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A Multi-State Agricultural Literacy Assessment of Extension Professionals and Volunteers

Rose Judd-Murray [1]
Nellie Hill-Sullins [2]
Shannon Norris-Parish [3]
Gaea Hock [4]

Abstract

Cooperative Extension employees and primary volunteers have opportunities to improve agricultural literacy among community members, yet little is known about the agricultural literacy proficiency of these community educators. It is generally assumed that Extension workers and volunteers are agriculturally literate; this study sought to provide evidence of existing agricultural literacy proficiency and identify high and low knowledge domains in Kansas, New Mexico, and Utah participants. The following objectives guided the study: 1) Describe the agricultural literacy proficiency of participants by state and focus area, 2) Determine the influence of years of service on agricultural literacy proficiency, and 3) Identify the strengths and weaknesses of Extension professionals and volunteers related to agricultural literacy. The Judd-Murray Agricultural Literacy Instrument (JMALI) assessment was used to capture data. Results showed that Extension professionals and volunteers were either factually literate or applicably proficient. Data indicated that role, years of service, and career stage had no significant relationship with assessment instrument score. We also determined that participants showed a high domain knowledge of agriculture and its connection to the environment but struggled to answer questions related to current topics of science, technology, engineering, and mathematics (STEM). Further research is needed to understand better why early career professionals and younger volunteers had proficiency scores like those with fifteen or more years of experience. The study shows the need for ongoing professional development for Extension employees and primary volunteers focusing on STEM integration and knowledge-based instruction.

Introduction

Agricultural literacy must improve among the public as agriculturists seek to address the greatest challenges facing food and fiber production (Vidgen, 2016). The positive implications of increased agricultural literacy include enhanced trust and favorability toward scientists and their research findings (Funk & Kennedy, 2016); diminished negative, reactionary responses to visual agricultural messages (Specht et al., 2014); and enhanced interest in agricultural careers, which can help address workforce shortages (Cosby et al., 2022). The depth of agriculture's complexities must be communicated, and those

[1]Rose Judd-Murray is an Assistant Professor of Nonformal and Community-Based Education in the Department of Agricultural Sciences, Technology, and Education at Utah State University, 6000 Old Main Hill, Logan, UT 84322-6000, rose.juddmurray@usu.edu. ORCID 0000-0002-2045-1015
[2]Nellie Hill-Sullins is an Assistant Professor of Agricultural Communications and Journalism in the Department of Communications and Agricultural Education at Kansas State University, 307 Umberger Hall, Manhattan, KS 66506, nlhill@ksu.edu. ORCID 0000-0002-8987-3259
[3]Shannon Norris-Parish is an Assistant Professor of Agricultural and Extension Education in the Department of Agricultural and Extension Education at New Mexico State University, PO Box 30003, MSC 3501, Las Cruces, NM 88003-8003, norriss@nmsu.edu. ORCID 0000-0001-6292-1532
[4]Gaea Hock is an Associate Professor of Agricultural Education in the Department of Communications and Agricultural Education at Kansas State University, 315 Umberger Hall, Manhattan, KS 66506, ghock@ksu.edu. ORCID 0000-0002-2511-0738

efforts rigorously evaluated for the meaningful improvement of agricultural literacy (Judd-Murray et al., 2019).

Efforts that amplify agricultural literacy should be accessible across diverse audience segments (Pauley et al., 2019; Reilly et al., 2022). Additionally, the voting population is often not included in agricultural literacy development efforts (Vidgen, 2016). Extension personnel reach audiences of all ages and sociodemographic levels as information hubs between universities and local communities (Kurtzo et al., 2019). Extension professionals and volunteers can and should utilize their unique positions as catalysts of community change (Buys & Rennekamp, 2020) to develop agricultural literacy among the public (Hand, 2020). Possession of content knowledge is crucial for these efforts to be effective (Van Driel & Berry, 2012). Yet, little is known about the agricultural literacy of these critical community educators (Dale et al., 2017) because the target audiences for agricultural literacy research have historically been secondary teachers and students (Cosby et al., 2022; Kovar & Ball, 2013). There is a need to determine the agricultural literacy of keystone community educators, such as Extension professionals and volunteers, at regional and national scales (Dale et al., 2017; Kovar & Ball, 2013). This study focused on identifying strengths and weaknesses among these groups to inform interventions to further their agricultural literacy (Gay et al., 2017), which should be available through professional development (Clemons et al., 2018).

The American Association for Agricultural Education (AAAE) National Research Values focus on a vision that guides research to help people make informed decisions as consumers and improve their educational capacity at a professional level (AAAE, 2023). The inclusion of Extension professionals and volunteers from Kansas, New Mexico, and Utah supports this view as "education efforts and engagement to public consumers and industry professionals...is critical to advancing AFNR systems and measuring the impact of community outreach" (AAAE, 2023, p. 7).

