

Exploring the Influence of Demographic Impact on Agricultural and Science Knowledge in Georgia

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Abstract

In an era marked by widespread access to information and debates over truth, the need for scientific and agricultural knowledge has become increasingly crucial. This study examined the demographic characteristics and baseline science and agricultural knowledge scores of respondents in Georgia using a non-probability, purposive sampling approach delivered through a Qualtrics survey. Results showed significant variation in science knowledge scores based on ethnicity, generational age, education, income, political ideology, and political affiliation, with higher scores among Boomers and the Silent Generation, individuals with graduate or professional degrees, and those with higher incomes. Gender differences in science knowledge were not statistically significant. Agricultural knowledge scores, however, varied significantly by gender, generational age, education, and political ideology. Female respondents, Boomers, and those with graduate or professional degrees scored highest, while no significant differences were observed based on ethnicity, income, or political affiliation. The findings highlight the importance of demographic factors in shaping science and agricultural literacy and emphasize the need for targeted educational policies and public outreach efforts. Addressing these disparities is critical for fostering a greater understanding of complex scientific and agricultural issues in society.

Introduction

The need for agricultural and scientific knowledge has been firmly established as society continues to progress, leveraging advancements in both fields to address critical challenges such as food security, environmental sustainability, and technological innovation (Burrows et al., 2020; Kovar & Ball, 2013; University of California Berkeley, n.d.). However, recent calls for increased knowledge among the American public have been echoed due to the rapid spread of misinformation that contradicts research-based information, particularly regarding agricultural and environmental topics (Howell & Brossard, 2021). The dissemination of misinformation on social media has made it increasingly difficult for the public to discern factual information from misconceptions (Garbacz, n.d.). With 50% of adults in the United States now obtaining news at least occasionally from social media platforms such as Facebook, YouTube, Instagram, and TikTok (Pew Research Center, 2023), the challenge of navigating complex scientific and agricultural issues has become more pronounced. This shift in news consumption highlights the critical

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importance of scientific and agricultural literacy, as individuals are increasingly exposed to complex, interdisciplinary topics without the traditional gatekeeping mechanisms of more established media. Therefore, fostering a deeper understanding of both science and agriculture is essential for empowering individuals to make informed decisions based on credible sources and navigate the digital landscape effectively.

A strong connection between science and agriculture is crucial to fostering this understanding (Vallera & Bodzin, 2016). Recent science and environmental education reform documents emphasize integrating disciplines like agriculture to promote conscientious citizenship and lifelong learning, with a focus on interdisciplinary concepts (NRC, 2012). By bridging science and agriculture, educational initiatives aim to prepare individuals to navigate complex, interconnected issues such as food security and technological innovation (Vallera & Bodzin, 2016).

Furthermore, as society grapples with issues at the intersection of science and agriculture, encompassing social, economic, and political dimensions, foundational understanding of these subjects becomes important (Hess, 2011). Voters and consumers of agricultural and scientific products should possess the knowledge needed to make informed decisions. A deficiency in agricultural comprehension leaves individuals susceptible to misinformation concerning food and agriculture (Mercier, 2018). Similarly, a lack of scientific knowledge often leads individuals to embrace pseudoscience, which masquerades as legitimate science but begins with predetermined claims rather than objective inquiry (Mercer, 2021). Society's ability to address the growing demands of agriculture and science depends on consumer understanding and acceptance of technological innovations and novel production methods.

Complementing these imperatives is a growing recognition of the significance of demographic characteristics, including ethnic identities, social class, geographical location, and gender (Gibson et al., 2020). Just as agricultural products exhibit diversity, so do the operations and individuals driving them, reflecting a multifaceted landscape characterized by differences in gender, ethnicity, age, and geographical location. The United States is undergoing a transformative demographic shift, with projections indicating a profound change in its composition by 2060 (Colby & Ortman, 2015). Notably, one of the fastest-growing demographic groups is Hispanics, comprising half of all population growth from 2010-2019 (Noe-Bustamante et al., 2020). Recognizing and understanding these demographic dynamics is crucial for effectively addressing the complex challenges at the nexus of science, agriculture, and society, as it allows for a comprehensive examination of how different demographics influence and interpret scientific and agricultural knowledge.

Demographic Effects on Science Knowledge

A 2015 Pew Research Center survey, using another set of questions to measure science knowledge, indicated White Americans scored higher versus Black participants and Hispanic participants, although sample sizes for Black participants and Hispanic participants were relatively low and, only a bivariate analysis was presented. Additionally, the same survey results indicated generally younger adults displayed slightly higher overall knowledge of science than adults ages 65 and older (Pew Research Center, 2015).

In a 2019 Pew Research Center study, findings revealed significant disparities in science knowledge across demographic groups. White participants outperformed Hispanic and Black participants on the science knowledge index, averaging 7.6 correct answers out of 11 questions, compared to 5.1 for Hispanic participants and 3.7 for Black participants. Additionally, about half of White participants (48%) were measured as having high science knowledge, compared to only 23% of Hispanic participants and 9% of Black participants. Furthermore, the study indicated men generally scored higher than women on the science knowledge scale, with men averaging 7.4 correct answers and women averaging 6.0. Approximately half of men (49%) scored high on the scale, compared to 30% of women. However, gender

differences were not consistent across all science knowledge questions. Interestingly, political affiliation showed no significant differences in science knowledge levels between Republicans and Democrats. Republicans and Independents leaning toward the Republican Party averaged seven correct answers, while Democrats and Independents leaning toward the Democratic Party averaged 6.6. Nevertheless, individuals at the ideological extremes (i.e., liberal Democrats and conservative Republicans) scored higher than those in the political middle. Age did not significantly affect science knowledge levels, with similar averages across age groups. However, differences existed across specific questions on the scale. Statistical models controlling for gender, race/ethnicity, and education found no significant differences by age.

