-grown food, thereby shaping their overall attitudes and purchase intentions.

Second, we investigate whether consumer innovativeness affects their acceptance of precision-grown food. According to the Elaboration Likelihood Model (ELM) (Petty & Cacioppo, 1986), individuals engage in a central route of information processing when they possess the motivation and capability to do so. Innovativeness is a critical individual variable in research concerning the diffusion of agricultural technologies (Rogers, 2003). Marketers believe that innovative consumers tend to have an open-minded approach, actively engage in the marketplace, and are more likely to adopt innovations (An et al., 2023; Clark & Goldsmith, 2005; Goldsmith et al., 2003; Hirschman, 1980). Specifically, innovative consumers are typically more inclined to process market information (Vandecasteele & Geuens, 2010) — reflecting motivation — and often showcase enhanced technological knowledge, denoting capability (Flynn & Goldsmith, 1993; Goldsmith & Flynn, 1995; Kamboj & Sharma; 2023; Vandecasteele & Geuens, 2010). Therefore, we explore whether innovativeness improves consumer responses toward precision-grown food when they are presented with production method details.

We recruited general U.S. consumers from the Amazon Mechanical Turk platform to take part in an online experiment. The present paper presents the empirical results of the experiment and concludes by discussing implications for marketers and policymakers, as well as the limitations of the present research and suggestions for future studies.

Literature Review

Consumer Evaluations of Food Quality and Safety

Food quality is the sum of all properties and assessable attributes of a food item (Leitzmann, 1993) and is typically divided into two dimensions: an objective dimension and a subjective dimension. The objective dimension of food quality refers to physical characteristics typically considered by food technologists and engineers. The subjective evaluation of food quality refers to consumers’ perceptions of the food quality, which can influence purchase decisions (Grunert, 2005). From a consumer perspective, food quality can be evaluated based on three categories: sensory value (e.g., taste), sustainability value (e.g., organic production, natural production, animal welfare, GMO-free etc.), and health value (e.g., nutrition such as vitamins and minerals) (Grunert, 2005; Leitzmann,1993).

Food safety refers to the likelihood that a person will not become ill because of consuming a food product. Like food quality, food safety also has an objective dimension and a subjective dimension. The objective dimension of food safety can only be assessed by scientists and experts, while the subjective dimension of food safety refers to consumer perceptions of the risks associated with consuming a food product (Grunert, 2005).

Food quality and safety both are important factors influencing consumers’ food choices. Consumers may not always make distinct decisions based on either food quality or food safety (van Rijswijk & Frewer, 2008). From a holistic view, food safety can be considered a basic attribute (Grunert, 2005; van Rijswijk & Frewer, 2008; Verbeke, 2005) and an implicit, integral part of food quality (Keast, 2009; Peri, 2006). Therefore, we consider consumer perceptions of food safety as the fourth category of food quality.

Production Method as Credence Cues

Consumers rely on a variety of information to assess food quality, which encompasses intrinsic and extrinsic cues (Grunert, 2005; van Rijswijk & Frewer, 2008). Intrinsic attributes are part of the physical product, while extrinsic attributes are associated with the physical product but not part of it (Fernqvist & Ekelund, 2014). Among the four categories of food quality, sensory value can be evaluated based on intrinsic cues, such as freshness, color, shape, size, structure, taste, tenderness, crunchiness, and juiciness (Chamhuri & Batt, 2015; Fernqvist & Ekelund, 2014; Ragaert et al., 2004). These cues can be acquired by direct observation and personal experience. Conversely, health value, sustainability value, and safety value cannot be evaluated by consumers even after normal use. These values are related to credence, which consumers can evaluate through credence cues, a special category of extrinsic cues (Fernqvist & Ekelund, 2014). Credence cues pose challenges for consumers to verify before, during, or after consumption (Becker, 1999). Some examples of credence cues include, but are not limited to, brand, label, packaging, retailers, product origins, agricultural production systems, genetically modified food, animal welfare, and farm labor conditions (Becker, 1999; Fernqvist & Ekelund, 2014; Grunert, 2005). In today's globalized food system, consumers' decisions are increasingly influenced by these credence cues, particularly given the diminishing trust and direct connections with producers. As a result, labels and information that convey credence become important search attributes (Fernqvist & Ekelund, 2014).

The production method is an important component of credence cues, which contains different factors. For example, organic production is a credence cue that includes aspects such as food safety, nutrition value, ethical considerations, health, and environmental concerns, as well as other production-specific issues like pest management, fertilizer usage and soil treatment (Fernqvist & Ekelund, 2014). A significant proportion of research investigating consumer preferences for food products, with production methods serving as credence cues, has primarily focused on the demand for organic food in comparison to their conventionally grown counterparts (Bourn & Prescott, 2002; Hsu & Chen, 2014; Rana & Paul, 2017). Consumers generally believe organic food is less damaging to the environment and healthier than conventional food (Hsu & Chen, 2014; Mondelaers et al., 2009; Schifferstein & Oude Ophuis, 1998; Williams & Hammitt, 2001). Two major factors that influence the purchase of organic food are (1) concerns about pesticide residues in food and consumers' own health (Dinc-Cavlak & Ozdemir, 2022; Hamzaoui-Essoussi & Zahaf, 2012; Koch et al., 2017; Rana & Paul, 2017), and (2) concerns about environmental issues such as protecting wildlife and water supplies from pesticide contamination (Goldman & Clancy, 1991; Wandel & Bugge, 1997).

Only a limited number of researchers have explored consumer acceptance of food cultivated using precision farming technologies (Krampe et al., 2021). A study conducted across three European countries discovered consumers have positive expectations regarding precision farming methods. They anticipate such methods can improve the environment (e.g., reduce emissions), increase food safety, and enhance animal welfare (Krampe et al., 2021). In other words, precision farming methods may potentially serve as credence cues for food quality and safety. The absence of a clear understanding of whether and why consumers prefer precision-grown food may lead to missing opportunities to boost demand for such food that could yield benefits for both consumers and the environment.

Theoretical Framework and Hypotheses

Consumer Responses Toward Food from Precision versus Conventional Farming

Message-based persuasion suggests that message content impact the consumer response process (Darley & Smith, 1993). According to the expectancy-value (EV) model (Fishbein & Ajzen, 1975), beliefs represent subjective probabilities linking an object with an attribute. For example, after reading a message stating that a food product is nutritious, consumers are likely to form a belief associating the product with nutritive qualities, with varying levels of subjective probability. This results in an associated expected value for each attribute. The combined or integrated evaluations of these attributes should approximate the overall attitude toward the object. Therefore, the traditional hierarchy-of-effects response models in marketing suggest that message acceptance determines beliefs, which subsequently influence attitudes, leading to purchase intentions (Darley & Smith, 1993).

Individuals can develop their beliefs about an object through not only direct experiences and interactions with it but also through exposure to information from external sources or by drawing inferences based on information cues (Fishbein & Ajzen, 1975). Thus, when consumers use production methods as information cues, their beliefs about food quality will be influenced by subjective assessments of health value, sustainability value, and safety value embodied by the food product, all of which require assessment using credence cues. These beliefs, in turn, shape their attitudes and intentions toward the product.

Consumers are well-acquainted with organic food, as evidenced by the significant increase in organic retail sales, reaching 54.50 billion euros in Europe in 2021 (Statista, 2023a) and 61.67 billion dollars in the U.S. in 2022 (Statista, 2023b), with this growth trend expected to continue. In contrast, precision farming remains unfamiliar not only to producers but also to the general consumer. According to the theory of diffusion of innovations (Rogers, 2003), during the knowledge stage of the innovation-decision process, consumers seek to reduce uncertainty about the advantages and disadvantages of an innovation through information-seeking and processing. Providing detailed information about precision technologies can serve as credence cues, helping consumers perceive the benefits of these production methods.

For example, consumers may be able to recognize that the precision systems can sense microsite-specific conditions in real time and automatically adjust treatments to cater to the unique requirements of each site. This includes precise amounts of fertilizers, pesticides, and water necessary for crops based on data analysis (Krampe et al., 2021; Kutter et al., 2011; NIFA, 2022; Said Mohamed et al., 2021). By offering consumers in-depth information, they can come to recognize that precision systems are employed to reduce the improper application of synthetic chemicals, ensure adequate nutrient provision, and conserve water. These insights can enhance consumers' beliefs regarding the quality of precision-grown food, ultimately boosting attitudes and purchase intentions compared to conventionally grown food.

