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Original Article

Cultivating trust: public perception of RNAi technologies in agriculture

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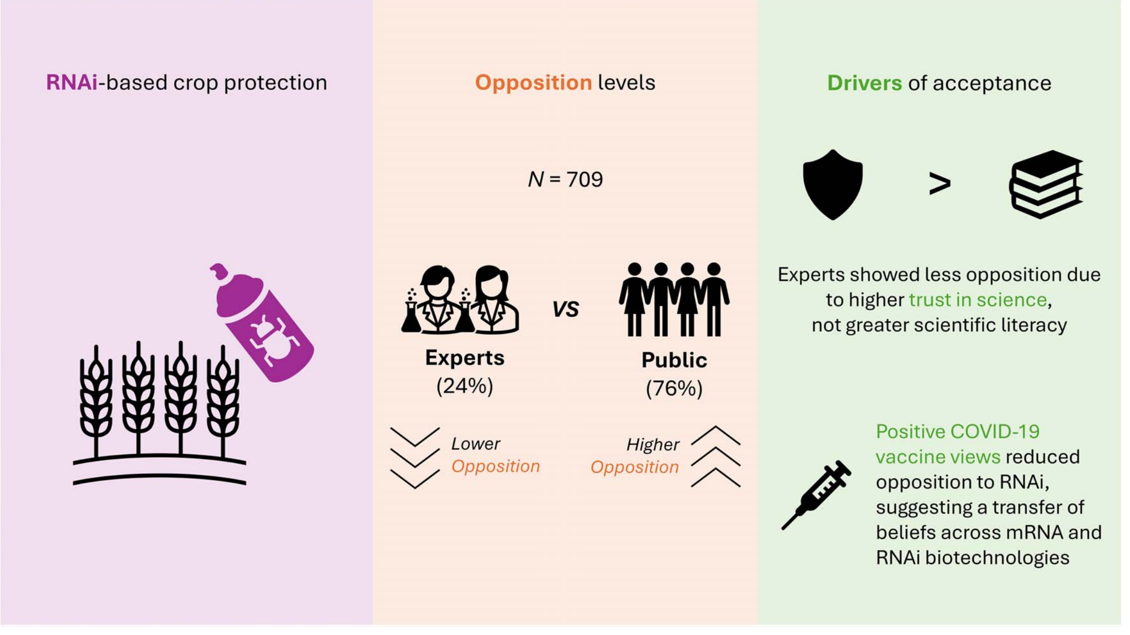
Abstract

RNA interference (RNAi) technology is emerging as a promising avenue for developing innovative agrochemicals to enhance crop protection and reduce reliance on chemical pesticides. However, public acceptance of RNAi in agriculture faces challenges, particularly in Europe, due to strict regulations and societal hesitation toward biotechnological advancements. This study examines the factors influencing opposition to RNAi in agriculture by comparing expert and public views in Italy, focusing on trust in science and scientific literacy as key drivers of acceptance. Findings reveal that experts exhibit significantly lower opposition to RNAi, primarily due to higher trust in science rather than superior scientific literacy. Furthermore, positive attitudes toward RNA-based technologies applied in other fields, such as human health, correlate with reduced opposition to RNAi in agriculture, suggesting a belief transfer across technological domains. These results indicate that trust, rather than knowledge, may play a more pivotal role in shaping public acceptance of RNAi, challenging the traditional knowledge deficit model. Policymakers should prioritise building trust and fostering transparent communication to mitigate scepticism regarding other technologies and emphasise RNAi's unique benefits, thereby encouraging public support for emerging biotechnologies.

Keywords: technology acceptance, biopesticides, public trust, expert-layperson divide, risk communication

Graphical abstract



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Introduction

RNA plays a fundamental role in cellular processes, including gene regulation and defence against diseases. Leveraging this natural mechanism, RNA interference (RNAi) enables precision-targeted silencing of pest genes. Integrating RNAi-based approaches into agricultural practices offers the potential to reduce reliance on traditional pesticides and support environmentally sustainable farming (Mezzetti et al., 2020). Its high specificity minimises environmental risks while enhancing food security, positioning RNAi as a transformative tool for addressing global agricultural challenges (Christiaens et al., 2022; Halder et al., 2022).