Demographic Effects on Agricultural Knowledge

The most widely cited definition of agricultural literacy is as follows: “possessing knowledge and understanding of the food and fiber system. An individual possessing such knowledge would be able to synthesize, analyze, and communicate basic information about agriculture” (Frick, 1990, p. 52; National Center for Agricultural Literacy, n.d.). In the context of the current study, agricultural knowledge was used to operationally define agricultural literacy (Whitehead & Estep, 2016). A study conducted by Lewis (2018) measured the effect of generation on agricultural literacy and found the Baby Boomer generation was more agriculturally literate than Generation X and Millennials. The study did not reveal any significant differences regarding respondents’ race and agricultural literacy. Similarly, a more recent study by Hand (2020) found males, older generations (Silent, Boomer, and Gen X), White respondents, and respondents with bachelor’s degrees had the highest levels of agricultural literacy. Furthermore, Whitehead and Estep (2016) assessed agricultural knowledge and perceptions among Hispanic and non-Hispanic students in agriscience programs near the Mexico border, while also examining how demographic factors influenced these perceptions and knowledge. The study found most students, regardless of ethnicity, scored poorly in all areas of agricultural knowledge except for one. Non-Hispanic students were the only group to achieve a passing score in environmental and natural resource knowledge (Whitehead & Estep, 2016).

Ultimately, there is a gap in research specifically aimed at studying agricultural knowledge with a focus on demographic characteristics. The current study was designed to identify demographic differences in agricultural knowledge to contribute to the existing literature.

National Agricultural Literacy Outcomes

In this study, we used the National Agricultural Literacy Outcomes (NALOs) as the framework to examine levels of agricultural knowledge in respondents. The National Center for Agricultural Literacy relies upon NALOs for determining agricultural literacy benchmarks (Judd-Murray, 2019). NALOs were constructed to serve as a tool for assessment unification for agricultural literacy stakeholders. The development of NALOs established a valid framework to provide consistency for determining the literacy level of adults (post-high school or grade 12 completion; Judd-Murray, 2019; Spielmaker & Leising, 2013). The development framework consisted of past literature, national education standards, current definitions, and the use of a Delphi method to ensure content and construct validity. NALOs consist of five benchmark themes: (1) agriculture and the environment; (2) plants and animals for food, fiber & energy; (3) food, health, and lifestyle; (4) science, technology, engineering & math; (5) culture, society, economy & geography (Judd-Murray, 2019). Past literature indicated that NALOs should be used as benchmarks for future assessment research (Brandt, 2016). Additionally, NALOs are aligned with the national educational standards for science, social studies, and health, therefore supporting the accuracy and relevance of the framework themes to daily life (Spielmaker & Leising, 2013). NALOs provide a well-established structure for assessing agricultural knowledge, ensuring this study’s findings contribute to ongoing discussions about the importance of agricultural education and outreach.

Science Literacy

National Science Board Science & Engineering Indicators

The National Science Board's *Science and Engineering Indicators* is the primary source of patterns and trends in the science enterprise in the United States. The National Science Board is required under the National Science Foundation Act to prepare and transmit the biennial Science and Engineering Indicators report to the President of the United States and Congress every even-numbered year since 2006 (National Science Board, 2016). This study used the Science and Engineering Indicators as the framework to examine levels of science knowledge in respondents as they provide high-quality quantitative information on the United States science and engineering enterprise (National Science Board, 2022). Each indicator provides a partial measure of overall activity, therefore multiple indicators facilitate a more accurate and comprehensive understanding of an issue. A good indicator is policy-relevant, contributing to an understanding of the current environment and informing the development of future policies (National Science Board, 2022). Indicators generally emphasize neutral and factual descriptions using simple statistical tools and then invite the exploration of more sophisticated causal models and relationships by the research community (National Science Board, 2022). When possible, the indicator is a direct measure of the intended concept, however, if the intended concept is hard to measure directly, related or proxy indicators are the best available (National Science Board, 2022). How well the survey-based indicator represents the intended population depends on how well the survey has been able to obtain responses from the targeted population (National Science Board, 2022). This is relevant to the study as the accuracy of the findings relies on the diversity and representativeness of the sample. If certain demographic groups are under or overrepresented, the conclusions drawn regarding agricultural and science knowledge across these populations may be skewed.

Pew Research Center Science Knowledge Quiz

This study also used the *Pew Research Center Science Knowledge Quiz*, which was developed to gauge the extent to which the public shares a unified understanding of scientific facts and processes in an era marked by easy access to information and sometimes intense debates over truth and falsehoods (Pew Research Center, 2019). The quiz, covering knowledge related to life sciences, earth and other physical sciences, numeracy, and understanding of scientific processes, was designed to serve as a comprehensive tool for assessing science knowledge (Pew Research Center, 2019). To evaluate the effectiveness of the quiz as a scale or index of science knowledge, several criteria were considered: 1) the internal consistency of responses, 2) the reflection of a single underlying latent dimension by the questions, and 3) the scale's ability to discriminate between individuals with high and low levels of knowledge, thus providing insights into varying levels of science knowledge (Pew Research Center, 2019). The scale demonstrated high internal reliability, with a Cronbach's alpha coefficient of 0.86, indicating strong consistency among responses (Pew Research Center, 2019). Importantly, Cronbach's alpha did not increase with the removal of any items, affirming the scale's robustness (Pew Research Center 2019).

Purpose and Objectives

The purpose of this study was to examine demographic characteristics and baseline science and agricultural knowledge scores of respondents in Georgia. We used the following research objectives to guide the study:

RO1: Describe respondents' baseline science knowledge scores.

RO2: Describe respondents' baseline agricultural knowledge scores.

RO3: Identify the relationship between respondents' baseline science knowledge scores and their demographic characteristics.

RO4: Identify the relationship between respondents' baseline agriculture knowledge scores and their demographic characteristics.