> **H1**: Consumers tend to develop more favorable (a) quality beliefs, (b) attitudes, and (c) purchase intentions toward the food when it was produced using precision farming methods compared to conventional farming methods.

Consumer Responses Toward Food from Precision versus Organic Farming

Despite the advantages of sustainable practices, precision farming still involves a certain level of synthetic chemical usage. In contrast, the major principles of organic farming are reducing pollution in all forms and abstaining from the use of synthetic chemicals, which revolve around natural processes, including enhancing biological cycles within the farming system to preserve and enhance soil fertility and upholding genetic diversity in the production system (Bourn & Prescott, 2002). However, researchers found that consumers still have little knowledge about how organic food is produced and processed (Fatha & Ayoubi, 2023; Naspetti & Zanoli, 2009; Wandel & Bugge, 1997). They may recognize organic food products through labels, such as "100% organic", "organic", or "made with organic ingredients", but may still wonder what is "organic." Knowledge shapes attitudes, which in turn influence purchasing behavior, highlighting the need for informative marketing strategies for organic food (Ghosh et al., 2019). If consumers are presented detailed information about farming methods, they may be inclined to perceive organic food as more nutritious, attributed to naturally enhanced soil fertility preservation, and as being eco-friendlier and safer due to the reduced presence of chemicals and pollutants in the production process, compared to precision-grown food.

Therefore, we propose that consumers who engage in detailed information processing regarding farming production methods are likely to develop less favorable quality beliefs, attitudes, and purchase intentions toward precision-grown food compared to organic food.

H2: Consumers tend to develop less favorable (a) quality beliefs, (b) attitudes, and (c) purchase intentions toward the food when it was produced using precision farming methods compared to organic farming methods.

The Elaboration Likelihood Model and the Impact of Consumer Innovativeness

Although marketers often aim to reduce consumer uncertainty through information provision, certain researchers argue that an abundance of information does not always result in better-informed decision-making by consumers (de Garidel-Thoron, 2005; Dranove et al., 2003; Grunert, 2005; Verbeke, 2005). Verbeke (2005) asserts that the effectiveness of information provision depends on how well it aligns with the needs of target consumers and their ability to understand and use it. These suggestions align with the ELM (Petty & Cacioppo, 1986), which posits that individuals have a limited amount of time and mental capacity to process information to which they are exposed. Elaboration refers to the amount and depth of thought a person will apply to a communication method or message (Perloff, 2014). Whether individuals will use considerable cognitive resources and engage in issue-relevant thinking or elaboration depends on their motivation and ability to evaluate the communication presented (Petty & Cacioppo, 1986). Motivation refers either to individuals' involvement with the communication topic or their likelihood to engage in complex thought. The ability to process information can be influenced by many factors, such as knowledge about the topic and mental capacity (Petty et al., 2009).

The ELM proposes two distinct routes of information processing: a central route and a peripheral route (Petty & Cacioppo, 1986). When motivation and ability are high, an individual will move through the central processing route and carefully consider the merit of the information presented. When motivation and ability are low, an individual will assess information through the peripheral processing route and use some simple cues in the persuasion context (e.g., attractive source) to make judgement without thoughtful scrutiny of the merit of the information presented.

The ELM framework has found application in numerous studies within the field of agricultural science communication (Ruth & Rumble, 2017; Ruth et al., 2020; Settle et al., 2023; Verbeke & Vackier, 2004; Verbeke & Ward, 2006) and has become an essential model in assessing risk communication and hazardous food products (Frewer et al., 1997). For example, researchers found many consumers tend to use the peripheral processing route when exposed to agricultural information (Verbeke & Vackier, 2004; Verbeke & Ward, 2006), and the extent of elaboration used could be influenced by the type of hazard being communicated (Frewer et al., 1997). To create effective marketing strategies for food products, it is crucial for marketers to understand why some consumers have a higher motivation and ability to process food-related information while others do not.

In investigating consumer acceptance of agricultural innovations, one widely explored individual variable is consumer innovativeness (Rogers, 2003). This concept refers to the degree to which an individual is willing to try new things, including products, services, and ideas (Goldsmith et al., 2003; Midgley & Dowling, 1978; Hirschman, 1980). It has been extensively documented in marketing literature as one of the most important psychological characteristics with immediate relevance to the adoption of new technologies (Aldas-Manzano et al., 2009; Bauer et al., 2005; Kim et al., 2021). First, innovative consumers may be motivated by their functional needs for new products and may be interested in understanding the utilitarian aspects of a new product (Hirschman, 1984; Venkatraman & Price, 1990). They tend to seek product information and new developments in the marketplace through various media channels, such as mobile communications services, to make shopping decisions (Bauer et al., 2005; Ryu & Murdock, 2013). For example, innovative consumers are more likely to scan a QR code to seek more product information (Ryu & Murdock, 2013). They also may be motivated by cognitive needs and desire mental stimulation, seeking to be involved in mentally demanding activities such as reading and deeply processing information (Vandecasteele & Geuens, 2010). Second, consumer innovativeness is positively correlated with product knowledge (Flynn & Goldsmith, 1993; Goldsmith & Flynn, 1995). Consumer knowledge and expertise influence individuals' abilities to process information (Alba & Hutchinson, 1987) and their confidence in their ability to make inferences (Selnes & Troye, 1989). Therefore, innovative consumers tend to have the ability to understand and apply complex technical knowledge better than less innovative consumers (Rogers, 2003). In summary, consumer innovativeness is an individual difference factor related to a consumer's motivation and ability to process new product information.

We hypothesize that innovative consumers, in contrast to less innovative ones, are more motivated and capable of processing information regarding production methods, leading to a higher likelihood of elaborating on such information. Consequently, innovative consumers are more inclined to perceive the advantages of precision-grown food compared to conventional alternatives and its disadvantages compared to organic options. As a result, they tend to develop more positive responses toward precision-grown food in comparison to conventional options, while their responses tend to be less favorable when compared to organic food.

H3: The impact of consumer innovativeness on consumers' (a) quality beliefs, (b) attitudes, and (c) purchase intentions toward the food is greater when it was produced using precision farming methods compared to conventional farming methods.

H4: The impact of consumer innovativeness on consumers' (a) quality beliefs, (b) attitudes, and (c) purchase intentions toward the food is lower when it was produced using precision farming methods compared to organic farming methods.

Methods

Participants

We conducted a multiple-step online experiment using the research platform Amazon Mechanical Turk (Mturk.com) to recruit participants. A total of 300 general consumers from the U.S. were recruited from Mturk.com; 276 of them completed the full questionnaire. Demographic data including age, gender, education, and income are shown in Table 1. These factors are potential control variables in our data analysis because they are important in consumer evaluations of food products (Ellis & Tucker, 2009).

Table 1

Demographics of Participants (n = 276)

Demographic variables	Frequency	Percent
Age		
18 - 49	250	90.6%
50 - 64	24	8.7%
> 65	2	0.7%
Gender		
Female	116	42.0%
Male	160	58.0%
Education		
Doctoral degree	1	0.4%
Master's degree	67	24.3%
College degree	186	67.4%
High school	22	8.0%
Income		
$29,999 or less	28	10.1%
$30,000 - $49,999	129	46.7%
$50,000 - $99,999	112	40.6%
$100,000 or more	7	2.5%

Experimental Design

To mitigate the demand effect potentially caused by participants' awareness of the study's hypotheses (Rubin, 2016), we employed a multiple-step process in the experiment. In the first step, we posted an invitation letter on Mturk.com, informing participants that the study was for a new online magazine called “Farm, Food & Life,” which was focused on food safety, nutritional health, and the food business. Participants were not told the actual purpose of our study. Instead, they were told they were invited to evaluate some articles in the first version and answer questions about food consumption. Second, in the beginning of the experiment, participants were asked to read three one-paragraph articles from the magazine, each related to a summer camp in a particular farm (Appendix 1). Third, participants were told they were assigned to evaluate an article related to the third farm, Ashley Lake Farm. At this step, each participant was randomly assigned to one of the three conditions (conventional farming = 99, precision farming = 89, and organic farming = 88) to read a paragraph about farming methods used in Ashley Lake Farm (Appendix 2). According to Roscoe (1975), a minimum of 30 responses per message stimulus was required for an experimental study. Therefore, the sample size for each condition in our study is acceptable. Fourth, after reading the paragraph about farming methods, participants were asked to complete a questionnaire of all measures. The questionnaire was designed and administered using the Qualtrics platform. Participants were asked to evaluate food products from Ashley Lake Farm made from cereal grains like wheat, corn, soybean, and oats. We chose cereal grain products because most grains in agricultural production are treated with fertilizers and pesticides to enhance productivity (Bajwa & Sandhu, 2014). Consequently, production method information for these foods is important for consumers to reduce uncertainty and make informed purchasing decisions.