RNAi-based technology can be deployed in two ways: by modifying plants to express target double-stranded RNAs (dsRNAs) through host-induced gene silencing or by externally applying dsRNAs to plants *via* spray-induced gene silencing (SIGS) (Cagliari et al., 2019; Das & Sherif, 2020). Both methods exploit RNAi mechanisms to silence specific genes in pests or pathogens, thereby improving plant health. Each approach has its advantages and disadvantages in terms of efficacy, stability, specificity, and regulatory considerations (Cagliari et al., 2019).

The commercial viability of RNAi-based products is significantly influenced by varying regulatory frameworks across different regions. Host-induced gene silencing products, which involve genetic modification of plants to produce dsRNAs, are regulated under Genetically Modified Organism (GMO) guidelines. In contrast, SIGS products, which do not alter a plant's genetic material but involve the external application of dsRNAs, are typically treated as chemical pesticides. For instance, in the European Union, SIGS products fall under Regulation (EC) 1107/2009, which mandates a thorough evaluation by the European Food Safety Authority and subsequent approval by the European Commission (De Schutter et al., 2022).

Despite regulatory challenges, significant progress has been made in some regions. A major milestone in the field of RNAi was achieved in December 2023, when the United States. Environmental Protection Agency (EPA) approved Ledprona, the first sprayable RNAi-based biopesticide for commercial use. Ledprona targets the Colorado potato beetle, a significant pest threatening potato crops across the United States, by silencing a crucial gene in the insect. This biopesticide offers a safer and more sustainable alternative to traditional chemical pesticides, which are often more toxic and less effective due to the development of pest resistance. The EPA's rigorous evaluation confirmed that Ledprona poses no unreasonable risks to human health or the environment, including protected ecosystems (Luo et al., 2024).

However, unlike the progress observed in the United States, the regulatory stance in the European Union is arguably more rigid, potentially stifling innovation and market expansion for RNAi technologies. This approach may deter investment and limit the availability of RNAi products in the EU compared to other regions with more adaptable regulatory frameworks (OECD, 2020).

The use of RNAi in agriculture also faces challenges and uncertainties regarding its public perception and acceptance. While consumers generally embrace technological innovations in many areas of their lives, they often exhibit resistance when such innovations are applied to the food sector (Frisio & Ventura, 2019; Vindigni et al., 2022). This resistance is particularly notable in food production and processing, where caution toward new technologies is common (Verneau et al., 2014). As a result, academic research increasingly focuses on understanding the factors influencing consumer acceptance of these innovations, as the success of these technologies in the market hinges on overcoming consumer scepticism (Califano et al., 2023).

The challenges faced by GMOs highlight the difficulty of gaining public acceptance for biotechnologies (Frisio & Ventura, 2019; Vindigni et al., 2022). Although RNAi technologies differ in mechanisms and applications, they may evoke similar concerns. The COVID-19 pandemic has further complicated the landscape, bringing RNA-based technologies, particularly mRNA vaccines, into public discourse. While the factual association between RNAi and mRNA vaccines is limited, public attitudes toward RNAi in agriculture may be influenced by the controversies surrounding RNA-based vaccines (Salali & Uysal, 2022). Understanding these connections is essential for separating RNAi's benefits from vaccine-related concerns and shaping effective communication strategies.

Addressing public scepticism requires more than knowledge dissemination—it involves building trust in the institutions that regulate these technologies (Miller, 1998; Simis et al., 2016). Studies suggest that trust in scientific institutions, alongside addressing societal and emotional concerns, is key to fostering the acceptance of new technologies (Bromme et al., 2022; Siegrist, 2021). As RNAi technologies advance, effective communication and trust-building efforts are essential for integrating these innovations into sustainable agricultural practices.

Study background

Public perception of risk is recognised as one of the most influential factors affecting the acceptance and commercialization of genetic technologies in plant science. As highlighted by Woźniak et al. (2021), public opinions can significantly shape the market success of such innovations. In Europe, genetic technologies continue to provoke controversy among food consumers, with notable differences in perspectives between experts and laypeople (Ewa et al., 2022). Over the past decades, numerous studies have underscored the varying public perceptions of food risks, influenced by factors such as cultural background, personal knowledge, and the level of trust in science and institutions (Cembalo et al., 2019; Lusk et al., 2014; Pappalardo et al., 2021; Slovic, 1987). These disparities play a crucial role in shaping public opinion and acceptance of food safety practices and new food technologies, highlighting the complexity of addressing concerns about food risks across diverse populations (Slovic, 1987).