Methodology

To address the proposed research objectives, we administered an online survey using Qualtrics to assess respondents' baseline science and agricultural knowledge scores. This study is part of a larger research effort to identify consumer perceptions of food and environmental impacts in Georgia.

Population and Sample

We used a non-probability, purposive sampling approach and recruited participants through Qualtrics Panels. Eligible participants were 18 years of age or older and resided in Georgia. Qualtrics applied internal panel matching and quota sampling based on key demographic variables (e.g., age, gender, race/ethnicity) to approximate the demographic distribution of Georgia residents, as reported in the 2020 U.S. Census. While the sampling strategy did not constitute a census, we aimed to create a broadly representative sample of Georgia's adult population.

We initially collected 503 responses. After removing incomplete responses and those who failed quality checks (e.g., straight-lining, speeding, incorrect responses to instructed items), we retained 492 usable responses ($n = 492$). The completion rate, determined by comparing the number of participants who started and completed the survey, was 97.8%.

The majority of respondents identified as female (67.4%, $n = 335$), non-Hispanic (81.3%, $n = 409$), and Millennial (32.7%, $n = 161$). Politically, the sample was moderate, with 44.3% ($n = 218$) identifying as such. Detailed respondent demographics can be viewed in Table 1.

Table 1*Demographics of Respondents (N = 492)*

		<i>n</i>	<i>%</i>
Gender	Female	335	68.1
	Male	154	31.3
	Non-binary/ other	3	.06
Ethnicity	Non-Hispanic/Latino(a)/Chicano(a)	409	81.3
	Hispanic/Latino(a)/Chicano(a)	83	16.9
Generational Age	Gen. Z	70	14.2
	Baby Boomer	146	29.7
	Gen. X	96	19.5
	Millennials	161	32.7
	Silent Gen.	19	3.9
Education	Less than 12 th grade	13	2.6
	High School	107	21.7
	Some college	117	23.8
	2-year college	117	23.8
	4-year college	67	13.6
	Graduate or Professional degree	71	14.4
Income	Less than \$25,000	110	22.3
	\$25,000 - \$49,999	122	24.7
	\$50,000 - \$74,999	118	23.9
	\$75,000 - \$149,999	105	21.3
	\$150,000 - \$249,999	26	5.3
	\$250,000 or more	11	2.2
Political Ideology	Very Liberal	46	9.3
	Liberal	62	12.6
	Moderate	218	44.3
	Conservative	101	20.5
	Very Conservative	65	13.2
Political Affiliation	Republican	196	39.84
	Democrat	172	34.96
	Independent	112	22.76
	Other	12	2.44

Instrument Development

Data were collected through a series of questions derived from the prior literature (National Science Foundation *Science and Engineering Indicators*; Pew Research Center *Science Knowledge Quiz*; Spielmaker & Leising, 2013), to acquire baseline agriculture and science knowledge scores. A panel of

experts, comprising a Professor of Science Communication and two Associate Professors of Agricultural Communication from the University of Georgia, reviewed the instrument for face and content validity. The panel evaluated items for clarity, accuracy, readability, and survey flow (Dillman et al., 2014; Wimmer & Dominick, 2014). To ensure reliability, prior to launching the survey questionnaire, a pilot test was conducted with a similar but separate sample to assess the reliability of the adapted scale items (Dillman et al., 2014). All scale items were found to be reliable ($\alpha \geq .80$), and we proceeded with the data collection process (Dillman et al., 2014; Wimmer & Dominick, 2014).

Data Collection Procedure and Variables

To complete the survey, the respondents were first asked to complete the University of Georgia approved IRB consent form. They then answered a series of agricultural and science literacy questions, followed by demographic items. At the end of the survey, we thanked participants for their time.

Science Knowledge

Science knowledge was assessed using a 10-item questionnaire, with questions adapted from the Pew Research Center Science Knowledge Quiz and the National Science Foundation's Science and Engineering Indicators. Questions included: "Oil, natural gas, and coal are examples of...", "Which of the following is an example of genetic engineering?," "What is the main cause of seasons on the Earth?," "A baby's biological gender is determined by which of the following?," "Which of the following are the smallest?," "Many diseases have an incubation period. Which of the following best describes what an incubation period is?," "When large areas of forest are removed so land can be converted for other uses, such as farming, which of the following occurs?," "An antacid relieves an overly acidic stomach because the main components of antacids are...", "Which of these is a major concern about the overuse of antibiotics?," and "Which is the process plants use to make sunlight into a food source?" For each question, respondents received a score of 1 for a correct answer and 0 for an incorrect answer. The total score, calculated by summing the 10 responses, represented an overall baseline science knowledge score. Higher scores indicated greater science knowledge (Holt et al., 2020; Lamm et al., 2020; Martinez et al., 2021).

Agricultural Knowledge

Respondents' agricultural knowledge was assessed using an eight-item questionnaire adapted from the National Agricultural Literacy Outcomes (Spielmaker & Leising, 2013), focusing on food and fibers. For each question, respondents received a score of 1 for a correct response and 0 for an incorrect response. The eight scores were summed to calculate an overall baseline agricultural knowledge score (Holt et al., 2020; Lamm et al., 2020; Martinez et al., 2021). Respondents answered the following questions: "Which country's citizens spend the smallest percentage of personal income on food?," "What is the primary indicator of a nation's economic stability?," "Two factors that determine the plants and animals that grow best in any given region of the world are ____ and ____," "Which of these plays a major role in both increasing the utilization of and improving the quality of animal feeds?," "Based on the image of the food label, what is the primary ingredient?," "Which of the following is a natural resource?," "Which is the reason a beneficial insect may be added to a garden or field?," and "Which is a reason for processing foods?" A mean score was calculated to represent respondents' overall agricultural knowledge, with higher scores indicating greater knowledge.

Data Analysis

We analyzed the data using SPSS 26.0. Given the categorical and numeric nature of the data, we conducted ANOVA tests to compare science and agricultural knowledge scores across demographic variables (Ziapoor & Kianipour, 2016).