Experiment Stimuli

The experiment included three distinct conditions—conventional, precision, and organic farming—each rooted in a comprehensive one-paragraph description of food production techniques. In the initial phase, these paragraphs were formulated based on a synthesis of prior research studies (Krampe et al., 2021; Kutter et al., 2011; Said Mohamed et al., 2021) and information sourced from the websites of reputable organizations, such as the Food and Agriculture Organization of the United Nations (FAO) (2022), the NIFA (2022), the Environmental Protection Agency (EPA) (2022), and the USDA (2022a, b, c). Subsequently, an evaluation and refinement process ensued, involving the modification of the experiment’s stimuli by two Agronomy professors independently. This iterative review was undertaken to ensure the precision in accurately depicting the nuances of each food production method (Appendix 2).

Measures

Dependent Variables

Quality Beliefs were measured using a three-item, seven-point bipolar scale adapted from Darley and Smith (1993). We focus on a quality category of credence: safety, nutritiousness (health value), and eco-friendliness (sustainability value). Participants rated how likely they thought the food products from Ashley Lake Farm were safe, nutritious, and eco-friendly [1 = Zero likelihood, 7 = Certain; Cronbach’s alpha (α) = .76].

Participants rated *Attitudes* toward the food products from Ashley Lake Farm using a three-item, seven-point bipolar scale adapted from Darley and Smith (1993) (bad/good; not likable/likable; low quality/high quality; α = .90). They also answered the probability that they would consider buying food from Ashley Lake Farm if it were available in a local store using a three-item, seven-point bipolar scale of *Purchase Intentions* adapted from Bearden et al. (1984) (Unlikely/Likely; Impossible/Possible; Improbable/probable; α = .85).

Consumer Innovativeness

Consumer Innovativeness was measured by a six-item, seven-point Likert scale adapted from Goldsmith et al. (2003): (1) In general, I am among the last in my circle of friends to purchase a new product; (2) If I heard that a new product was available through a local store, I would be interested enough to buy it; (3) Compared to my friends, I do little shopping; (4) I will consider buying a new product, even if I haven't heard of it yet; (5) In general, I am the last in my circle of friends to know the names of the latest products on the market; (6) I know more about new products before other people do (1 = strongly disagree, 7 = strongly agree; α = .83).

Covariate Variables

According to previous research, factors such as green consumerism, health consumerism (Sparks & Shepherd, 1992), food purchase decision involvement (Mittal, 1995; Tkaczyk, 2017), and demographics (e.g., age, education, gender, and income) (Ellis & Tucker, 2009) may influence consumer attitudes and purchase intentions toward a food product. Therefore, these variables are considered potential covariates to be controlled for in our data analysis.

Green Consumerism was measured by a three-item, seven-point bipolar scale adapted from Sparks and Shepherd (1992). We asked participants to rate how important in general it is to consider environmental damage, amount of energy, and amount of waste involved in producing food (1 = not important at all, 7 = very important; α = .62). *Health Consumerism* was measured by a five-item, seven-point Likert scale adapted from Sparks and Shepherd (1992). We asked participants to rate to what extent they worry about chemicals in the food, concern about drinking water quality, avoid foods containing nitrites and preservatives, avoid high levels of cholesterol in the diet, and their daily meals are nutritionally balanced (1 = strongly disagree, 7 = strongly agree; α = .69). *Food Purchase Decision Involvement* was measured by a five-item, seven-point Likert scale adapted from Mittal (1995). We asked participants to rate to what extent they agree that, "when buying food products, brand matters to me", "most food products in a given category are similar to each other", "it is very important to me to make the right choice among available food products", "I have an extensive knowledge on food products", and "it is a problem for me if a purchased food product is not up to my expectations" (1 = strongly disagree, 7 = strongly agree; α = .75).

Data Analysis and Results

Consumer Responses Toward Production Method Information

To examine the influence of production method information (conventional farming coded as 1, precision farming as 2, and organic farming as 3) on quality beliefs, attitudes, and purchase intentions as outlined in H1 and H2, we need to conduct a Multivariate Analysis of Covariance (MANCOVA) if covariates are included or a Multivariate Analysis of Variance (MANOVA) if covariates are not included in the test model.

First, univariate normality of raw data of the three dependent variables has been assessed to meet the assumption for multivariate analysis. Statistics of skewness (Quality beliefs = -1.01, Attitudes = -0.89, Purchase intentions = -1.41) and Kurtosis (Quality beliefs = 1.39, Attitudes = 0.18, Purchase intentions = 2.46) for the raw data did not suggest that all the three variables were normally distributed. Therefore, these data were transformed by taking the squared terms for each variable. For the transformed variables, all statistics of skewness (Quality beliefs = -0.63, Attitudes = -0.33, Purchase intentions = -0.32) and Kurtosis (Quality beliefs = 0.08, Attitudes = -0.62, Purchase intentions = -0.26) did not exceed the ±1.00 threshold, indicating each transformed variable was approximately normally distributed. Additionally, the sample size was greater than 200, indicating fewer concerns about non-normally distributed variables (Hair et al., 2019). Thus, the three transformed dependent variables were used for further analysis.

Second, we need to decide whether we should include all dependent variables and potential covariates suggested by existing research (i.e., age, gender, education, income, green consumerism, health consumerism, and food purchase decision involvement) in the test model. Inter-correlations among the independent variable (i.e., production method information), dependent variables, and the potential covariates were evaluated (Table 2). The levels of inter-correlations among the three dependent variables were all between .40 and .60, which was within the recommended range (Hair et al., 2019). Then, we applied a stepwise procedure to determine whether to include covariates for the multivariate analysis and which covariates should be included. We began with variables that had the highest correlations with the dependent variables and no correlations with the independent variable (Hair et al., 2019). The results of the MANOVA and MANCOVA programs suggested that the model without covariates exhibits the highest statistical significance compared to other stepwise models controlling for one to seven potential covariates. Specifically, the model without covariates yielded the lowest Wilk's Lambda = .92 [$F(6, 542) = 3.94$, $p < .001$] and the highest Roy's Largest Root = .09 [$F(3, 272) = 7.74$, $p < .001$], Hotelling's Trace = .09 [$F(6, 540) = 3.99$, $p < .001$], and Pillai's Trace= .08 [$F(6, 544) = 3.88$, $p < .001$] among all stepwise models. Therefore, conducting MANOVA without covariates is the best option to test H1 and H2 in this study.

In addition, Box's M obtained from the MANOVA program was not significant (M=17.87, F = 1.47, df1=12, df2 = 352567.89, p = 0.13), indicating equality of variance-covariance matrices across the three groups (Hair et al., 2019). That suggested that the data met the assumption of homogeneity of variance-covariance matrices for all treatment groups.

Table 2

Correlations of Variables

Variables	Production Method	Quality beliefs	Attitudes	Purchase intentions
Production Method	1			
Quality beliefs	.23**	1		
Attitudes	.20**	.41**	1	
Purchase intentions	.21**	.58**	.59**	1
Age	-.01	.10	.09	.03
Gender	-.00	-.01	-.00	.02
Education	-.06	-.16**	-.07	-.04
Income	.15*	.18**	.10	.08
Food involvement	.08	.47**	.18*	.35**
Green concerns	.10	.53**	.25**	.52**
Health concerns	.20**	.53**	.22**	.47**

Note. * $p < .05$. ** $p < 0.01$.

The results of MANOVA (Table 3) indicated that the production method information significantly influenced participant responses for quality beliefs ($p < .001$), attitudes ($p = .003$), and purchase intentions ($p < .001$). Specifically, the results of the Bonferroni tests revealed significant group differences between precision and conventional farming for quality beliefs ($p = .002$) and purchase intentions ($p = .004$), supporting H1a and H1c, respectively. Additionally, the group difference between precision and conventional farming was marginally significant for attitudes ($p = .063$), providing marginal support for H1b.