One of the seminal works in this field is by Slovic (1987), who was among the first to investigate the potential differences in attitudes toward food risks between lay consumers and experts. Slovic noted that the knowledge deficit among laypeople—their relative lack of scientific understanding—could lead to the rejection of technology. Furthermore, a lack of familiarity with a technology, beyond basic scientific literacy, may contribute to laypeople's reluctance to adopt new food technologies (Lusk et al., 2014). When individuals are unfamiliar with a given technology, this unfamiliarity can foster distrust or concern, particularly with food technologies. The familiarity hypothesis is closely tied to the deficit model, which posits that a lack of knowledge leads to technology rejection (Slovic, 1987). Supporting this theory, Lusk et al. (2014) argue that several studies examining the attitudes of laypeople and experts toward food risks reveal that the knowledge deficit among laypeople is indeed responsible for the rejection of technology (Kato-Nitta et al., 2021; Slovic, 1987).

In light of these findings, scientific literacy—specifically, knowledge of molecular biology and genetics—could play a critical role in shaping attitudes toward RNAi technologies.

Experts equipped with specialised knowledge are more likely to perceive the benefits of these technologies. In contrast, the general public may be more influenced by emotional, sociopolitical factors, and media representations (Frewer et al., 2004). This literacy might enable experts to engage with the complexities of RNAi technology, reducing opposition by providing a clearer understanding of its mechanisms and potential applications in agriculture (Vermeulen et al., 2013). On the other hand, the general public, with lower levels of scientific literacy, may overestimate risks or rely on heuristic thinking, associating terms like "genetically modified" or "RNA-based" with negative connotations (Gaskell et al., 2004).

A significant contribution to this discourse was made by Kato-Nitta et al. (2019), who examined the influence of domain-specific knowledge on attitudes toward gene editing, genetic modification, and conventional crop breeding among Japanese scientists and the general public. Their empirical analysis revealed differences between experts and laypeople in their perceptions of risks, benefits, and values associated with different technologies. Specifically, they found that experts in molecular biology had lower risk perceptions regarding gene editing technology, thus supporting the deficit model theory.

However, some authors have observed that increased scientific knowledge does not always correlate with greater acceptance of technology. Bucchi and Neresini (2002) noted negative correlations between scientific knowledge and attitudes toward technology. Their study, conducted in Italy from 2000 to 2001 on the acceptability of genetically modified foods, found that information exposure does not always lead to increased trust in gene editing technologies. It also showed that greater media exposure to science does not necessarily improve levels of understanding. Additionally, Xu et al. (2023) demonstrated that increasing consumer knowledge about the use of gene editing technologies in livestock reduced consumers' willingness to pay for such products. Recent empirical research has similarly found that while higher scientific literacy supports acceptance of advancements in plant breeding, it does not influence acceptance of advancements in animal breeding (Kato-Nitta et al., 2021). These findings underscore the complexity of public attitudes toward biotechnologies, suggesting that different applications may elicit varying levels of support, even among scientifically informed audiences. Thus, while scientific knowledge remains significantly linked to public attitudes toward science and technology, it may not be the sole determining factor.

The divide between expert and public opinion on scientific innovations is often attributed not only to differences in scientific literacy but also to varying levels of trust in scientific institutions. Trust and scientific literacy may act as complementary yet parallel characteristics that help explain the differences in attitudes between experts and the general public (Sturgis et al., 2010). Trust in science is a key factor influencing public acceptance of new technologies, especially in times of scientific uncertainty or rapid advancement (Siegrist, 2021). Experts, who are embedded within scientific networks and familiar with peer-reviewed research, tend to have higher levels of trust in the scientific process. This trust can lead to greater acceptance of novel technologies like RNAi, where complex biological mechanisms might be challenging for non-experts to fully comprehend (Cummings, 2014). Conversely, individuals sceptical of science or mistrustful of scientific authorities may be more inclined to oppose such technologies, even when evidence supports their safety and efficacy (Wynne, 2006).

An important aspect of the present study is the investigation into the transfer of beliefs from one scientific domain to another. The COVID-19 pandemic, which brought vaccine technologies to the forefront of public debate, offers a unique context for examining how attitudes toward one type of biotechnology might influence perceptions of another. During the pandemic, vaccines—particularly those based on novel mRNA technology—became subjects of widespread debate, with some groups strongly opposing their use while others accepted them as essential public health measures (Salali & Uysal, 2022). Beyond the biological similarities between mRNA vaccines and RNAi technology—both involving RNA-based mechanisms for targeted biological outcomes—there is also a similarity in nomenclature. The presence of "RNA" in both technologies may lead to public confusion, where individuals sceptical of one may transfer their concerns to the other, despite significant differences in their functions and applications.