We assessed normality using Shapiro–Wilk tests and visual inspection of histograms and Q–Q plots for both science and agricultural knowledge scores. While minor deviations from normality were observed, these were within acceptable limits given our large sample size ($n = 492$), and the ANOVA procedure is generally robust to such deviations. Boxplots revealed a small number of mild outliers but no extreme values; therefore, all data points were retained in the analysis.

SPSS 26.0 software was used to analyze the data. Categorical and numeric data were collected in this study; therefore, ANOVA tests between agricultural and science knowledge scores compared across multiple demographic variables were used to address the research objectives in this study (Ziapoor & Kianipoor, 2016).

Limitations

As a non-probability sample, the findings may not be generalizable to the broader population beyond Georgia. However, this approach was appropriate given this study's focus on residents within a specific geographic region.

Results

ROI: Describe respondents' baseline science knowledge scores

The respondents' science knowledge was assessed through 10 questions, resulting in an overall mean score of $M = 0.56$ ($SD = 0.23$). Table 2 presents the percentages of correct responses for each individual science knowledge question. The highest average score was observed on the question about the process plants use to make food from sunlight (photosynthesis), with 84.1% answering correctly. The lowest average score was observed on the question about determining a baby's biological gender, with 49.0% answering correctly.

Table 2

Percent Correct for Science Knowledge Questions (N = 492)

Question	% Correct
Oil, natural gas, and coal are examples of...	68.1%
Which of the following is an example of genetic engineering?	43.5%
What is the main cause of seasons on the Earth?	57.7%
A baby's biological gender is determined by which of the following?	49.0%
Which of the following are the smallest?	23.2%
Many diseases have an incubation period. Which of the following best describes what an incubation period is?	74.0%
When large areas of forest are removed so land can be converted for other uses, such as farming, which of the following occurs?	54.1%
An antacid relieves an overly acidic stomach because the main components of antacids are...	31.7%
Which of these is a major concern about the overuse of antibiotics?	77.4%
Which is the process plants use to make sunlight into a food source?	84.1%

Note. Responses were coded as 0 (incorrect) and 1 (correct). Higher means indicate greater knowledge accuracy.

RO2: Describe respondents' baseline agricultural knowledge scores

Respondents' agricultural knowledge was evaluated through eight agriculture-related questions, resulting in an overall mean score of $M = 0.55$ ($SD = 0.19$). Table 3 presents the percentages of correct responses for each agricultural knowledge question. The highest average score was observed on the question regarding the identification of the primary ingredient on a food label, with 82.2% of respondents answering correctly. The lowest score was for the question on which country's citizens spend the smallest percentage of their income on food, with only 30.4% answering correctly.

Table 3*Percent Correct for Agricultural Knowledge Questions (N = 492)*

Question	% Correct
Which country's citizens spend the smallest percentage of personal income on food?	30.4%
What's the primary indicator of a nation's economic stability?	42.3%
Two factors that determine the plants and animals that grow best in any given region of the world are ____ and ____.	58.9%
Which of these plays a major role in both increasing the utilization of and improving the quality of animal feeds?	51.0%
Based on the image of the food label, what is the primary ingredient?	82.2%
Which of the following is a natural resource?	66.2%
Which is the reason a beneficial insect may be added to a garden or field?	78.9%
Which is a reason for processing foods?	32.8%

Note. Responses were coded as 0 (incorrect) and 1 (correct). Higher means indicate greater knowledge accuracy.

RO3: Identify the relationship between respondents' baseline science knowledge scores and their demographic characteristics.

To examine the relationship between respondents' science knowledge scores and their demographic characteristics, a series of one-way ANOVAs were conducted for gender, ethnicity, generational age, education, household income, political ideology, and political affiliation. The results of these analyses are presented below, with each demographic analyzed separately.

Gender

A one-way ANOVA was conducted to compare science knowledge scores between males and females. The analysis revealed no statistically significant difference in scores, $F(1, 487) = 2.204$, $p = 0.138$, $\eta^2 = 0.005$ (see Table 4). Descriptive statistics showed males ($M = 0.587$, $SD = 0.239$) scored slightly higher than females ($M = 0.554$, $SD = 0.226$; see Table 5). Due to the small sample sizes of the non-binary and 'prefer not to answer' groups ($n = 1$ and $n = 2$, respectively), these respondents were excluded from the analysis to ensure statistical reliability. Only Male ($n = 154$) and Female ($n = 335$) respondents were included in the final analysis.

Table 4*ANOVA Results for Gender and Science Knowledge Scores*

Source	Sums of Squares	<i>df</i>	Mean Square	F	<i>p</i>	η^2
Gender	0.11	1	0.11	2.20	.138	.005

Note. Significance at the $p < .05$ level.

Table 5*Descriptive Statistics for Gender and Science Knowledge Scores*

Gender	<i>n</i>	<i>M</i>	<i>SD</i>
Male	154	0.58	0.23
Female	335	0.55	0.22

Note. Science knowledge scores range from 0 (no correct responses) to 1 (all responses correct).

Ethnicity

A one-way ANOVA compared science knowledge scores between Hispanic/Latino(a)/Chicano(a) and non-Hispanic/Latino(a)/Chicano(a) respondents. The analysis revealed a statistically significant difference, $F(1, 490) = 6.644$, $p = 0.010$, $\eta^2 = 0.013$ (see Table 6). Non-Hispanic respondents ($M = 0.575$, $SD = 0.229$) scored higher than Hispanic respondents ($M = 0.504$, $SD = 0.234$; see Table 7).

Table 6*ANOVA Results for Ethnicity and Science Knowledge Scores*

Source	Sums of Squares	<i>df</i>	Mean Square	F	<i>p</i>	η^2
Ethnicity	0.35	1	0.35	6.64	.010	.013

Note. Significance at the $p < .05$ level.