However, the group differences between precision and organic farming were all non-significant for quality beliefs ($p = 1.000$), attitudes ($p = .848$), and purchase intentions ($p = .957$). Therefore, H2a, H2b, and H2c are not supported. In addition, the group differences between organic and conventional farming were significant for all three dependent variables (all p-values $< .05$), consistent with previous research (Koch et al., 2017; Rana & Paul, 2017).

Table 3

MANOVA Results for Consumer Responses to Production Method Information (n = 276)

Consumer responses	Production methods						F (2, 273)	p	η^2
	Conventional		Precision		Organic				
	M	*SD*	*M*	*SD*	*M*	*SD*			
Quality beliefs	26.29	10.99	31.39	8.72	32.14	10.59	9.28	<.001**	.064
Attitudes	26.07	12.72	30.10	11.44	32.07	12.26	5.95	.003**	.042
Purchase intentions	29.69	12.58	34.89	9.52	35.35	10.63	7.69	<.001**	.053

Note. * p < .05. ** p < 0.01. The value of production method information was coded as 1 for conventional farming, as 2 for precision farming, and as 3 for organic farming.

Following the significant MANOVA test, we also conducted discriminant function analysis (DFA) to determine the relative importance of each of the three predictors (i.e., quality beliefs, attitudes, and purchase intentions) in discriminating between the three groups based on production methods (Field, 2018; Grice & Iwasaki, 2007; Hair et al., 2019). DFA results (Table 4) revealed Functions 1 through 2 as statistically significant (Wilks's $\lambda = 0.92$, $\chi^2(6) = 23.20$, $p < .001$). The value of canonical correlation for Function 1 was 0.28 and for Function 2 was 0.06, indicating that 8.20% ($0.28^2 + 0.06^2$) of variances in total were explained by the two discriminant functions using the three predictors. In addition, the results of structure matrix (i.e., discriminant loadings) revealed the importance of the three predictors. The discriminant loadings for the three variables in Function 1, which explained most of the variance in the model, all exceeded the ±0.40 threshold, indicating they were all meaningful and thus warranting inclusion for interpretation purposes (Hair et al., 2019).

Table 4.

DFA for Combined Dependent Variables Based on Production Methods

Variables	Structure Matrix		Standardized Canonical Coefficient	
	Function 1	**Function 2**	**Function 1**	**Function 2**
Quality beliefs	0.89	-0.15	0.61	-0.08
Attitudes	0.70	0.31	0.30	1.16
Purchase intentions	0.81	0.61	0.30	-9.92
Functions	**Eigenvalue**	**% of variance**	**Cumulative %**	**Canonical Correlation**
1	0.09	96.20	96.20	0.28
2	0.00	3.80	100.00	0.06
Test of Functions	**λ**	**χ^2**	**df**	**p**
1 through 2	0.92	23.20	6	<.001
2	1.00	0.92	2	0.632

The Impact of Consumer Innovativeness

As suggested by Hair et al. (2019), we conducted a moderation analysis using PROCESS Model 1 in SPSS with 5,000 bootstrap resamples (Hayes, 2017) to examine the interaction effect of consumer innovativeness (independent variable) and production method information (moderator) on quality beliefs, attitudes, and purchase intentions, respectively.

PROCESS is a statistical software tool developed by Andrew F. Hayes (2017) for conducting mediation, moderation, and conditional process analysis, which are techniques that build upon and extend the concepts of regression analysis to examine more complex relationships and interactions among variables. Through a multiple regression analysis, Model 1 in PROCESS examines the interaction effect of one independent variable (e.g., consumer innovativeness) and one moderator (e.g., production method information) on the dependent variable (e.g., quality beliefs). In the regression model, consumer innovativeness, production method information, the interaction term of innovativeness and production method information, and covariate variables are a set of predictors, and each of the three dependent variables (i.e., quality beliefs, attitudes, and purchase intentions) is the outcome or dependent variable. The testing model using PROCESS Model 1 for H3a, H3b, H3c, H4a, H4b, and H4c is depicted in Figure 1. In general term, the PROCESS Model 1 without covariates can be written as:

$$Y = \beta_0 + \beta_1 \times X_1 + \beta_2 \times X_2 + \beta_3 \times X_1 \times X_2 + E \quad (1)$$

where:

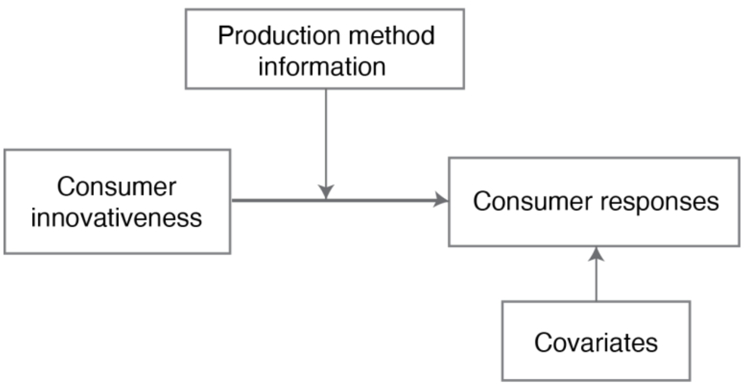
Y = Consumer responses, including quality beliefs, attitudes, and purchase intentions.
X_1 = Consumer innovativeness.
X_2 = Production method information.
β_0 = Constant number.
β_1 = Coefficient associated with consumer innovativeness.
β_2 = Coefficient associated with production method information.

β_3 = Coefficient associated with the interaction term.
E = Prediction error.

Stepwise procedures were conducted to identify covariates for the regression model for each dependent variable (Hair et al, 2019). In the model with quality beliefs as the dependent variable, green consumerism, health consumerism, food purchase decision involvement, age, and income were included as the covariates because each of them increased R^2 by at least one percent. In the model with attitudes as the dependent variable, green consumerism was included as a covariate because it increased R^2 by at least one percent. In the model with purchase intentions as the dependent variable, green consumerism and health consumerism were included as covariates because each of them increased R^2 by at least one percent.

Figure 1

The Interaction effect of Consumer Innovativeness and Production Method Information



Note: The testing model is PROCESS Model 1. The dependent variable "consumer responses" refers to "quality beliefs" in H3a and H4a, "attitudes" in H3b and H4b, and "purchase intentions" in H3c and H4c, respectively.

In addition, a bootstrap resampling process is robust to violations of normality assumptions and can provide accurate confidence intervals and p-values even with non-normal data or small sample sizes. This is appropriate for our study, which employs an experimental design with a relatively small sample size compared to a large-scale survey.

When comparing precision (n = 89) versus conventional (n = 99) farming, only data from these two groups were included in the analysis. The results based on a 5,000 bootstrap resampling process indicated that the interaction effects were positive and significant for attitudes ($p = .005$) and purchase intentions ($p < .001$), supporting H3b and H3c, respectively. However, the interaction effect on quality beliefs was positive but marginal ($p = .056$), providing only marginal support for H3a (Table 5).

When the cross-over point of an interaction falls within the range of values of X_1 (consumer innovativeness), the interaction effect is disordinal, whereas when it falls on the boundary or outside of the range, the interaction effect is ordinal (Widaman et al., 2012). Based on (1), the cross-over point can be calculated using (2) (Widaman et al., 2012):

$$X_1 = -\frac{\beta_2}{\beta_3} \quad (2)$$

The model with quality beliefs as the dependent variable had a cross-over point at X_1 = 3.47 [-(-17.60)/5.07]. Likewise, for attitudes, the cross-over point was at X_1 = 3.76 [-(-40.47)/10.77], and for purchase intentions, it occurred at X_1 = 3.73 [-(-35.77)/9.59]. All three cross-over points fell within the observed range of values (1 to 7) on consumer innovativeness. Therefore, the data significantly supported that the interaction effects of consumer innovativeness and production method information on attitudes and purchase intentions were disordinal. Additionally, the interaction effect on quality beliefs was also disordinal, though marginally supported by the data. In summary, the data support that (1) as innovativeness increases, consumer responses show a greater increase for precision-grown food compared to conventional food, and (2) when innovativeness is low, consumers may tend to have better evaluations for conventional food, whereas when innovativeness is high, consumers tend to have better evaluations for precision-grown food.