This study aims to assess the gap between expert and public perspectives on RNAi technologies in agriculture, providing a nuanced understanding of the factors driving opposition. Specifically, it compares the levels of opposition between experts and laypeople and examines the role of expertise components—such as trust in science and scientific literacy—in shaping these attitudes. Furthermore, the study investigates whether attitudes toward COVID-19 vaccines transfer to perceptions of RNAi technologies, offering a broader view of how public trust and beliefs influence the acceptance of emerging biotechnologies.

To this end, the study tests the following research hypotheses:

H1: Acceptance level of RNAi technologies in agriculture is higher among experts compared to laypeople.

H2: Positive attitudes toward COVID-19 vaccines negatively influence opposition to RNAi technologies in agriculture.

H3: The relationship between being an expert and opposition to RNAi technologies in agriculture is mediated by (a) trust in science and (b) knowledge of molecular biology and genetics.

To test these hypotheses, we conducted a survey involving both the general public and experts from universities and research centres. The results will contribute to the ongoing discussion about the integration of new biotechnologies in agriculture and inform strategies for addressing public concerns. Ultimately, understanding these dynamics is crucial for fostering a more informed and nuanced dialogue between scientists, policymakers, and the public regarding the future of sustainable agricultural innovations.

Materials and methods

Participants and procedure

To explore attitudes toward RNAi technologies, data were gathered from participants in Italy through an online survey disseminated *via* social platforms and targeted invitations to researchers in genetics and molecular biology. The final sample consisted of 709 participants: 54% female, 45% male, and 1% who preferred not to specify their sex assigned at birth. Participants ranged in age from 19 to 74 years ($M = 37.9$, $SD = 14.8$), with experts comprising 24% of the sample.

After reading the informed consent and agreeing to participate, respondents were asked whether they had worked or were currently working in a field related to genetics or molecular biology, specifying their area of expertise. They also provided basic sociodemographic information, such as age and sex assigned at birth (see Table 1 for sample characteristics).

Participants then completed a series of psychographic measures. Attitudes toward COVID-19 vaccines were assessed using three items on a 5-point semantic differential scale (Capasso et al., 2021, 2022). Responses ranged from low values, reflecting

Table 1. Sample characteristics ($N = 709$).

	Frequency (*n*)	Percent (%)
Sex assigned at birth		
Male	318	44.85
Female	385	54.30
Prefer not to say	6	0.85
Region		
Northern Italy	128	18.05
Central Italy	46	6.49
Southern Italy or islands	535	75.46
Area of residence		
Village with fewer than 1,000 inhabitants	20	2.82
Town or city with 1,000 to 100,000 inhabitants	424	59.80
City with more than 100,000 inhabitants	265	37.38
Education		
Middle school	25	3.53
High school	212	29.90
University degree	290	40.90
Postgraduate degree	182	25.67
Household income (€/month)		
<2,000	189	26.66
2,000–4,000	334	47.11
>4,000	186	26.23

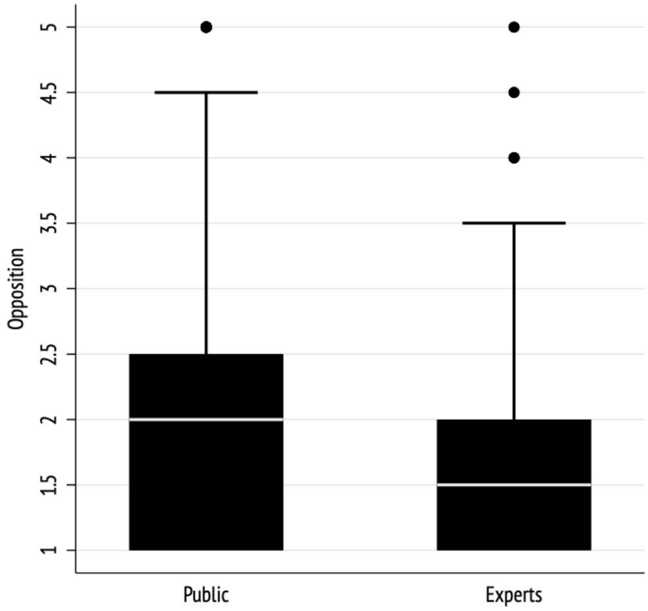

Figure 1. Distribution of opposition for public and experts. The boxplot includes the lowest and highest data points (whiskers), the first and third quartiles (box extremities), the median (line within the box), and any outliers (represented as dots).

the negative pole ("Harmful/Useless/Dangerous"), to high values, reflecting the positive pole ("Beneficial/Useful/Safe") (Cronbach's $\alpha = 0.86$).