Conceptual Framework

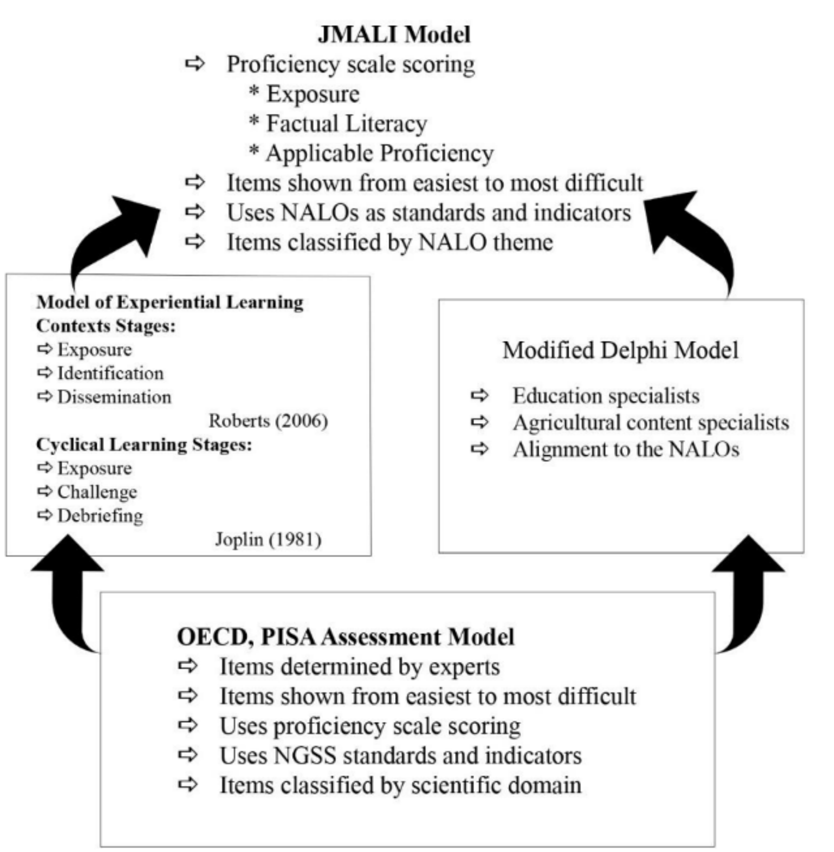
The National Agricultural Literacy Outcomes (NALO) Framework guided this study as it was developed to uniformly assess agricultural literacy (Brandt, 2016; Spielmaker & Leising, 2013). The framework's foundation includes previous literature, national education standards, and a Delphi study to establish content and construct validity (Judd-Murray et al., 2019; Longhurst et al., 2020; Spielmaker et al., 2014). The NALOs serve as benchmarks for agricultural literacy, grouped into five themes, "Agriculture and the Environment; Plants and Animals for Food, Fiber, and Energy; Food, Health, and Lifestyle; Science, Technology, Engineering, and Math; and Culture, Society, Economy, and Geography" (Spielmaker & Leising, 2013, p. 2). The multidisciplinary nature of the themes allows the NALOs to dynamically evolve in a manner that will continue to provide an assessment structure that solves real-world problems as agricultural literacy evolves (Judd-Murray et al., 2019; Vasquez et al., 2013). To assess agricultural literacy, grade-grouping standards within each NALO progressively assess literacy because knowledge is created by building on previous experience (Kolb, 1984).

To address the call for the NALOs to be used for uniform agricultural literacy assessment research, the Judd-Murray Agricultural Literacy Instrument (JMALI) operationalizes the NALOs into a standardized and validated assessment tool to summatively evaluate agricultural literacy among post-K-12 adults (Brandt, 2016; Judd-Murray et al., 2019; Longhurst et al., 2020). The assessment recognizes three levels of proficiency development: exposure, factually literate, and applied proficiency. Exposure level proficiency reflects lower-order learning skills used to recognize basic agricultural terms, recollect singular facts, and recognize simple cause-and-effect relationships (Judd-Murray et al., 2019). Factual literacy level proficiency demonstrates an ability to "construct explanations, make simple predictions, and identify the relevancy of facts in context" (Judd-Murray et al., 2019, p. 106). This is usually a result of direct knowledge and repetitive practice in articulating the information, such as through work opportunities, exposure to rural communities, socio-cultural influences, and real-life experiences. Applied-level proficiency uses the highest-order learning skills to synthesize and apply what they already know to complex, unfamiliar information and applications (Judd-Murray et al., 2019).

The inclusion of these levels and the resulting questions in the assessment was guided by the learning theories discussed by Dewey (1938), Kolb (1984), Joplin (1981), and Roberts (2006). The JMALI was written to assess adult agricultural literacy proficiency levels along a spectrum within a progressive learning process (Judd-Murray et al., 2019). See Figure 1 for the theoretical framework for the assessment.

Figure 1:

Theoretical framework for the JMALI. Model is from Judd-Murray et al., 2019.



Literature Review

Since the Smith-Lever Act of 1914 established the Cooperative Extension System, land-grant universities have extended and made publicly accessible, practical, research-based information and resources. Extension serves nearly 100% of all counties in the United States (Brewer et al., 2016). “Charged with helping people, businesses, and communities solve problems, develop skills, and build a better future” (Association of Public and Land Grant Universities [APLU], 2023, para. 3). Extension personnel serve increasingly diverse audiences (Donaldson et al., 2022). Facing changing demographics and a rural-to-urban shift, Extension professionals foresee more collaborations across program areas as more issues span disciplines. To meet this challenge and others, Extension professionals have asked for professional development based on individual needs (Donaldson et al., 2022). Such training is often limited after the first year in a state Extension system but is needed well beyond (Benge et al., 2020). Providing professional development opportunities can increase an Extension employee's willingness to stay with the organization (Martin, 2011).

The professional development model for Extension professionals is marked by stages of competencies and organizational strategies that drive the professional to the next level. These stages happen throughout a professional's career, beginning with pre-entry, then entry, colleague, counselor, and advisor (Benge et al., 2011; Kutilek et al., 2002). As professionals move through the stages, their expertise grows and expands. Those in the latter stages begin to share their expertise with wider audiences, internally and externally (Benge et al., 2011).