Table 5

The Impact of Consumer Innovativeness for Conventional versus Precision Farming (n = 188)

Antecedent	Consequent			
	Quality beliefs (H3a)			
	Coeff	SE	t	p
Consumer innovativeness (X)	-9.56	4.13	-2.32	.022*
Production method (W)	-17.60	10.81	-1.63	.105
X *W	5.07	2.63	1.93	.056
Model summary	R^2 = .39, F(8, 179) = 14.25, p < .001**			
Antecedent	Attitudes (H3b)			
	Coeff	SE	t	p
Consumer innovativeness (X)	-18.09	5.81	-3.11	.002**
Production method (W)	-40.47	15.08	-2.68	.008*
X *W	10.77	3.68	2.93	.004**
Model summary	R^2 = .11, F(4, 183) = 5.51, p < .001**			
Antecedent	Purchase intentions (H3c)			
	Coeff	SE	t	p
Consumer innovativeness (X)	-17.27	4.69	-3.68	< .001**
Production method (W)	-35.77	12.21	-2.93	.004**
X *W	9.59	2.97	3.23	.002**
Model summary	R^2 = .35, F(10, 177) = 19.23, p < .001**			

Note. *p < .05. **p < .01.

When comparing organic (n = 88) versus precision (n = 89) farming, only data from these two groups were included in the analysis. Results based on a 5,000 bootstrap resampling process indicated that the interaction effects on quality beliefs (p = .302), attitudes (p = .311), and purchase intentions (p = .820) were all non-significant (Table 6), providing no evidence for H4a, H4b, and H4c.

In addition, when comparing organic (n = 88) versus conventional (n = 99) farming, only data from these two groups were included in the analysis. Results based on the 5,000 bootstrap resampling process indicated that the interaction effects on the three dependent variables were all significant (all p-values < .05), aligning with previous research (Li et al., 2021).

Table 6

The Impact of Consumer Innovativeness for Precision versus Organic Farming (n = 177)

Antecedent	Consequent			
	Quality beliefs (H4a)			
	Coeff	SE	t	p
Consumer innovativeness (X)	-4.24	6.68	-0.64	.526
Production method (W)	-11.08	11.16	-0.99	.322
X *W	2.81	2.71	1.04	.302
Model summary	R^2 = .44, F(8, 168) = 16.34, p < .001**			
Antecedent	Attitudes (H4b)			
	Coeff	SE	t	p
Consumer innovativeness (X)	-5.03	9.57	0.53	.600
Production method (W)	-14.31	16.07	-0.89	.375
X *W	3.97	3.90	1.02	.311
Model summary	R^2 = .16, F(4, 172) = 8.28, p < .001**			
Antecedent	Purchase intentions (H4c)			
	Coeff	SE	t	p
Consumer innovativeness (X)	3.27	6.98	0.47	.640
Production method (W)	2.74	11.68	0.23	.815
X *W	-0.647	2.84	-0.227	.820
Model summary	R^2 = .40, F(5, 171) = 22.76, p < .001**			

Note. *p < .05. **p < .01.

Discussion/Conclusions/Implications

The present study aims to shed light on consumer adoption of food cultivated through precision farming methods, a prominent sustainable approach projected to be economically and environmentally superior to conventional farming methods (Krampe et al., 2021; Kutter et al., 2011; Said Mohamed et al., 2021). This study is dedicated to enhancing the marketing of precision-grown food by emphasizing that information about food production methods, such as farming techniques, can provide valuable insights into quality aspects. This includes the appropriate utilization of synthetic fertilizers, pesticides, and water during production.

The results indicate consumers tend to have more favorable quality beliefs, attitudes, and purchase intentions toward precision-grown food compared to conventionally grown food when provided with detailed production method information. Our findings highlight the crucial role of information transparency in shaping consumer perceptions of food quality and safety (Rumble &

Irani, 2016; Wu et al., 2020). The results suggest consumers' uncertainty about food quality and safety could be reduced through processing comprehensive production method information. This, in turn, might foster greater acceptance of sustainably grown food, such as precision-grown alternatives, in comparison to conventional options.

Moreover, in alignment with the ELM, our study demonstrates that consumer innovativeness has the potential to enhance positive responses regarding quality beliefs, attitudes, and purchase intentions toward precision-grown food over conventionally grown food. Innovative consumers, as opposed to their less innovative counterparts, possess heightened motivation and capability to comprehend technical details. Consequently, when provided with information about food production techniques, they are more likely to thoughtfully consider the merit of the information and cultivate more favorable beliefs, attitudes, and purchase intentions toward precision-grown food compared to conventional food.

However, using the same conceptual framework, this study fails to provide evidence supporting the hypothesis that consumers would favor organic food over precision-grown food. Instead, it offers evidence that food produced through precision farming could potentially garner comparable positive assessments from consumers as does organic food. It is conceivable that the information surrounding organic farming methods often focuses solely on the absence of synthetic chemicals in the production process. Consumers may still have limited knowledge about the entire production process of organic food (Fatha & Ayoubi, 2023; Naspetti & Zanoli, 2009; Wandel & Bugge, 1997). Positive perceptions and attitudes toward organic food may largely stem from the label "organic" itself. Indeed, recent controversies surrounding organic food, including contamination issues, have led some consumers to express significant concerns about its quality and safety, particularly in terms of trust in the organic supply chain (Naspetti & Zanoli, 2009; Siderer et al., 2005). Detailing production methods may raise consumer concerns about the use of alternative organisms aimed at enhancing soil fertility and addressing pest and disease issues. Consequently, consumers may not perceive more advantages from organic food compared to precision-grown food.

Our findings hold significance for marketers that precision-grown food could emerge as an alternative for consumers seeking non-conventional food options while expressing concerns about the safety of organic food. If marketers can develop effective promotional strategies to convey detailed information about the sustainable technologies used in production, food from precision farming may achieve market success comparable to organic food.

In fact, despite the widespread adoption of organic food in the consumer market, sustainability concerns related to organic farming have been raised by scientists (Poore & Nemecek, 2018). One line of argument stems from the realization that producing an equivalent yield of cash crops through organic farming might require anywhere from 16% to 100% more land when compared to conventional agriculture. Another downside of organic farming is the unsustainable utilization of soil resources (Leifeld, 2012). Promoting precision-grown food may encourage producers to adopt precision agriculture, addressing these sustainability challenges.

In addition, our findings have implications for policymakers. With advancements in labeling technologies like SmartLabel and QR codes, alongside the growth of mobile marketing, there is now the capacity to provide consumers with extensive information through labeling and packaging (Li & Messer, 2019). Therefore, policies related to labeling precision farming practices should be established. It is important to note that the adoption rates of precision agriculture vary among different crops, technologies, and farms (McFadden et al., 2023).

Without regulations, there is a risk of deceptive promotional messages exploiting consumers' positive attitudes and intentions toward food from precision farming.

Limitations and Future Research

The present study reveals that less innovative consumers may not develop more favorable responses toward precision-grown food compared to conventional food through processing production method information, but it does not offer remedies for this issue. Less innovative individuals are less inclined to carefully process technical information. According to the ELM framework, when individuals have a lower motivation or ability to process information and their likelihood of elaboration is low, they would rely on heuristics, such as source credibility, in peripheral thinking for perceptions and judgement (Petty & Cacioppo, 1986). Future research could investigate whether endorsements from innovators or opinion leaders (such as social media influencers) could yield advantageous outcomes in marketing precision-grown food, when targeting less innovative consumers.

In addition, we did not examine consumers' existing knowledge and prior experience of precision-grown and organic food in this study. Consumers' prior knowledge may lead to increased ability to detect superior new products (Varma Citrin et al., 2000). Prior knowledge and experience might mitigate consumer uncertainty and enhance confidence in understanding marketing messages related to food production technologies, warranting further investigation.

Finally, future research could also investigate whether consumers perceive precision farming as a method to reduce production costs, a factor that may benefit producers but not directly benefit consumers. Such perceptions might lead consumers to respond less favorably to this innovation.

Appendix 1. Articles about Three Farms

Article 1. Wake Forest Town Farm

As a non-for-profit, education is front and center at this community farm. Campers and adult of all ages are welcomed here to participate in a myriad programming, such as culinary camps, community event (such as wine dinners), and of course a wide variety of educational talks and workshops on farming and the environment.