Trust in science was measured using 10 items on a Likert scale ranging from 1 ("Strongly disagree") to 5 ("Strongly agree") (Farias et al., 2013). An example item is: 'Science is the most efficient means of attaining truth' (Cronbach's $\alpha = 0.93$).

Participants then indicated their attitudes toward the use of RNAi technology in agriculture by responding to two questions about their opposition (1 = no opposition; 5 = extreme opposition) and concern (1 = no concern; 5 = extreme concern) (adapted from Fernbach et al., 2019). Overall, 53% of respondents expressed some degree of opposition to the use of RNAi technologies, and 64% reported some level of concern. Opposition and concern regarding RNAi technologies in agriculture were strongly correlated ($r = 0.76$, $p < .001$); hence, the average of these two scores was used as the primary dependent variable, referred to as "opposition."

Finally, participants' general knowledge of molecular biology and genetics was assessed through seven true/false items (see Table 2). Correct responses were coded as 1, while incorrect and "don't know" responses were coded as 0. The total score, ranging from 0 to 7 ($M = 3.76$, $SD = 1.77$), was used for analysis. As expected, experts demonstrated significantly higher objective knowledge ($M = 5.25$, $SD = 1.19$) compared to non-experts ($M = 3.30$, $SD = 1.66$), $t(707) = 14.12$, $p < .001$.

Statistical analysis

An independent samples *t*-test was performed to assess differences in opposition between experts and non-experts (H1). To address H2 and H3, a Partial Least Squares Structural Equation Model (PLS-SEM) was employed, supplemented by two mediation analyses. Similar to Covariance-Based SEM, PLS-SEM comprises a measurement model (outer model) and a structural model (inner model). The outer model evaluates the associations between constructs and their indicators, while the inner model examines the relationships among constructs (Venturini & Mehmetoglu, 2019).

PLS-SEM was selected for its flexibility in integrating latent and observed variables and its robustness in estimating relationships under conditions of small sample sizes and non-normal data distributions (Hair et al., 2017). The reliability and validity of the measurement model were confirmed through multiple criteria: factor loadings exceeding 0.5, Cronbach's α and rho_A values above 0.7, and an Average Variance Extracted (AVE) of 0.5 or greater for convergent validity. Discriminant validity was verified using the Fornell-Larcker criterion (Venturini & Mehmetoglu, 2019). The structural model was evaluated based on the significance and magnitude of the path coefficients.

To test mediation effects, the Baron and Kenny (1986) stepwise approach, adjusted by Iacobucci et al. (2007), was used. This method consists of a series of regression analyses to establish mediation by evaluating the relationships between the independent variable, mediator, and dependent variable. First, the independent variable (i.e., being an expert) must significantly predict the dependent variable (i.e., opposition to RNAi technologies). Second, the independent variable must significantly predict the mediator (e.g., trust in science). Third, the mediator must significantly predict the dependent variable when controlling for the independent variable. Finally, mediation is confirmed if the effect of the independent variable on the dependent variable is reduced (partial mediation) or becomes nonsignificant (complete mediation) when the mediator is included in the model.

Results

The results of the *t*-test revealed that experts exhibited significantly lower levels of opposition ($M = 1.70$, $SD = 0.82$) compared to non-experts ($M = 2.02$, $SD = 1.01$), $t(707) = -3.85$, $p < .001$, supporting H1 (see Figure 1).

Regarding the PLS-SEM analysis, Table 3 shows the results of the measurement model, indicating adequate factor loadings for the three constructs analysed. Cronbach's α (as well as rho_A) also shows good reliability for opposition, attitude toward COVID-19 vaccines, and trust in science.

Table 2. Knowledge of molecular biology and genetics: Questionnaire used and participants' responses.