Extension professionals require competencies in building community relationships, managing volunteers, and effective communication (Benge et al., 2020); internal communications practices (Kurtzo et al., 2019); program planning, program evaluation, and leadership skills (Cooper & Graham, 2001; Harder et al., 2010); and evaluation and activities reporting (Diaz et al., 2019; Franz & McCann, 2007). We do not know the current Extension professional or volunteer expertise level relevant to agricultural literacy and whether it differs by career service duration. Identification of Extension professionals' and volunteers' agricultural literacy can be used to determine in-service training needs (Lakai et al., 2014).

The agricultural literacy of Extension professionals and volunteers is important because they deliver nonformal, public education to adult learners (Mars & Ball, 2016; Ota, 2006). Although largely absent from agricultural literacy development activities and evaluation, adults have voting and purchasing power. To engage the variety of stakeholder groups Extension serves, personnel would benefit from understanding the various paradigms of agricultural production and consumption (Mars & Ball, 2016). The scope of agricultural literacy activities must better account for serving adult learners (Kovar & Ball, 2013). Our study addresses the call from Mars and Ball (2016) to "track agricultural literacy development as a lifelong learning process rather than one confined to the school-based experience" (p. 69).

Purpose and Objectives

The purpose of this study was to assess the agricultural literacy proficiency of Extension professionals and volunteers in three states. The following objectives guided this study: 1) describe the agricultural literacy proficiency for participants by state and focus area, 2) determine the influence of years of service on agricultural literacy proficiency, and 3) identify the strengths and weaknesses of Extension professionals and volunteers related to agricultural literacy.

Method

This study was designed to collect data from participants (i.e., extension employees and volunteers) using an anonymous online survey that collected information about their work or volunteer experience, exposure to agriculture, basic demographics and asked them to complete the JMALI 9–12th grade (post-high school) agricultural literacy assessment. Ethics review approvals in each state defined the methods for this study.

Participant Selection

We targeted two populations from three states Kansas, New Mexico, and Utah for this quantitative study. The first group was land-grant Extension professionals, which included Extension faculty and other Extension employees, such as program coordinators, paraprofessionals, and program educators. Employees were not recruited based on their direct experience with agriculture and natural resources work or educational experience. This allowed us to recruit those who may or may not engage with their communities in topics directly related to agriculture because agricultural literacy knowledge requires a basic understanding of "food, clothing, and shelter," which are central tenets of community-based work. Employees were included in the selection process if identified as having a "role in community education." Employees were excluded from the selection process if they were identified as general staff members (i.e., secretarial, business managers). The second group was a population designated as "primary volunteers." We defined this population as those individuals with repeated participation as either a youth or adult program volunteer leader or educator, particularly targeting those with 4-H involvement. There were no age exclusions, but individuals were excluded if regional administrators identified them as having "limited experience involvement." Participation for both groups was voluntary and anonymous.

Recruitment

Extension email contact lists were the primary recruitment tools in all three states. Regional and statewide administrators approved the use of email contact for employees and volunteers. They directly assisted in narrowing the email contacts to the selection parameters. In some states, this process involved a single list and point of contact, and in others, it required several administrative contacts and individual county contact lists. Once employees and volunteers were identified, administrators used a recruitment message that included a statewide or regional memo detailing the importance of the assessment for improving agricultural literacy education and agricultural education program efforts throughout the state. The recruitment emails were sent directly from a county or regional extension person. Administrators voluntarily chose to assist the research team without compensation. Participants did not receive any stipends for taking part in the survey. Still, after the assessment, they could enter their contact information to engage in a random drawing for two $100 gift baskets and one $50 gift basket. These incentives were offered in each state to improve participants' chances of winning and increase interest in survey participation.

We administered the JMALI (Judd-Murray et al., 2019) assessment and a demographic questionnaire via Qualtrics for best practices for data collection (Dillman, 2000). The online Qualtrics survey remained open for four weeks. Administrators sent reminder messages crafted by the research team each week requesting participation and renewing interest in the incentive. At the end of the survey period, we selected the prize winners, sent notifications, and delivered their awards.

Collectively, we surveyed a total of 1,019 employees, with a response rate of 29% (n = 291), and 3,914 volunteers, with a response rate of 15% (n = 588).

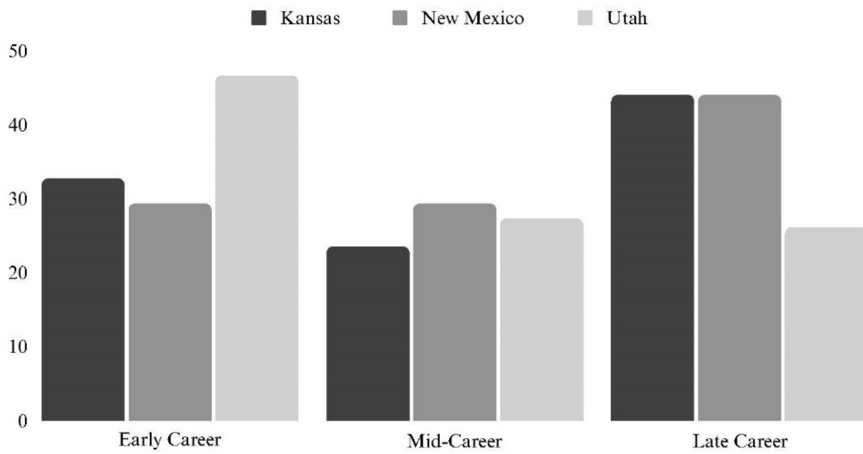
Survey Design

There were two versions of the survey. The employee-centered survey asked participants to self-report their age range, gender identity, and ethnicity. We also asked them to identify their specialty areas for their current role (i.e., agriculture and natural resources, nutrition, family and home), how long they had worked in that current role, and how long they had worked for Extension. Items that collected information about how frequently they communicated with community members regarding agricultural topics and details about agricultural experiences and level of exposure to agriculture were also included.