Article 2. Rachel Penny Farm

Located on eighteen acres of grazing land, Rachel Penny Farm practices Regenerative Agriculture as their sheep move from field to field, grazing their natural diet while restoring soil health all the while. In addition to the sheep, this teaching and fiber farm boasts llamas, ducks, turkeys, goats, chickens, rabbits, and a potbellied pig named Felix. Camp sizes are limited to eight children.

Article 3. Ashley Lake Farm

Ashley Lake Farm offers summer camps for youth to experience science, technology, engineering, agriculture and math, or STEAM. "One of the things I love about it is the kids are so curious and they're coming up with their own research questions, with their own challenges," said Rachael Weir, a STEAM camp instructor. "They're traveling all over. They went to different places. They saw big machines…"

Appendix 2. Experiment Stimuli

Condition 1: Conventional Farming

Ashely Lake Farm is a typical farm that uses conventional agriculture practices. Producers on this farm use a variety of practices to minimize losses caused by weeds, insects, and diseases, and increase farming profitability. They may apply synthetic chemical pesticides, including herbicides, insecticides, and fungicides, usually through spraying the fields. Synthetic fertilizers containing nitrogen, phosphorus, and potassium are applied to economically meet crop demand and are essential in the production of crops used for food, feed, fiber, and fuel.

Condition 2: Precision Farming

Ashely Lake Farm uses precision agriculture practices. Producers on this farm integrate a variety of advanced technologies such as artificial intelligence (AI), Internet of Things (IoT), and mobile internet to provide "real-world" solutions to increase production, reduce input costs, alleviate potential environmental impacts, and increase profitability. Precision technologies can provide site-specific and real time "on the go" information about crop condition (e.g., weeds, pests, and plant diseases). These technologies can provide reliable information to adjust treatments based on data analysis to meet each site's unique needs, such as the exact amounts of water and synthetic fertilizers/pesticides necessary for the crop, which helps avoid over-irrigation and the misuse of synthetic fertilizers/pesticides from blanket application.

Condition 3: Organic Farming

Ashely Lake Farm uses organic agriculture practices, which is a holistic production management system that promotes and enhances agricultural-ecosystem health. Producers on this farm avoid the use of synthetic fertilizers and chemical pesticides, including herbicides, insecticides, and fungicides. They are much more reliant on production practices, such as crop rotation, tillage, adjustments to planting and harvesting dates, and the use of beneficial organisms to maintain and increase long-term soil fertility and prevent pests and diseases.

References

Alba, J. W., & Hutchinson, J. W. (1987). Dimensions of consumer expertise. *Journal of Consumer Research*, *13*(4), 411–454. https://doi.org/10.1086/209080

Aldas-Manzano, J., Ruiz-Mafe, C., & Sanz-Blas, S. (2009). Mobile commerce adoption in Spain: The influence of consumer attitudes and ICT usage behaviour. In *Handbook of research in mobile business: Technical, methodological, and social perspectives* (2nd ed., pp. 282–292). IGI Global. https://doi.org/10.4018/978-1-60566-156-8.ch026

An, S., Eck, T., & Yim, H. (2023). Understanding consumers' acceptance intention to use mobile food delivery applications through an extended technology acceptance model. *Sustainability*, *15*(1), 832.

Bajwa, U., & Sandhu, K. S. (2014). Effect of handling and processing on pesticide residues in food – A review. *Journal of Food Science and Technology*, *51*, 201-220. https://doi.org/10.1007/s13197-011-0499-5

Bauer, H. H., Reichardt, T., Barnes, S. J., & Neumann, M. M. (2005). Driving consumer acceptance of mobile marketing: A theoretical framework and empirical study. *Journal of Electronic Commerce Research*, *6*(3), 181-192.

Bearden, W. O., Lichtenstein, D. R., & Teel, J. E. (1984). Comparison price, coupon, and brand effects on consumer reactions to retail newspaper advertisements. *Journal of Retailing*, *60*(2), 11-34.

Becker, T. (1999). "Country of origin" as a cue for quality and safety of fresh meat. In Sylvander, B., Barjolle, D. and Arfini, F. (Eds.), *The socio-economics of origin labelled products: Spatial, institutional and co-ordination aspects* (pp. 187-208), Proceedings of the 67th European Association of Agricultural Economists Seminar, LeMans, France. https://doi.org/10.22004/AG.ECON.241034

Bourn, D., & Prescott, J. (2002). A comparison of the nutritional value, sensory qualities, and food safety of organically and conventionally produced foods. *Critical Reviews in Food Science and Nutrition*, *42*(1), 1-34. https://doi.org/10.1080/10408690290825439

Califano, G., Crichton-Fock, A., & Spence, C. (2024). Consumer perceptions and preferences for urban farming, hydroponics, and robotic cultivation: A case study on parsley. *Future Foods*, 100353.

Chamhuri, N., & Batt, P. J. (2015). Consumer perceptions of food quality in Malaysia. *British Food Journal*, *117*(3), 1168-1187. https://doi.org/10.1108/BFJ-08-2013-0235

Clark, R. A., & Goldsmith, R. E. (2005). Market mavens: Psychological influences. *Psychology & Marketing*, *22*(4), 289-312. https://doi.org/10.1002/mar.20060

Darley, W. K., & Smith, R. E. (1993). Advertising claim objectivity: Antecedents and effects. *Journal of Marketing*, *57*(4), 100-113. https://doi.org/10.2307/1252222

de Garidel-Thoron, T. (2005). Welfare-improving asymmetric information in dynamic insurance markets. *Journal of Political Economy*, *113*(1), 121-150. https://doi.org/10.1086/426039

Dinc-Cavlak, O., & Ozdemir, O. (2022). Using the theory of planned behavior to examine repeated organic food purchasing: Evidence from an online survey. *Journal of International Food & Agribusiness Marketing*, 1-30. https://doi.org/10.1080/08974438.2022.2068102

Dranove, D., Kessler, D., McClellan, M., & Satterthwaite, M. (2003). Is more information better? The effects of "report cards" on health care providers. *Journal of Political Economy*, *111*(3), 555-588. https://doi.org/10.1086/374180

Ellis, J. D., & Tucker, M. (2009). Factors influencing consumer perception of food hazards. *CABI Reviews*, 1-8. https://doi.org/10.1079/PAVSNNR20094006

Environmental Protection Agency. (2022, August 17). Organic farming. https://www.epa.gov/agriculture/organic-farming#:~:text=%22Organically%20grown%22%20food%20is%20food,in%20producing%20organically%20grown%20food

Fatha, L., & Ayoubi, R. (2023). A revisit to the role of gender, age, subjective and objective knowledge in consumers' attitudes towards organic food. *Journal of Strategic Marketing, 31*(3), 499-515. https://doi.org/10.1080/0965254X.2021.1939405

Fernqvist, F., & Ekelund, L. (2014). Credence and the effect on consumer liking of food–A review. *Food Quality and Preference*, *32*, 340-353. https://doi.org/10.1016/j.foodqual.2013.10.005

Field, A. (2018). *Discovering statistics using IBM SPSS Statistics* (North American ed., 5th ed.). Sage, Thousand Oaks, CA.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Addison-Wesley Publishing Company.

Flynn, L. R., & Goldsmith, R. E. (1993). A validation of the Goldsmith and Hofacker innovativeness scale. *Educational and Psychological Measurement*, *53*(4), 1105-1116. https://doi.org/10.1177/0013164493053004023

Food and Agriculture Organization of the United Nations. (2022, August 17). What is organic agriculture? https://www.fao.org/organicag/oa-faq/oa-faq1/en

Frewer, L. J., Howard, C., Hedderley, D., & Shepherd, R. (1997). The elaboration likelihood model and communication about food risks. *Risk Analysis*, *17*(6), 759-770. https://doi.org/10.1111/j.1539-6924.1997.tb01281.x

Ghosh, S., Barai, P., & Datta, B. (2019). Identify customer involvement during organic food purchase through FCB grid. *Journal of International Food & Agribusiness Marketing, 31*(3), 237-254. https://doi.org/10.1080/08974438.2018.1520176

Goldman, B. J., & Clancy, K. L. (1991). A survey of organic produce purchases and related attitudes of food cooperative shoppers. *American Journal of Alternative Agriculture*, *6*(2), 89-96. https://doi.org/10.1017/S0889189300003933

Goldsmith, R. E., & Flynn, L. R. (1995). The domain specific innovativeness scale: Theoretical and practical dimensions. In *Association for Marketing Theory and Practice Proceedings* (Vol. 4, pp. 177-182).