Statement	Alternatives	Responses	
		n	%
1. Cloning of living beings produces offspring that are exactly identical.	True	316	44.57
	False	149	21.02
	Don't know	244	34.41
2. Beer yeast contains living organisms.	**True**	480	67.70
	False	69	9.73
	Don't know	160	22.57
3. It is possible to detect if a baby will have Down syndrome in the first months of pregnancy.	**True**	539	76.02
	False	42	5.92
	Don't know	128	18.05
4. It is possible to transfer animal genes onto plants.	**True**	173	24.40
	False	127	17.91
	Don't know	409	57.69
5. Conventional tomatoes do not contain genes, while genetically modified ones do.	True	40	5.64
	False	372	52.47
	Don't know	297	41.89
6. By eating a genetically modified fruit, a person's genes could be altered.	True	24	3.39
	False	524	73.91
	Don't know	161	22.71
7. Genetically modified fruits and vegetables are always larger than ordinary ones.	True	55	7.76
	False	430	60.65
	Don't know	224	31.59

Note. In bold the correct answers.

Table 3. Partial Least Squares Structural Equation Model (PLS-SEM) measurement model, with factor loadings, Cronbach's α, and rho$_A$.

	OPP	ATT	TRUST	Knowledge	Expert
OPP.1	0.937				
OPP.2	0.928				
ATT.1		0.899			
ATT.2		0.895			
ATT.3		0.864			
TRUST.1			0.784		
TRUST.2			0.765		
TRUST.3			0.794		
TRUST.4			0.804		
TRUST.5			0.694		
TRUST.6			0.827		
TRUST.7			0.728		
TRUST.8			0.762		
TRUST.9			0.841		
TRUST.10			0.755		
Knowledge				–	
Expert					–
Cronbach's α	0.850	0.864	0.927	–	–
rho$_A$	0.853	0.868	0.936	–	–

Note. OPP = opposition to RNAi technologies; ATT = attitude toward COVID-19 vaccines; TRUST = trust in science.

In addition, the results for discriminant validity (Table 4) show low conceptual overlap between constructs, with AVE for each factor largely exceeding the square of correlations between other factors.

Figure 2 illustrates the results of the structural model, showing the standardised direct path coefficients between the variables. The negative and significant relationship between attitudes toward COVID-19 vaccines and opposition to RNAi technologies in agriculture suggests that more positive attitudes toward vaccines were associated with lower opposition to RNAi, supporting H2.

Table 4. Squared interfactor correlation vs. AVE.

	OPP	ATT	TRUST	Knowledge	Expert
OPP	–				
ATT	0.077	–			
TRUST	0.096	0.101	–		
Knowledge	0.019	0.024	0.040	–	
Expert	0.019	0.030	0.030	0.225	–
AVE	0.870	0.785	0.603	–	–

Note. OPP = opposition to RNAi technologies; ATT = attitude toward COVID-19 vaccines; TRUST = trust in science.

Opposition was also negatively influenced by trust in science, but not by scientific literacy or expert status. Additionally, being an expert was positively associated with trust in science and objective knowledge. Attitudes toward COVID-19 vaccines were positively influenced by both knowledge and, to a greater extent, trust in science.

Finally, Table 5 presents the results of mediation analyses. The results indicate a complete mediation effect between being an expert and opposition to RNAi technologies for trust in science (H3a), but not for objective knowledge (H3b). These findings suggest that the lower opposition observed among experts was primarily explained by their higher trust in science, rather than merely their higher scientific literacy.

Discussion

This study provides insights into the public and expert attitudes toward RNAi-based technologies in agriculture, specifically focusing on the factors that shape opposition. The results highlight that opposition is significantly lower among experts compared to the general public, primarily driven by higher levels of trust in science rather than superior objective knowledge. Furthermore, the findings suggest a notable association between attitudes toward