The second volunteer-centered survey asked participants to self-report their age range, gender identity, and ethnicity. We also asked them to identify the areas where they volunteered (i.e., agriculture and natural resources, nutrition, 4-H & youth), how long, and how frequently they volunteered for Extension. Items that collected information about how frequently they communicated with community members regarding agricultural topics and details about agricultural experiences and level of exposure to agriculture were also included. We used participants' demographic self-reported information as independent variables for determining the relationships between each variable and the individual and mean proficiency scores.

Lastly, the JMALI Instrument II was added to both surveys. The instrument contains 15 assessment items with three questions in each of the five NALO themes. The number of total correct answers determines each participant's proficiency score. Those with *applicable proficiency* answered ≥ 12 questions correctly, *factually literate* answered ≥ 8–11 questions correctly, and *exposure* answered ≤ 7 correctly. Participants cannot pass or fail; instead, they exist along a scale of understanding. We used individual and mean proficiency scores to address Objective 1 directly and as the dependent variable for the relationships of the other objectives of the study.

Based on the information retrieved from the survey, we operationalized participants into career stages and roles. “Early career” professionals were labeled as those between the ages of 18–40 years old, “mid-career” as those 41–50 years old, and “late-career” as 51–66+ years old. We determined these numbers based on Extension administration expertise due to a lack of literature that firmly demarcated professional career ranges. Based on these parameters, Figure 2 shows that Utah had the highest number of early career professionals with 46.6% (*n* = 41), followed by Kansas, 32.7% (*n* = 52), and New Mexico, 29.3% (*n* = 11). Mid-career numbers were steady across the states: Kansas, 23.5% (*n* = 38), New Mexico, 29.3% (*n* = 12), and Utah, 27.3% (*n* = 24). Kansas and New Mexico tied for the greatest number of late-career professionals



at 44% (*n* = 71, 18), and Utah followed with 26.1% (*n* = 23).

Figure 2. State percentages of career stages.

Note. As identified by the extension administration, “Early career” professionals were between the ages of 18 and 40, “mid-career” professionals were 41 to 50, and “late-career” professionals were 51 to 66+.

Table 1 shows a simple breakdown of gender for both Extension professionals and volunteers, which showcased that most participants identified as female (Professional: 69%, Volunteer: 76%). Table 2 shows ethnicity from both populations, highlighting that most multistate participants were white (Professional: 87%, Volunteer: 76.2%).

Table 1

Extension Professionals and Volunteers Participation and Gender

State	Population surveyed	*N*	*n*	Response rate %	Gender %
Kansas	Professionals	444	162	36	M: 32, F: 68, NA: .6
Kansas	Volunteers	2,270	338	15	M: 14, F: 86, NA: .6
New Mexico	Professionals	147	41	28	M: 29, F: 68, NA: 2
New Mexico	Volunteers	65	5	8	M: 13, F: 63, NA: 13
Utah	Professionals	428	88	21	M: 27, F: 72, NC: 1
Utah	Volunteers	1,579	245	16	M: 22, F: 78, NA: .4
Multistate Total	Professionals	1,019	291	29	M: 29, F: 69, NA: 5.5, NC: 1
Multistate Total	Volunteers	3,914	588	15	M: 13, F: 76, NA: 14

Note. M is identified as male, F is identified as female, NC is nonconforming or binary gender, and NA did not wish to identify gender.

Table 2

Extension Professionals' and Volunteers' Ethnicity Percentages

State	Population Surveyed	White	Black	Latinx	Asian	AI/AN	PI/NH	Do not wish to identify
Kansas	Professionals	94	.6	1.2	.6	.6	.6	4
Kansas	Volunteers	95.6	0	0	0	.3	0	4.1
New Mexico	Professionals	73	0	16	0	2.3	0	2.3
New Mexico	Volunteers	40	0	0	0	20	40	0
Utah	Professionals	93	1.1	1.1	1.1	0	0	3.2
Utah	Volunteers	93	.4	.8	1.2	0	0	3.8
Multistate Total	Professionals	87	.6	6.1	.6	1	.2	3.2
Multistate Total	Volunteers	76.2	.13	.3	.4	6.8	13.3	2.6

Note: AI/AN is American Indigenous or Alaskan Native, and PI/NH is Pacific Islander or Native Hawaiian. The Latinx column was written as Latino, Hispanic, or Spanish in the survey.

Data Analysis

We analyzed the data using the IBM Statistical Package for the Social Sciences (SPSS) Statistics 28.0 for Macintosh™. For each of the three objectives, we used percentages and frequencies for nominal data and central tendencies to report descriptive data (Creswell, 2012). For objective two, we used Pearson's correlational coefficient to evaluate the correlation between time spent in current roles and years served with Extension. Then, we used a one-way ANOVA to compare the effect of years of experience on Extension professional's agricultural literacy scores at the $p < 0.05$. For Kansas and Utah, we met the assumption of homogeneity using Levene's test (Kansas: $p = 0.91$; Utah: $p = 0.20$) and found no significant effect Kansas: [$F(2, 158) = 1.10$, $p = 0.34$; Utah: $F(2, 85) = 0.78$, $p = 0.46$]. We did not meet the assumption of homogeneity in New Mexico ($p = 0.02$), so we used a Welch ANOVA and found no significant differences ($F(2, 25) = 2.17$, $p = 0.14$).