Table 7*Descriptive Statistics for Ethnicity and Science Knowledge Scores*

Ethnicity	<i>n</i>	<i>M</i>	<i>SD</i>
Hispanic/Latino(a)/Chicano(a)	83	0.50	0.23
non-Hispanic/Latino(a)/Chicano(a)	409	0.57	0.22

Note. Science knowledge scores range from 0 (no correct responses) to 1 (all responses correct).

Generational Age

A one-way ANOVA was conducted to examine the relationship between generational age and science knowledge scores. The analysis revealed a statistically significant effect of generational age on science knowledge, $F(4, 487) = 8.109$, $p < 0.001$, $\eta^2 = 0.062$ (see Table 8). Descriptive statistics showed Boomers ($M = 0.6267$, $SD = 0.21557$) and the Silent generation ($M = 0.6368$, $SD = 0.19497$) scored the highest, while Millennials scored the lowest ($M = 0.4856$, $SD = 0.22894$; see Table 9). Post hoc Tukey tests

indicated Millennials scored significantly lower than Boomers ($p < 0.001$) and the Silent generation ($p = 0.047$). No other pairwise differences were statistically significant.

Table 8

ANOVA Results for Generational Age and Science Knowledge Scores

Source	Sums of Squares	df	Mean Square	F	p	η^2
Generational Age	1.63	4	0.40	8.10	.001	.062

Note. Significance at the $p < .05$ level.

Table 9

Descriptive Statistics for Generational Age and Science Knowledge Scores

Gender	n	M	SD
Gen Z	70	0.55	0.24
Millennial	146	0.48	0.22
Gen X	96	0.56	0.21
Boomer	161	0.62	0.21
Silent	19	0.63	0.19

Note. Generational age categories are defined as follows: Gen Z (born 1997–2012), Millennial (born 1981–1996), Gen X (born 1965–1980), Boomer (born 1946–1964), and Silent (born before 1946). Science knowledge scores range from 0 (no correct responses) to 1 (all responses correct).

Education

A one-way ANOVA was conducted to compare science knowledge scores across education levels. The results showed a statistically significant effect of education on science knowledge, $F(5, 486) = 7.221$, $p < .001$, $\eta^2 = 0.069$ (see Table 10). Descriptive statistics revealed science knowledge scores increased with higher education levels, with graduate or professional degree holders scoring highest ($M = 0.6478$, $SD = 0.24946$) and those with less than 12th-grade education scoring lowest ($M = 0.4692$, $SD = 0.29264$; see Table 11). Post hoc Tukey tests indicated significant differences between high school graduates and those with graduate or professional degrees ($p < .001$), as well as between some college education and graduate degree holders ($p = .043$).

Table 10

ANOVA Results for Education and Science Knowledge Scores

Source	Sums of Squares	df	Mean Square	F	p	η^2
Education	1.80	5	0.36	7.22	.001	.069

Note. Significance at the $p < .05$ level.

Table 11

Descriptive Statistics for Education and Science Knowledge Scores

Education	<i>n</i>	<i>M</i>	<i>SD</i>
Less than 12th grade	13	0.46	0.29
High school graduate	107	0.47	0.20
Some college, no degree	117	0.54	0.20
2-year college degree	71	0.58	0.24
4-year college degree	117	0.60	0.21
Graduate or professional degree	67	0.64	0.24

Note. Science knowledge scores range from 0 (no correct responses) to 1 (all responses correct).

Income

A one-way ANOVA was conducted to examine the relationship between household income and science knowledge scores. The results showed a statistically significant effect of income on science knowledge, $F(5, 486) = 2.759, p = 0.018, \eta^2 = 0.028$ (see Table 12). Descriptive statistics revealed science knowledge scores generally increased with higher income levels, with respondents earning \$150,000 to \$249,999 scoring highest ($M = 0.6269, SD = 0.24258$) and those earning less than \$25,000 scoring lowest ($M = 0.5073, SD = 0.23135$; see Table 13). Post hoc Tukey tests indicated a significant difference between respondents earning less than \$25,000 and those earning \$75,000 to \$149,999 ($p = 0.028$).

Table 12

ANOVA Results for Income and Science Knowledge Scores

Source	Sums of Squares	<i>df</i>	Mean Square	F	<i>p</i>	η^2
Income	0.72	5	0.14	2.75	.018	.028

Note. Significance at the $p < .05$ level.

Table 13

Descriptive Statistics for Gender and Science Knowledge Scores

Income	<i>n</i>	<i>M</i>	<i>SD</i>
<\$25,000	110	0.50	0.23
\$25,000-\$49,999	122	0.54	0.21
\$50,000-\$74,999	118	0.58	0.22
\$75,000-\$149,999	105	0.60	0.23
\$150,000-\$249,999	26	0.62	0.24
\$250,000+	11	0.53	0.26

Note. Science knowledge scores range from 0 (no correct responses) to 1 (all responses correct).

Political Ideology

A one-way ANOVA was conducted to examine the relationship between political beliefs and science knowledge scores. The analysis revealed a statistically significant effect of political ideology on science knowledge, $F(4, 487) = 3.319, p = 0.011, \eta^2 = 0.027$ (see Table 14). Descriptive statistics indicated

Liberal respondents scored the highest ($M = 0.6081$, $SD = 0.21140$), while Very Liberal respondents scored the lowest ($M = 0.4804$, $SD = 0.23629$; see Table 15). Post hoc Tukey tests showed significant differences between Very Liberal and Liberal respondents ($p = 0.035$) and between Very Liberal and Conservative respondents ($p = 0.020$). No other pairwise comparisons were statistically significant.

Table 14*ANOVA Results for Political Ideology and Science Knowledge Scores*

Source	Sums of Squares	<i>df</i>	Mean Square	F	<i>p</i>	η^2
Political Ideology	0.69	4	0.17	3.31	.011	.027

Note. Significance at the $p < .05$ level.