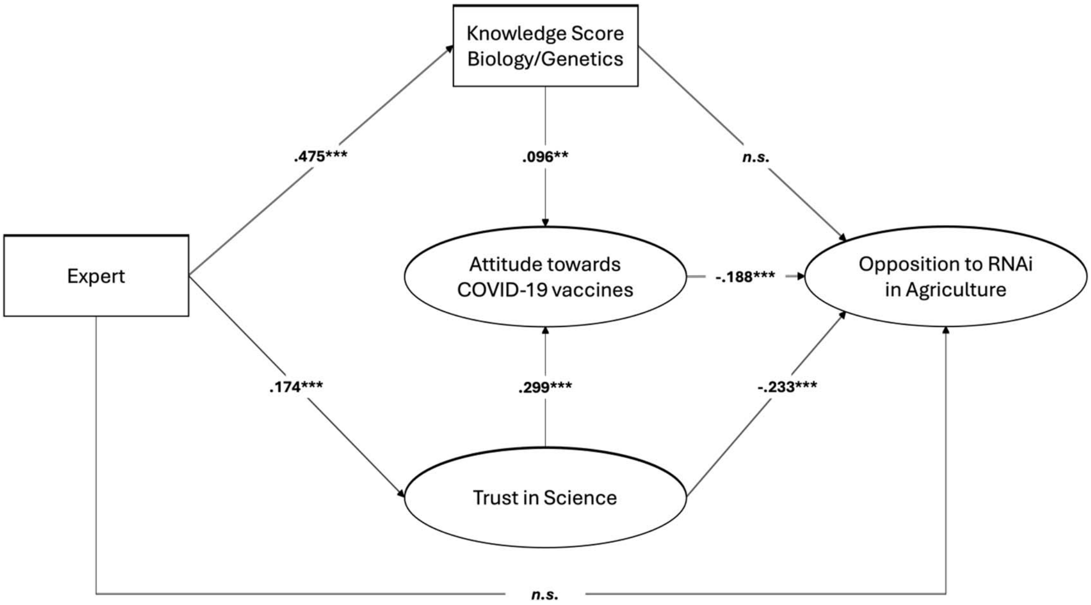

Figure 2. PLS-SEM structural model with standardised direct effects. R^2 knowledge = .224; R^2 trust = .029; R^2 attitude = .108; R^2 opposition = .131; *n.s.* = $p > .05$; $^{**}p < .01$; $^{***}p < .001$; PLS-SEM = partial least squares structural equation model.

Table 5. Results of the mediation analysis.

	Indirect effect	Bootstrap *SE*	z	*p*-value	Mediation
Expert → Knowledge → OPP	−0.019	0.020	−0.949	0.372	None
Expert → TRUST → OPP	−0.041	0.011	−3.513	<0.001	Complete

Note. OPP = opposition to RNAi technologies; TRUST = trust in science. Bootstrap replications = 1,000.

COVID-19 vaccines and perceptions of RNAi technologies, confirming the transfer of beliefs between these two biotechnological domains.

The first hypothesis (H1), which posited that experts would show less opposition to RNAi technologies, was supported by the data. Experts demonstrated significantly lower opposition levels, consistent with the literature indicating that scientific expertise often correlates with greater acceptance of novel biotechnologies. This finding mirrors previous studies on GMOs and nanotechnologies, where experts—equipped with a deeper understanding of the underlying scientific mechanisms—tended to perceive lower risks than the public (Pappalardo et al., 2021; Siegrist et al., 2007).

However, this divide should not solely be attributed to differences in scientific literacy. Experts' higher trust in science emerged as the primary mediating factor in shaping their attitudes. While experts scored significantly higher on the knowledge scale, the mediation analysis showed that trust in science played a more critical role in reducing opposition to RNAi technologies (H3a). This finding supports the argument that while scientific literacy is important, trust is a more powerful determinant of acceptance, particularly in complex and novel biotechnologies (Cummings, 2014; Wynne, 2006).

The second hypothesis (H2), which explored the relationship between attitudes toward COVID-19 vaccines and opposition to RNAi technologies, was also supported. Participants who held positive attitudes toward COVID-19 vaccines were less likely to oppose RNAi technologies in agriculture. This result underscores the role of public trust in science and suggests that trust-related attitudes may transfer across scientific domains. This transfer of beliefs has been observed across similar biotechnological innovations (Salali & Uysal, 2022).

The cognitive consistency theory provides a framework for understanding this relationship, suggesting that individuals strive to maintain coherent beliefs across related domains, particularly when trust serves as a heuristic in decision-making (Siegrist et al., 2021). This has important implications for public communication strategies, as fostering trust in one domain, such as vaccines, could enhance public acceptance of other biotechnologies, particularly those sharing similar scientific foundations, like RNA-based mechanisms (Salali & Uysal, 2022). Conversely, negative biases toward COVID-19 vaccines may obstruct the acceptance of RNAi in agriculture. While leveraging the familiarity of vaccines to promote RNAi might seem intuitive, these findings highlight the necessity of clear and differentiated communication strategies to mitigate misconceptions and avoid unwarranted generalisations of risks across distinct technologies.