Results

Three research objectives guide the results of this study.

Objective 1: Agricultural Literacy Proficiency Levels by State and Focus Area

Most Extension professionals were either *factually literate* (46–57%) or *applicably proficient* (42–51%; see Table 3). New Mexico had the highest percentage of participants gauging applied proficiency (51%), and Utah had the highest percentage of factually literate participants (57%).

Table 3

Extension Professionals' Proficiency Scores for Each Participating State

State	Primary Professional Role	*n*/% of total participants	Assessment Summary: Exposure Literacy %	Factual Literacy %	Applied Proficiency %
Kansas	Agriculture & Natural Resources	106/65%	2	46	52
	Family & Home	36/22%	3	72	25
	Nutrition & SNAP	35/22%	0	37	63
	Youth & 4-H	61/38%	3	43	54
	Total Participants	**160/100%**	**1**	**49**	**49**
New Mexico	Agriculture & Natural Resources	22/50%	5	55	40
	Family & Home	9/22%	0	34	66
	Nutrition & SNAP	2/5%	0	100	0
	Youth & 4-H	5/12%	0	20	80
	Total Participants	**41/100%**	**2**	**46**	**51**
Utah	Agriculture & Natural Resources	29/33%	0	31	69
	Family & Home	24/27%	0	50	50
	Nutrition & SNAP	20/23%	5	75	20
	Youth & 4-H	14/16%	0	63	37
	Total Participants	**88/100%**	**1**	**57**	**42**

Note: The Supplemental Nutrition Assistance Program (SNAP) provides nutrition benefits to supplement the food budget of needy families so they can purchase healthy food. Science, Technology, Engineering, and Mathematics (STEM) is a science-based integration program. The total number of participants may be inconsistent with the combined number of participants in the roles displayed because some roles did not fit these general categories.

Most volunteers in Kansas ($n = 178$, 56%) and Utah ($n = 132$, 54%) scored as *factually literate,* and volunteers from New Mexico ($n = 3$, 60%) scored as *applied proficient* on the NALO themes (see Table 4). While the overall scores of the volunteers were lower than the Extension professionals, only 7% of professionals and volunteers scored at the *exposure* level (answered ≤ 7 questions correctly).

Table 4

Volunteers' Proficiency Scores for Each Participating State

State	Volunteer Role	*n*/% of total participants	Assessment Summary Exposure Literacy %	 Factual Literacy %	 Applied Proficiency %
Kansas	4-H: Agriculture & Natural Resources/ Animal Science	140/44%	2	52	46
	4-H: Family & Consumer Science	58/18%	3	62	35
	4-H: STEM	23/7%	0	60	40
	4-H: Creative Arts	47/15%	2	51	47
	4-H: Personal Development	51/16%	2	68	30
	Total Participants	**319/100%**	**4**	**56**	**40**
New Mexico	Youth & 4-H	5/100%	0	40	60
	Total Participants	**5/100%**	**0**	**40**	**60**
Utah	Youth & 4-H	132/54%	5	63	32
	Master Gardening	18/7%	5	61	34
	Total Participants	**245/100%**	**7**	**54**	**39**

Note: The total number of participants may be inconsistent with the combined number of participants in the roles displayed because some roles did not fit these general categories.

Objective 2: Influence of Years of Service on Agricultural Literacy Proficiency

The mean across all three states showed that most professionals were employed by Extension between six and fifteen years (n = 80, M = 29.6%) but that nearly 40% had only been in their current role for fewer than three years (n = 105, M = 37%). The professionals' limited service time remained, even when it increased to five years or less (n = 159, M = 28%). Over one-quarter of professionals reported Extension employment for less than three years (n = 70, M = 26%); the remaining quarter represented 15+ years of employment in Extension (n = 85, M = 25.1%). Twenty-one percent (n = 68, M = 21.7%) of respondents reported that they had served in their current role for over fifteen years. Table 5 shares states' data on the years professionals served within their current role and the number of years they were employed by Extension.

Nearly eighty percent (79.4%, n = 193) of volunteers in Utah reported six or fewer years of service. Thirty-eight percent (n = 122) of Kansas volunteers reported serving for that same amount of time, but almost 40% of their volunteers committed for ten or more years (38,9%, n = 124). New Mexico volunteers reported 40% serving under ten years and 60% more than ten, but their sample size was limited (n = 5). Table 6 provides information on the length of volunteers' service time.

Table 5

Number of Years Within a Professional's Current Role and Length of Extension Employment

State	Years in Role	*n*/% of Participants	Years Employed by Extension	*n*/% of Participants
Kansas	Less than 3 years	53/32.7%	Less than 3 years	32/19.8%
	B/W 3–5 years	29/17.9%	B/W 3-5 years	29/17.9%
	B/W 6–10 years	20/12.3%	B/W 6-10 years	24/14.8%
	B/W 11–15 years	14/8.6%	B/W 11-15 years	16/9.9%
	15+ years	46/28.4%	B/W 15-20 years	17/10.5%
			B/W 20-25 years	18/11.1%
			25+ years	26/16%
New Mexico	Less than 3 years	15/36.6%	Less than 3 years	11/26.8%
	B/W 3–5 years	7/17.1%	B/W 3-5 years	8/19.5%
	B/W 6–10 years	5/12.2%	B/W 6-10 years	7/17.1%
	B/W 11–15 years	5/12.2%	B/W 11-15 years	7/17.1%
	15+ years	9/22.0%	B/W 15-20 years	3/7.3%
			B/W 20-25 years	3/7.3%
			25+ years	2/4.9%
Utah	Less than 3 years	37/42%	Less than 3 years	27/31%
	B/W 3–5 years	18/20.5%	B/W 3-5 years	18/20.7%
	B/W 6–10 years	15/17%	B/W 6-10 years	19/21.8%
	B/W 11–15 years	5/5.7%	B/W 11-15 years	7/8%
	15+ years	13/14.8%	B/W 15-20 years	7/8%
			B/W 20-25 years	6/6.9%
			25+ years	3/3.4%