Table 15*Descriptive Statistics for Political Ideology and Science Knowledge Scores*

Political Ideology	<i>n</i>	<i>M</i>	<i>SD</i>
Very Liberal	46	0.48	0.23
Liberal	62	0.60	0.21
Moderate	218	0.54	0.22
Conservative	101	0.60	0.23
Very Conservative	65	0.57	0.23

Note. Science knowledge scores range from 0 (no correct responses) to 1 (all responses correct).

Political Affiliation

A one-way ANOVA was conducted to examine the relationship between political affiliation and science knowledge scores. The analysis revealed a statistically significant effect of political affiliation on science knowledge, $F(3, 488) = 3.584$, $p = 0.014$, $\eta^2 = 0.022$ (see Table 16). Descriptive statistics indicated respondents identifying as “Other” scored the highest ($M = 0.7083$, $SD = 0.21933$; see Table 17), while Democrats scored the lowest ($M = 0.5308$, $SD = 0.22745$). Post hoc Tukey tests showed a significant difference between Democrats and those identifying as “Other” ($p = 0.048$). No other pairwise comparisons were statistically significant.

Table 16*ANOVA Results for Political Affiliation and Science Knowledge Scores*

Source	Sums of Squares	<i>df</i>	Mean Square	F	<i>p</i>	η^2
Political Affiliation	0.56	3	0.18	3.58	.014	.022

Note. Significance at the $p < .05$ level.

Table 17

Descriptive Statistics for Political Affiliation and Science Knowledge Scores

Political Affiliation	<i>n</i>	<i>M</i>	<i>SD</i>
Republican	196	0.58	0.21
Democrat	172	0.53	0.22
Independent	112	0.55	0.25
Other	12	0.70	0.21

Note. Science knowledge scores range from 0 (no correct responses) to 1 (all responses correct).

RO4: Identify the relationship between respondents’ baseline agriculture knowledge scores and their demographic characteristics.

To examine the relationship between respondents’ agricultural knowledge scores and their demographic characteristics, a series of one-way ANOVAs were conducted for gender, ethnicity, generational age, education, household income, political ideology, and political affiliation. The results of these analyses are presented below, with each demographic analyzed separately.

Gender

A one-way ANOVA was conducted to compare agricultural knowledge scores between males and females. The analysis revealed a statistically significant difference in scores, $F(1, 487) = 4.417, p = .036, \eta^2 = .009$ (see Table 18). Descriptive statistics showed females ($M = 0.566, SD = 0.182$) scored higher than males ($M = 0.528, SD = 0.188$; see Table 19). Due to the small sample sizes of the non-binary and 'prefer not to answer' groups ($n = 1$ and $n = 2$, respectively), these respondents were excluded from the analysis to ensure statistical reliability. Only Male ($n = 154$) and Female ($n = 335$) respondents were included in the final analysis.

Table 18

ANOVA Results for Gender and Agricultural Knowledge Scores

Source	Sums of Squares	<i>df</i>	Mean Square	F	<i>p</i>	η^2
Gender	0.14	1	0.41	4.41	.036	.009

Note. Significance at the $p < .05$ level.

Table 19

Descriptive Statistics for Gender and Agricultural Knowledge Scores

Gender	<i>n</i>	<i>M</i>	<i>SD</i>
Male	154	0.52	0.18
Female	335	0.56	0.18

Note. Agricultural knowledge scores range from 0 (no correct responses) to 1 (all responses correct).

Ethnicity

A one-way ANOVA was conducted to examine the relationship between ethnicity and agricultural knowledge scores. The analysis revealed no statistically significant difference in scores, $F(1, 490) = 2.412, p = .121, \eta^2 = .005$ (see Table 20). Descriptive statistics showed non-Hispanic respondents ($M = 0.5587,$

$SD = 0.184$, $n = 409$) scored slightly higher than Hispanic respondents ($M = 0.5241$, $SD = 0.188$, $n = 83$; see Table 21).

Table 20

ANOVA Results for Ethnicity and Agricultural Knowledge Scores

Source	Sums of Squares	df	Mean Square	F	p	η^2
Ethnicity	0.08	1	0.08	2.41	.121	.005

Note. Significance at the $p < .05$ level.

Table 21

Descriptive Statistics for Ethnicity and Agricultural Knowledge Scores

Ethnicity	n	M	SD
Hispanic/Latino(a)/Chicano(a)	83	0.52	0.18
non-Hispanic/Latino(a)/Chicano(a)	409	0.55	0.18

Note. Agricultural knowledge scores range from 0 (no correct responses) to 1 (all responses correct).

Generational Age

A one-way ANOVA was conducted to examine the relationship between generational age and agricultural knowledge scores. The analysis revealed a statistically significant effect of generational age on agricultural knowledge, $F(4, 487) = 6.914$, $p < .001$, $\eta^2 = .054$ (see Table 22). Descriptive statistics indicated Boomers scored the highest ($M = 0.6095$, $SD = 0.152$, $n = 161$), while Millennials scored the lowest ($M = 0.5120$, $SD = 0.209$, $n = 146$; see Table 23). Post hoc Tukey tests revealed significant differences between Boomers and Gen Z ($p = .005$) as well as Boomers and Millennials ($p < .001$). No other pairwise comparisons were statistically significant.

Table 22

ANOVA Results for Generational Age and Agricultural Knowledge Scores

Source	Sums of Squares	df	Mean Square	F	p	η^2
Generational Age	0.90	4	0.22	6.91	.001	.054

Note. Significance at the $p < .05$ level.

Table 23*Descriptive Statistics for Generational Age and Agricultural Knowledge Scores*

Gender	<i>n</i>	<i>M</i>	<i>SD</i>
Gen Z	70	0.51	0.17
Millennial	146	0.51	0.20
Gen X	96	0.55	0.18
Boomer	161	0.60	0.15
Silent	19	0.49	0.19

Note. Generational age categories are defined as follows: Gen Z (born 1997–2012), Millennial (born 1981–1996), Gen X (born 1965–1980), Boomer (born 1946–1964), and Silent (born before 1946). Agricultural knowledge scores range from 0 (no correct responses) to 1 (all responses correct).