The results regarding H2 also challenge the traditional knowledge deficit model, which suggests that public opposition to new technologies stems from a lack of information or understanding (Miller, 1998; Simis et al., 2016). Simply increasing public knowledge about RNAi technologies may not be sufficient to reduce scepticism or opposition. Instead, fostering trust in scientific institutions and addressing emotional and societal concerns may be more effective strategies for increasing acceptance. This finding aligns with research emphasising the importance of trust in shaping public attitudes toward science. Studies show that trust is often more influential than knowledge in determining whether individuals accept or reject new technologies (Bromme et al., 2022; Siegrist, 2021). Therefore, efforts to engage the public should focus not only on improving scientific literacy but also on building and maintaining trust in the institutions that regulate and communicate about these technologies (Stilgoe et al., 2014).

The findings have important implications for policymakers and communicators seeking to foster public acceptance of RNAi technologies in agriculture. The strong relationship between trust in science and opposition highlights the need for transparent and consistent communication from scientific and regulatory bodies. Public trust can be undermined when communication is inconsistent or when regulatory processes are perceived as opaque or biassed. Therefore, clear, evidence-based communication about the safety, efficacy, and environmental benefits of RNAi technologies is essential for building and maintaining public trust (De Schutter et al., 2022; Hamstra, 2005).

Moreover, given the association between attitudes toward COVID-19 vaccines and RNAi technologies, policymakers should consider how public debates and communication strategies about one technology may influence perceptions of another. For instance, misinformation about RNA-based vaccines could spill over into opposition to agricultural biotechnologies, while positive communication strategies emphasising the benefits of RNA-based innovations may foster acceptance across multiple domains (Kossowska et al., 2021).

While the study offers important insights, it is not without limitations. One key limitation is the use of a convenience sample, which may introduce selection bias and limit the generalizability of the findings. The sample was recruited primarily through social media, potentially over representing individuals more engaged with scientific issues or with strong opinions about biotechnologies. Future research should aim to use more representative sampling methods to capture a broader range of public attitudes. Additionally, the study was conducted in Italy, which has its own unique cultural and regulatory context for biotechnologies. Public attitudes toward new technologies vary significantly across countries, influenced by cultural, political, and economic factors (Gaskell et al., 2004). Future research should explore how attitudes toward RNAi technologies differ across cultural contexts, as well as how regulatory frameworks influence perceptions. Another limitation is the cross-sectional nature of the study, which prevents causal inferences about the relationships between trust, knowledge, and opposition.

Conclusion

This study highlights the critical role that trust in science plays in shaping public acceptance of RNAi technologies in agriculture. Our findings show that opposition to RNAi is significantly lower among experts, primarily due to their higher trust in scientific institutions rather than superior knowledge. This challenges the idea that simply increasing public knowledge will reduce opposition, emphasising instead the need to build trust and address societal concerns.

The study also reveals that attitudes toward COVID-19 vaccines can transfer to perceptions of RNAi technologies. Those with positive views on vaccines were more likely to support RNAi, suggesting that trust in one scientific domain can influence attitudes toward others. This highlights the importance of consistent, transparent communication across different areas of science to avoid negative spillovers from unrelated technologies.

Moreover, our results suggest that public scepticism toward RNAi cannot be addressed solely through educational campaigns. A more effective approach involves fostering trust, engaging with ethical and environmental concerns, and ensuring transparency in the regulatory process. Differences in regulatory frameworks, such as the more flexible U.S. approach compared to the rigid European Union policies, further affect the adoption and public perception of RNAi technologies.

In conclusion, the successful integration of RNAi into sustainable agricultural practices will require strategies that build public trust, involve clear communication, and support adaptable regulatory frameworks. Future research should continue exploring the links between public trust, knowledge, and attitudes toward emerging biotechnologies.

Data availability

The data that support the findings of this study are available from the corresponding author upon request.

Author contributions

Daniela Spina (Conceptualization, Investigation, Methodology, Writing—original draft [equal]), Gioacchino Pappalardo (Methodology [equal]), Maria Raimondo (Writing—original draft, Writing—review & editing [equal]), Giovanbattista Califano (Data Curation, Writing—original draft [equal]), Giuseppe Di Vita (Writing—review & editing [equal]), Francesco Caracciolo (Formal analysis, Writing—review & editing [equal]), and Mario D'Amico (Supervision [equal]).

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Conflicts of interest

None declared.

Acknowledgements

None declared.

Ethical statement

Before starting the questionnaire, participants were informed about the anonymity of data collection and gave written (electronic) consent, declaring that they were at least 18 years old. This study was performed in accordance with the Declaration of Helsinki. The data were analysed anonymously.

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