Table 6

Number of Years Volunteers Served Within Extension

State	Years of Service	n/% of Participants
Kansas	Less than 6 months	23/7.2%
	Less than 1 year	30/9.4%
	B/W 1-3 years	8/2.5%
	B/W 4-6 years	61/19.1%
	B/W 7-10 years	73/23%
	B/W 11-15 years	53/16.6%
	B/W 16-20 years	49/15.4%
	20+ years	22/6.9%
New Mexico	Less than 6 months	NA
	Less than 1 year	NA
	B/W 1-3 years	NA
	B/W 4-6 years	NA
	B/W 7-10 years	2/40%
	B/W 11-15 years	3/60%
	B/W 16-20 years	NA
	20+ years	NA
Utah	Less than 6 months	25/10.3%
	Less than 1 year	47/19.3%
	B/W 1-3 years	81/33.3%
	B/W 4-6 years	40/16.5%
	B/W 7-10 years	20/8.2%
	B/W 11-15 years	16/6.6%
	B/W 16-20 years	9/3.7%
	20+ years	5/2.1%

We wanted to understand how the professional or volunteer service length affected the literacy proficiency score. We used a one-way ANOVA to compare the effect of years of experience on Extension professionals' agricultural literacy scores at $p < 0.05$. Kansas had no significant effects [$F(6, 153) = .46$, $p = 0.84$] with a small effect size ($\eta^2 = .02$). New Mexico had no significant effect [$F(6, 34) = .84$, $p = 0.55$] with a moderate effect size ($\eta^2 = .13$). Utah did not meet the assumption of homogeneity of variance ($p = .001$), so we used a Welch ANOVA and found no significant differences [$F(6, 80) = .63$, $p = .70$] with a small effect size ($\eta^2 = .05$). Table 7 provides a multistate compilation suggesting that there is not a connection within the data that showed years of Extension employment had a relationship with agricultural literacy proficiency levels.

Table 7

One-way ANOVA Using Years of Extension Employment and Agricultural Literacy Proficiency

Variable	Sum of Squares	*df*	Mean Square	*F*	Sig.	η^2	95% CI [LL, UL]
Kansas: Years of Employment	.77	6	.13	.46	.84	.02	.00,.03
Within	43.17	153	.28				
Total	43.94	159					
New Mexico: Years of Employment	1.59	6	.26	.84	.55	.13	.00,.22
Within	10.66	34	.32				
Total	12.24	40					
Utah: Years of Employment	1.04	6	.17	.63	.70	.05	.00, .09
Within	21.88	80	.27				
Total	22.92	86					

We used a one-way ANOVA to compare the effects of years of Extension service on the volunteer's agricultural literacy scores at the $p < 0.05$ level. For Kansas, we met the assumption of homogeneity using Levene's test ($p = .75$), and we found no significant effect [$F(7, 311) = .95$, $p = 0.47$]. New Mexico could not be analyzed due to missing variable information and a small sample size. Utah did not meet the assumption of homogeneity. We used a Welch ANOVA ($p = 0.30$) that indicated a significant difference [$F(7, 235) = 2.40$, $p = .02$]. Games-Howell post hoc testing, however, did not identify any significant differences between the variables. The effect size for this test was moderate, but a lack of statistical power (small sample size) may be preventing the detection of more significant differences. Table 8 provides additional information regarding the ANOVA results for volunteer participants.

Table 8

One-way ANOVA Using Years of Volunteer Service and Agricultural Literacy Proficiency

Variable	Sum of Squares	*df*	Mean Square	*F*	Sig.	η^2	95% CI [LL, UL]
Kansas: Volunteer Service Time	2.04	7	.29	.95	.47	.02	.00, .04
Within	95.78	311	.31				
Total	97.82	318					
Utah: Volunteer Service Time	5.83	7	.83	2.40	.02**	.07	.001, .11
Within	81.48	235	.35				
Total	87.32	242					

Note: New Mexico could not be determined based on the minimal sample size and missing variable data.
** Denotes significance at $p < .05$.

Objective 3: Strengths and Weaknesses of Agricultural Literacy

The 15-question JMALI measures proficiency in each theme with three questions. The questions are validated to show understanding at three levels: exposure, factual literacy, and applicable proficiency. This study showed that Extension employees' and volunteers' greatest strengths and highest JMALI scores were related to NALO Theme 1: Agriculture and the Environment. Questions in this theme addressed the dependence and interactions of agriculture and the environment in natural systems and their critical relationships. The mean percentage of correct answers across the three Theme 1 questions showed high domain knowledge (Professionals: $M_{Kansas} = 92.30$, $M_{New\ \text{Mexico}} = 91.10$, $M_{Utah} = 88.63$; Volunteers: $M_{Kansas} = 87.87$, $M_{New\ \text{Mexico}} = 86.70$, $M_{Utah} = 86.30$). Literacy levels related to NALO Theme 4: STEM were employees' and volunteers' greatest weaknesses. On average, few participants could answer the questions correctly at the literacy or proficiency level. The mean percentage of correct answers across the three Theme 4 questions showed low domain knowledge (Professionals: M_{Kansas} = 51.5, $M_{New\ Mexico}$ = 56.9, M_{Utah} = 50.93; Volunteers: M_{Kansas} = 46.5, M_{New} Mexico = 46.67, M_{Utah} = 47.1). Using partial scoring of the two most frequently missed questions, volunteers could not identify drones and cloning as practical applications, nor could they recognize precision agricultural techniques beyond determining topsoil depth. Across both populations, the questions most frequently answered incorrectly related to animal welfare regulations, marketing terms, and precision agriculture. While professionals and volunteers scored similarly on these questions, more professionals comprehended the use of drones in agriculture than volunteers. Figures 3, 4, and 5 illustrate the thematic proficiencies in all states and across both populations.