Education

A one-way ANOVA was conducted to examine the relationship between education level and agricultural knowledge scores. The analysis revealed a statistically significant effect of education level on agricultural knowledge, $F(5, 486) = 3.682, p = .003, \eta^2 = .036$ (see Table 24). Descriptive statistics indicated respondents with a Graduate or Professional degree scored the highest ($M = 0.5933, SD = 0.172, n = 67$), while those with less than a 12th-grade education scored the lowest ($M = 0.4231, SD = 0.120, n = 13$; see Table 25). Post hoc Tukey tests showed significant differences between respondents with a Graduate or Professional degree and those with less than a 12th-grade education ($p = .027$) and high school graduates ($p = .039$). No other pairwise comparisons were statistically significant.

Table 24*ANOVA Results for Education and Agricultural Knowledge Scores*

Source	Sums of Squares	<i>df</i>	Mean Square	F	<i>p</i>	η^2
Education	0.61	5	0.12	3.68	.003	.036

Note. Significance at the $p < .05$ level.

Table 25*Descriptive Statistics for Education and Agricultural Knowledge Scores*

Education	<i>n</i>	<i>M</i>	<i>SD</i>
Less than 12th grade	13	0.42	0.12
High school graduate	107	0.50	0.19
Some college, no degree	117	0.57	0.18
2-year college degree	71	0.57	0.17
4-year college degree	117	0.55	0.17
Graduate or professional degree	67	0.59	0.17

Note. Agricultural knowledge scores range from 0 (no correct responses) to 1 (all responses correct).

Income

A one-way ANOVA was conducted to examine the relationship between household income and agricultural knowledge scores. The analysis did not reveal a statistically significant effect of household income on agricultural knowledge, $F(5, 486) = 1.989, p = .079, \eta^2 = .020$ (see Table 26). Descriptive statistics showed respondents earning \$50,000 to \$74,999 scored the highest ($M = 0.5816, SD = 0.166, n = 118$), while those earning \$250,000 or more scored the lowest ($M = 0.4773, SD = 0.146, n = 11$; see Table 27). No pairwise comparisons reached statistical significance in the post hoc Tukey tests.

Table 26

ANOVA Results for Income and Agricultural Knowledge Scores

Source	Sums of Squares	df	Mean Square	F	p	η^2
Income	0.33	5	0.06	1.98	.079	.020

Note. Significance at the $p < .05$ level.

Table 27

Descriptive Statistics for Gender and Agricultural Knowledge Scores

Income	n	M	SD
<\$25,000	110	0.52	0.19
\$25,000-\$49,999	122	0.55	0.19
\$50,000-\$74,999	118	0.58	0.16
\$75,000-\$149,999	105	0.57	0.18
\$150,000-\$249,999	26	0.51	0.17
\$250,000+	11	0.47	0.14

Note. Agricultural knowledge scores range from 0 (no correct responses) to 1 (all responses correct).

Political Ideology

A one-way ANOVA was conducted to examine the relationship between political ideology and agricultural knowledge scores. The analysis revealed a statistically significant effect of political ideology on agricultural knowledge, $F(4, 487) = 3.975, p = .003, \eta^2 = .032$ (see Table 28). Descriptive statistics indicated Conservative respondents scored the highest ($M = 0.5941, SD = 0.176, n = 101$), while Very Liberal respondents scored the lowest ($M = 0.4837, SD = 0.212, n = 46$; see Table 29). Post hoc Tukey tests revealed significant differences between Very Liberal and Liberal respondents ($p = .020$) as well as Very Liberal and Conservative respondents ($p = .007$). No other pairwise comparisons were statistically significant.

Table 28

ANOVA Results for Political Ideology and Agricultural Knowledge Scores

Source	Sums of Squares	df	Mean Square	F	p	η^2
Political Ideology	0.53	4	0.13	3.97	.003	.032

Note. Significance at the $p < .05$ level.

Table 29

Descriptive Statistics for Political Ideology and Agricultural Knowledge Scores

Political Ideology	<i>n</i>	<i>M</i>	<i>SD</i>
Very Liberal	46	0.48	0.21
Liberal	62	0.59	0.16
Moderate	218	0.54	0.18
Conservative	101	0.59	0.17
Very Conservative	65	0.54	0.18

Note. Agricultural knowledge scores range from 0 (no correct responses) to 1 (all responses correct).

Political Affiliation

A one-way ANOVA was conducted to examine the relationship between political affiliation and agricultural knowledge scores. The analysis did not reveal a statistically significant effect of political affiliation on agricultural knowledge, $F(3, 488) = 2.359, p = .071, \eta^2 = .014$ (see Table 30). Descriptive statistics showed respondents identifying as "Other" scored the highest ($M = 0.6563, SD = 0.094, n = 12$), while Democrats scored the lowest ($M = 0.5356, SD = 0.188, n = 172$; see Table 31). No pairwise comparisons reached statistical significance in the post hoc Tukey tests.

Table 30

ANOVA Results for Political Affiliation and Agricultural Knowledge Scores

Source	Sums of Squares	<i>df</i>	Mean Square	F	<i>p</i>	η^2
Political Affiliation	0.24	3	0.08	2.35	.071	.014

Note. Significance at the $p < .05$ level.

Table 31

Descriptive Statistics for Political Affiliation and Agricultural Knowledge Scores

Political Affiliation	<i>n</i>	<i>M</i>	<i>SD</i>
Republican	196	0.56	0.18
Democrat	172	0.53	0.18
Independent	112	0.54	0.18
Other	12	0.65	0.09

Note. Agricultural knowledge scores range from 0 (no correct responses) to 1 (all responses correct).