Goldsmith, R. E., Flynn, L. R., & Goldsmith, E. B. (2003). Innovative consumers and market mavens. *Journal of Marketing Theory and Practice*, *11*(4), 54-65. https://doi.org/10.1080/10696679.2003.11658508

Grice, P.E., & Iwasaki, M. (2007). A truly multivariate approach to MANOVA. *Applied Multivariate Research, 12* (3), 199-226. http://doi.org/10.22329/amr.v12i3.660

Grunert, K. G. (2005). Food quality and safety: Consumer perception and demand. *European Review of Agricultural Economics*, *32*(3), 369-391. https://doi.org/10.1093/eurrag/jbi011

Hair, J. F. Jr., Black, W.C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning, India.

Hamzaoui-Essoussi, L., & Zahaf, M. (2012). Canadian organic food consumers' profile and their willingness to pay premium prices. *Journal of International Food & Agribusiness Marketing*, 24(1), 1-21. https://doi.org/10.1080/08974438.2011.621834

Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A Regression-Based Approach* (2nd ed.). Guilford Publications.

Hirschman, E. C. (1980). Innovativeness, novelty seeking, and consumer creativity. *Journal of Consumer Research*, *7*(3), 283–295. https://doi.org/10.1016/0148-2963(84)90042-0

Hirschman, E. C. (1984). Experience seeking: a subjectivist perspective of consumption. *Journal of Business research*, *12*(1), 115-136. https://doi.org/10.1016/0148-2963(84)90042-0

Hsu, C.-L., & Chen, M.-C. (2014). Explaining consumer attitudes and purchase intentions toward organic food: Contributions from regulatory fit and consumer characteristics. *Food Quality and Preference*, *35*, 6-13. https://doi.org/10.1016/j.foodqual.2014.01.005

Jin, S., & Zhou, L. (2014). Consumer interest in information provided by food traceability systems in Japan. *Food Quality and Preference*, *36*, 144-152. https://doi.org/10.1016/j.foodqual.2014.04.005

Kamboj, S., & Sharma, M. (2023). Social media adoption behaviour: Consumer innovativeness and participation intention. *International Journal of Consumer Studies, 47*(2), 523-544. https://doi.org/10.1111/ijcs.12848

Keast, R. S. (2009). Food quality perception. In E. Ortega-Rivas (Eds), *Processing effects on safety and quality of foods* (pp. 67-81). CRC press.

Kim, M., Kim, J. H., Park, M., & Yoo, J. (2021). The roles of sensory perceptions and mental imagery in consumer decision-making. *Journal of Retailing and Consumer Services*, *61*, 102517. https://doi.org/10.1016/j.jretconser.2021.102517

Koch, S., Epp, A., Lohmann, M., & Böl, G.-F. (2017). Pesticide residues in food: Attitudes, beliefs, and misconceptions among conventional and organic consumers. *Journal of Food Protection*, *80*(12), 2083-2089. https://doi.org/10.4315/0362-028X.JFP-17-104

Krampe, C., Serratosa, J., Niemi, J. K., & Ingenbleek, P. T. M. (2021). Consumer perceptions of precision livestock farming—A qualitative study in three European countries. *Animals*, *11*(5), 1221. https://doi.org/10.3390/ani11051221

Kutter, T., Tiemann, S., Siebert, R., & Fountas, S. (2011). The role of communication and co-operation in the adoption of precision farming. *Precision Agriculture*, *12*(1), 2-17. https://doi.org/10.1007/s11119-009-9150-0

Leifeld, J. (2012). How sustainable is organic farming? *Agriculture, Ecosystems & Environment*, *150*, 121-122. https://doi.org/10.1016/j.agee.2012.01.020

Leitzmann, C. (1993). Food quality—definition and a holistic view. In *Safeguarding Food Quality* (pp. 3-15). Springer Berlin Heidelberg.

Li, L., Wang, Z., Li, Y., & Liao, A. (2021). Impacts of consumer innovativeness on the intention to purchase sustainable products. *Sustainable Production and Consumption*, *27*, 774-786. https://doi.org/10.1016/j.spc.2021.02.002

Li, T., & Messer, K. D. (2019). To scan or not to scan: The question of consumer behavior and QR codes on food packages. *Journal of Agricultural and Resource Economics*, *44*(2), 311-327. https://www.jstor.org/stable/26797559

Lucht, J. (2015). Public acceptance of plant biotechnology and GM crops. *Viruses*, *7*(8), 4254-4281. https://doi.org/10.3390/v7082819

McFadden, J., Njuki, E., & Griffin, T. (2023, September 6). Precision agriculture in the digital era: Recent adoption on US farms. https://www.ers.usda.gov/publications/pub-details/?pubid=105893

Midgley, D. F., & Dowling, G. R. (1978). Innovativeness: The concept and its measurement. *Journal of Consumer Research*, *4*(4), 229-242. https://doi.org/10.1086/208701

Mittal, B. (1995). A comparative analysis of four scales of consumer involvement. *Psychology & Marketing*, *12*(7), 663-682. https://doi.org/10.1002/mar.4220120708

Mondelaers, K., Aertsens, J., & Guido, V. H. (2009). A meta-analysis of the differences in environmental impacts between organic and conventional farming. *British Food Journal*, *111*(10), 1098-1119. https://doi.org/10.1108/00070700910992925

Naspetti, S., & Zanoli, R. (2009). Organic food quality and safety perception throughout Europe. *Journal of Food Products Marketing*, *15*(3), 249-266. https://doi.org/10.1080/10454440902908019

National Institute of Food and Agriculture. (2022, December 16). Precision agriculture crop production. https://www.nifa.usda.gov/grants/programs/precision-geospatial-sensor-technologies-programs/precision-agriculture-crop-production

Peri, C. (2006). The universe of food quality. *Food Quality and Preference*, *17*(1-2), 3-8. https://doi.org/10.1016/j.foodqual.2005.03.002

Perloff, R. M. (2014). *The dynamics of persuasion: Communication and attitudes in the 21st century* (4th ed.). New York, NY: Routlage.

Petty, R. E., Brinol, P., & Priester, J. R. (2009). Mass media attitude change: Implications of the elaboration likelihood model of persuasion. In J. Bryant, & M. Oliver (Eds.), *Media effects: Advances in theory and research* (3rd ed., pp. 125-164). New York, NY: Routledge.

Petty, R. E., & Cacioppo, J. T. (1986). The Elaboration Likelihood Model of persuasion. In R. E. Petty & J. T. Cacioppo (Eds.), *Communication and persuasion: Central and peripheral routes to attitude change* (pp. 1-24). Springer New York.

Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science*, *360*(6392), 987-992. https://www.science.org/doi/epdf/10.1126/science.aaq0216

Ragaert, P., Verbeke, W., Devlieghere, F., & Debevere, J. (2004). Consumer perception and choice of minimally processed vegetables and packaged fruits. *Food Quality and Preference*, 15(3), 259-270. https://doi.org/10.1016/S0950-3293(03)00066-1

Ramankutty, N., Ricciardi, V., Mehrabi, Z., & Seufert, V. (2019). Trade-offs in the performance of alternative farming systems. *Agricultural Economics*, *50*, 97-105. https://doi.org/10.1111/agec.12534

Rana, J., & Paul, J. (2017). Consumer behavior and purchase intention for organic food: A review and research agenda. *Journal of Retailing and Consumer Services*, *38*, 157-165. https://doi.org/10.1016/j.jretconser.2017.06.004

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Simon and Schuster.

Roscoe, J.T. (1975). *Fundamental research statistics for the behavioral sciences* (2nd ed.) New York: Holt Rinehart & Winston.