Figure 3.

Kansas professional and volunteer theme proficiency percentages

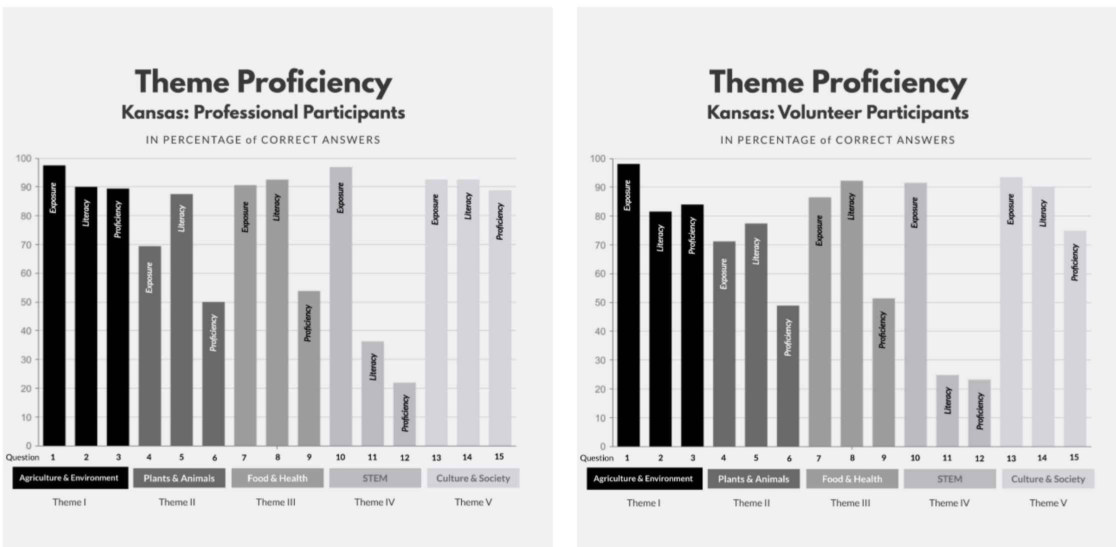


Figure 4.

New Mexico professional and volunteer theme proficiency percentages

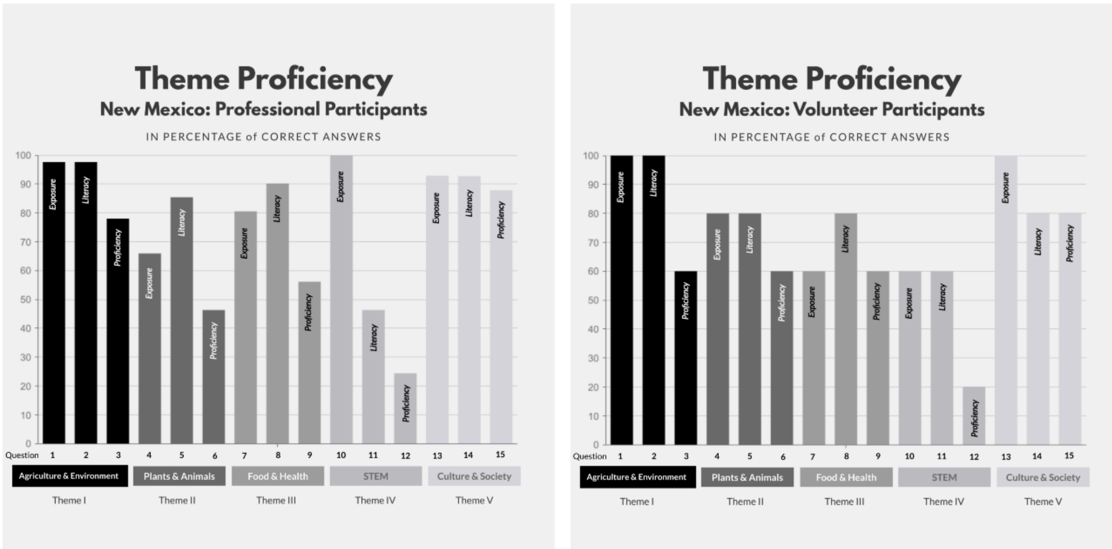
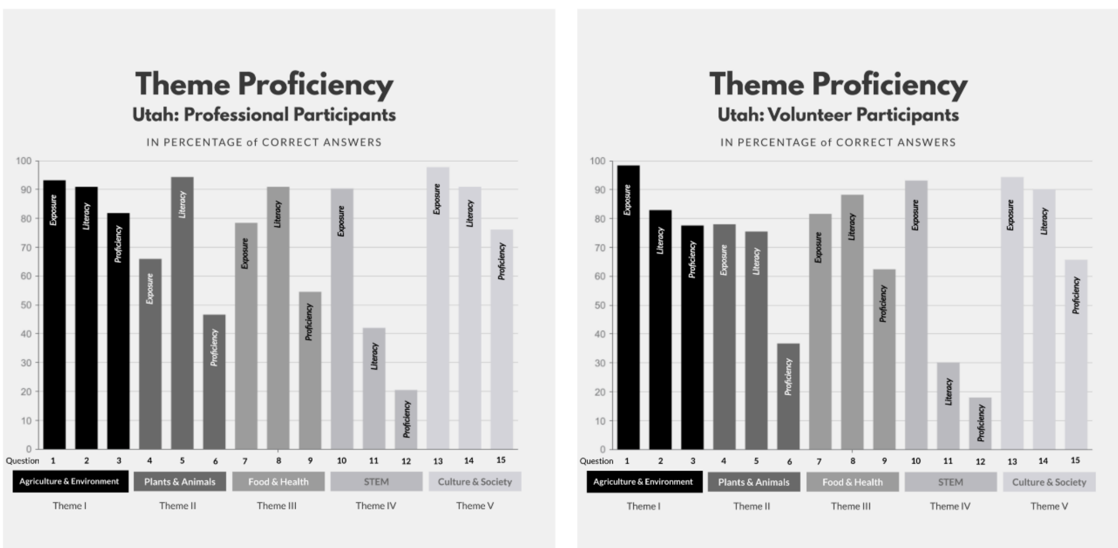