Conclusions

This study aimed to explore baseline science and agricultural knowledge among respondents, with an emphasis on identifying demographic differences. Our findings revealed several notable patterns in science and agricultural literacy across various demographic groups.

Science Knowledge

Consistent with the 2019 Pew Research Center study, we observed significant disparities in science knowledge across demographic groups, particularly in relation to education level, income, and political ideology. As in prior research, individuals with higher educational levels, especially those holding graduate or professional degrees, exhibited the highest levels of science literacy. Similarly, respondents with higher household incomes demonstrated greater science knowledge, mirroring findings that socioeconomic status plays a crucial role in shaping science literacy.

However, our results diverged from previous research regarding generational differences. Unlike the 2015 Pew Research Center survey, which found that younger adults displayed slightly higher science knowledge than older adults, our findings indicate that Boomers and the Silent Generation scored higher than Millennials.

Regarding political ideology and affiliation, our findings partially align with prior research. While the 2019 Pew study found no significant differences in science knowledge between Republicans and Democrats, it noted individuals at ideological extremes (i.e., liberal Democrats and conservative Republicans) scored higher than those in the political middle. Similarly, our study found Very Liberal respondents exhibited significant differences in science knowledge compared to both Liberal and Conservative respondents, suggesting that ideological extremity, rather than party affiliation alone, may be a stronger predictor of science knowledge. This distinction highlights the need for further exploration into the role of political ideology in shaping science literacy.

Agricultural Knowledge

Consistent with Hand (2020) and Lewis (2018), we found that older generations, particularly Boomers, exhibited the highest agricultural knowledge scores. Additionally, our results revealed female respondents exhibited slightly higher agricultural literacy than males, however, this finding diverged from Hand's (2020) findings, which identified males as having higher agricultural literacy levels.

Similar to previous research on education and agricultural literacy, our study confirmed higher educational attainment correlated with increased agricultural knowledge, with graduate or professional degree holders scoring the highest. This aligns with findings from Hand (2020) that bachelor's degree holders demonstrated higher agricultural literacy than those with lower levels of education.

Our study also identified political ideology as a significant factor, with Conservative and Liberal respondents scoring higher than Very Liberal respondents. While political ideology was not a primary focus in previous agricultural knowledge studies, our findings contribute new insights into the intersection of ideological perspectives and agricultural literacy.

Lastly, our results differed from science knowledge findings, as income and political affiliation did not significantly impact agricultural knowledge levels.

Discussion, Implications, and Recommendations

This study provides important insights into the demographic factors influencing science and agricultural knowledge, offering practical applications for educators, policymakers, and science communicators. By leveraging comprehensive instruments such as the Agricultural Awareness Survey (Frick et al., 1995) and the Pew Research Center Science Knowledge Quiz (2019), this research establishes a robust foundation for understanding knowledge gaps across diverse populations.

The findings highlight the critical need to address the rapid spread of misinformation, particularly through social media platforms, which serve as a primary source of news for nearly half of United States adults (Pew Research Center, 2023). The growing susceptibility to pseudoscience and misinformation underscores the importance of integrating digital literacy skills into science and agricultural education. Educational initiatives should prioritize equipping individuals with the tools needed to critically evaluate online information and discern credible sources. For example, programs designed to teach critical thinking and fact-checking strategies could help individuals navigate the digital landscape more effectively.

Additionally, this research reinforces the importance of interdisciplinary approaches in education, as emphasized by NRC (2012) and Vallera and Bodzin (2016). Bridging science and agriculture within curricula is vital for addressing complex societal challenges such as food security, environmental sustainability, and technological innovation. Educational reform efforts should focus on incorporating agriculture into STEM programs, fostering systems thinking, and promoting problem-solving skills that span multiple disciplines. For instance, case studies and experiential learning activities focusing on real-world issues, such as renewable energy, climate change, or food systems, can enhance public understanding of the interconnectedness of these fields.

This study also highlights the significant role demographic diversity plays in shaping knowledge levels. Differences in gender, ethnicity, geographical location, and social class influence how individuals engage with and interpret scientific and agricultural concepts (Colby & Ortman, 2015; Gibson et al., 2020). For example, the increasing diversity of the United States population, particularly the rapid growth of Hispanic communities (Noe-Bustamante et al., 2020), underscores the importance of designing educational programs that are culturally relevant and linguistically accessible. Tailoring outreach efforts to specific demographics (e.g., developing bilingual resources for Hispanic audiences or connecting agricultural literacy to urban gardening initiatives in metropolitan areas) can help reduce disparities and ensure broader engagement.

Generational differences in knowledge levels also warrant attention. The finding that older generations scored higher than younger ones in both science and agricultural literacy suggests gaps in education and engagement with these topics among Millennials and Gen Z. This trend may reflect shifts in educational priorities, changing media consumption habits, or decreased exposure to agriculture and science in modern curricula. Addressing this gap requires innovative approaches, such as integrating gamified learning experiences, interactive digital tools, and virtual reality simulations into science and agricultural education to make these topics more accessible and engaging for younger audiences.

Finally, the relationship between political ideology and science literacy, particularly the observation that individuals at ideological extremes scored higher than those in the political middle, suggests ideological perspectives influence how individuals engage with scientific information. This nuance aligns with prior research emphasizing the need for values-based framing in science communication (Hess, 2011). Policymakers and educators should consider framing messages in ways that resonate with diverse ideological perspectives. For instance, emphasizing economic benefits may appeal to conservative audiences, while focusing on social equity and sustainability may engage liberal audiences. This approach can foster broader support for evidence-based policies and educational initiatives.

By addressing the challenges posed by misinformation, demographic diversity, and generational shifts, this research contributes to a deeper understanding of science and agricultural literacy and provides actionable insights for advancing these fields. Continued research should explore how experiential learning, cultural influences, and ideological values shape literacy, while evaluating the effectiveness of targeted interventions designed to address these gaps.

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