Rubin, M. (2016). The perceived awareness of the research hypothesis scale: Assessing the influence of demand characteristics. *Figshare*. https://doi:10.6084/m9.figshare.4315778

Rumble, J. N., & Irani, T. (2016). Opening the doors to agriculture: The effect of transparent communication on attitude. *Journal of Applied Communications*, *100*(2), 57-73. https://doi.org/10.4148/1051-0834.1030

Ruth, T. K., & Rumble, J. N. (2017). What's in a name? The influence of persuasive communication on Florida consumers' attitude toward genetically modified food. *Journal of Applied Communications*, *101*(2). https://doi.org/10.4148/1051-0834.1006

Ruth, T. K., Rumble, J. N., Lamm, A. J., & Ellis, J. D. (2020). How consumers process complex information related to food biotechnology: The case of citrus greening. *Journal of Food Products Marketing*, *26*(2), 103-122. https://doi.org/10.1080/10454446.2020.1736227

Ryu, J. S., & Murdock, K. (2013). Consumer acceptance of mobile marketing communications using the QR code. *Journal of Direct, Data and Digital Marketing Practice*, *15*(2), 111-124. https://doi.org/10.1057/dddmp.2013.53

Said Mohamed, E., Belal, A. A., Kotb Abd-Elmabod, S., El-Shirbeny, M. A., Gad, A., & Zahran, M. B. (2021). Smart farming for improving agricultural management. *Egyptian Journal of Remote Sensing and Space Sciences*, *24*(3), 971-981. https://doi.org/10.1016/j.ejrs.2021.08.007

Schifferstein, H. N. J., & Oude Ophuis, P. A. M. (1998). Health-related determinants of organic food consumption in The Netherlands. *Food Quality and Preference*, *9*(3), 119-133. https://doi.org/10.1016/S0950-3293(97)00044-X

Schrobback, P., Zhang, A., Loechel, B., Ricketts, K., & Ingham, A. (2023). Food credence attributes: a conceptual framework of supply chain stakeholders, their motives, and mechanisms to address information asymmetry. *Foods*, *12*(3), 538.

Selnes, F., & Troye, S. V. (1989). Buying expertise, information search, and problem solving.

Journal of Economic Psychology, *10*(3), 411-428. https://doi.org/10.1016/0167-4870(89)90032-9
Settle, Q., Harvey, L., Ruth, T., & Rumble, J. N. (2023). Young mothers' trust of celebrities and influencers for food safety and nutrition information. *Journal of Applied Communications*, *107*(2), 1-19. https://doi.org/10.4148/1051-0834.2464
Siderer, Y., Maquet, A., & Anklam, E. (2005). Need for research to support consumer confidence in the growing organic food market. *Trends in Food Science & Technology*, *16*(8), 332-343. https://doi.org/10.1016/j.tifs.2005.02.001
Silva, C. B., do Vale, S. M. L. R., Pinto, F. A. C., Müller, C. A. S., & Moura, A. D. (2007). The economic feasibility of precision agriculture in Mato Grosso do Sul State, Brazil: A case study. *Precision Agriculture*, *8*(6), 255-265. https://doi.org/10.1007/s11119-007-9040-2
Sparks, P., & Shepherd, R. (1992). Self-identity and the theory of planned behavior: Assessing the role of identification with "green consumerism." *Social Psychology Quarterly*, *55*(4), 388-399. https://doi.org/10.2307/2786955
Statista (2023a, August 30). Organic retail sales value in the European Union and Europe from 2004 to 2021. https://www.statista.com/statistics/541536/organic-retail-sales-value-european-union-europe-statistic/
Statista (2023b, August 30). Organic food sales in the United States from 2005 to 2022. https://www.statista.com/statistics/196952/organic-food-sales-in-the-us-since-2000/
Sylvester-Bradley, R., Lord, E., Sparkes, D. L., Scott, R. K., Wiltshire, J. J. J., & Orson, J. (2006). An analysis of the potential of precision farming in Northern Europe. *Soil Use and Management*, *15*(1), 1-8. https://doi.org/10.1111/j.1475-2743.1999.tb00054.x
Takács-György, K. (2008). Economic aspects of chemical reduction in farming – future role of precision farming. *Food Economics - Acta Agriculturae Scandinavica Section C*, *5*(2), 114-122. https://doi.org/10.1080/16507540903093242
Teisl, M. F., & Roe, B. (1998). The economics of labeling: An overview of issues for health and environmental disclosure. *Agricultural and Resource Economics Review*, *27*(2), 140-150. https://doi.org/10.1017/s1068280500006468
Tkaczyk, J. (2017). Consumer involvement in the purchase of food products and the willingness to generate feedback through word-of-mouth communication. *Journal of Agribusiness and Rural Development*, *45*(3), 685-692. http://dx.doi.org/10.17306/J.JARD.2017.00345
Tsakiridou, E., Mattas, K., Tsakiridou, H., & Tsiamparli, E. (2011). Purchasing fresh produce on the basis of food safety, origin, and traceability labels. *Journal of Food Products Marketing*, *17*(2-3), 211-226. https://doi.org/10.1080/10454446.2011.548749
United States Department of Agriculture. (2022a, August 17). Organic agriculture. https://www.ers.usda.gov/topics/natural-resources-environment/organic-agriculture/
United States Department of Agriculture. (2022b, August 17). Fertilizers and pesticides. https://www.ers.usda.gov/topics/farm-practices-management/fertilizers-pesticides/
United States Department of Agriculture. (2022c, August 17). Conventional farming. https://www.usda.gov/sites/default/files/documents/coexistence-conventional-farming-factsheet.pdf
Vandecasteele, B., & Geuens, M. (2010). Motivated consumer innovativeness: Concept, measurement, and validation. *International Journal of Research in Marketing*, *27*(4), 308-318. https://doi.org/10.1016/j.ijresmar.2010.08.004
van Rijswijk, W., & Frewer, L. J. (2008). Consumer perceptions of food quality and safety and their relation to traceability. *British Food Journal*, *110*(10), 1034-1046.

https://doi.org/10.1108/00070700810906642

Varma Citrin, A., Sprott, D. E., Silverman, S. N., & Stem, D. E. (2000). Adoption of Internet shopping: the role of consumer innovativeness. *Industrial Management & Data Systems*, *100*(7), 294-300. https://doi.org/10.1108/02635570010304806

Vandecasteele, B., & Geuens, M. (2010). Motivated consumer innovativeness: Concept, measurement, and validation. *International Journal of Research in Marketing*, *27*(4), 308-318. https://doi.org/10.1016/j.ijresmar.2010.08.004

Venkatraman, M. P., & Price, L. L. (1990). Differentiating between cognitive and sensory innovativeness. *Journal of Business Research*, *20*(4), 293-315. https://doi.org/10.1016/0148-2963(90)90008-2

Verbeke, W. (2005). Agriculture and the food industry in the information age. *European Review of Agricultural Economics*, *32*(3), 347-368. https://doi.org/10.1093/eurrag/jbi017

Verbeke, W., & Vackier, I. (2004). Profile and effects of consumer involvement in fresh meat. *Meat Science*, *67*, 159-168. http://doi:10.1016/j.meatsci.2003.09.017

Verbeke, W., & Ward, R. W. (2006). Consumer interest in information cues denoting quality, traceability and origin: An application of ordered profit models to beef labels. *Food Quality and Preference*, *17*(6), 453-467. http://doi:10.1016/j.foodqual.2005.05.010

Walter, A., Finger, R., Huber, R., & Buchmann, N. (2017). Smart farming is key to developing sustainable agriculture. *Proceedings of the National Academy of Sciences*, *114*(24), 6148-6150. https://doi.org/10.1073/pnas.1707462114

Wandel, M., & Bugge, A. (1997). Environmental concern in consumer evaluation of food quality. *Food Quality and Preference*, *8*(1), 19-26. https://doi.org/10.1016/S0950-3293(96)00004-3

Widaman, K. F., Helm, J. L., Castro-Schilo, L., Pluess, M., Stallings, M. C., & Belsky, J. (2012). Distinguishing ordinal and disordinal interactions. *Psychological Methods, 17*(4), 615–622. https://doi.org/10.1037/a0030003

Williams, P. R., & Hammitt, J. K. (2001). Perceived risks of conventional and organic produce: pesticides, pathogens, and natural toxins. *Risk Analysis: An Official Publication of the Society for Risk Analysis*, *21*(2), 319-330. https://doi.org/10.1111/0272-4332.212114

Wu, Y. L., Rumble, J. N., Lamm, A. J., & Ellis, J. D. (2020). Communication of genetic modification science: Consumers' critical thinking style, perceived transparency of information, and attitude. *Journal of International Agricultural and Extension Education*, *27*(2), 49-61. https://doi.org/10.4148/2831-5960.1117