Figure 5.

Utah professional and volunteer theme proficiency percentages



Discussion & Recommendations

Because Extension professionals and volunteers are the primary land-grant representatives for disseminating agricultural information to the public, investigating agricultural literacy is valuable for programming. Fortunately, participants had a foundational awareness of agricultural production as noted by their agricultural literacy equaling *factually literate* (≥ 8 correct answers) or higher. We anticipated that Extension professionals with a role associated with agriculture and natural resources would score higher than other participants. This was the case for Kansas and Utah professionals; however, participants in other roles also had impressive literacy achievements that were comparable or even slightly better. Volunteers—primarily 4-H volunteers—reported *factual literacy* (≥ 8 correct answers). However, the volunteer data from New Mexico was an exception because the low response rate cannot be generalized to the population.

Interestingly, many employees had worked in Extension for fewer than five years. These trends could also represent how long professionals had served in a particular role before seeking advancement or a career change. More notable was that we identified no significant relationships related to agricultural literacy proficiency scores in any career stage or years of service. Comparatively, the length of time volunteers served had no significant effect on their proficiency scores. While these results are reassuring to know literacy levels were consistent, we question why there is no difference among career stages. Because many of the participants had been in the profession for five years or less, we wonder if their agricultural literacy levels could be higher due to the proximity of completing a degree or relearning material because of relocating to a new position. Similarly, a positive correlation between years of experience and current role implies professionals are staying within their roles as they move through their Extension career, which may limit their ability to learn more about new agricultural practices through a career shift. Nevertheless, we recommend investigating state-level preparedness efforts to support agricultural literacy advancement.

As Vidgen (2016) and Pauley et al. (2019) suggested, continued amplified efforts to improve agricultural literacy among the public are vital to addressing the industry's greatest challenges. Therefore, we recommend implementing additional programmatic efforts to connect Extension professionals and volunteers to lay audiences. Investigating agricultural literacy levels among key stakeholder populations could be foundational to determining the success or influence of respective Extension efforts. As such, we recommend creating and evaluating outreach efforts organized by the NALO theme to target agricultural literacy priorities.

In conclusion, this study provides data that can be used to determine the next best steps toward improving Extension programming and strengthening community impacts as they relate to agricultural literacy. The JMALI was not designed to comprehensively address agricultural content knowledge. However, it offers a standardized assessment that can measure agricultural literacy across populations. As a result, the impact of this work increases when other organizations and stakeholders use the tool to collect additional data points and compare them to develop a broader understanding of strengths and weaknesses in educational programming and effort. Therefore, we recommend that other stakeholders replicate similar studies to continue investigating agricultural literacy efforts across Extension platforms.

Limitations

Many Extension organizations have general similarities in scope and purpose but vary significantly depending on local, state, and regional needs and funding. Therefore, the results of this study cannot be inferred broadly to all Extension programs beyond the scope of this study.

References

American Association for Agricultural Education (AAAE). (2023). *AAAE research values.* https://aaaeonline.org/resources/Documents/AAAE%20Research%20Values%20-%20For%20Online%20BLUE%20(8.5%20_%2011%20in).pdf

Association of Public and Land-Grant Universities (APLU). (2023). Cooperative Extension section. https://www.aplu.org/members/commissions/food-environment-and-renewable-resources/board-on-agriculture-assembly/cooperative-extension-section/

Benge, M., Harder, A., & Carter, H. (2011). Necessary pre-entry competencies as perceived by Florida Extension agents. *Journal of Extension, 49*(5), Article v49–5a2. https://doi.org/10.34068/joe.49.05.03

Benge, M., Muscato, A. F., & Beattie, P. N. (2020). Professional development needs of early-career Extension agents beyond the first year: Florida county Extension director perspectives. *Journal of Extension*, *58*(6), 11. https://doi.org/10.34068/joe.58.06.11

Brewer, J. P., Hiller, J. G., Burke, S., & Teegerstrom, T. (2016). A primer: Extension, Indian land tenure, and rangeland limitations. *Rangelands, 38*(1), 16–22. https://www.doi.org/10.1016/j.rala.2015.12.002

Buys, D. R., & Rennekamp, R. (2020). Cooperative Extension as a force for healthy, rural communities: Historical perspectives and future directions. *American Journal of Public Health*, *110*(9), 1300–1303. https://doi.org/10.2105/ajph.2020.305767

Cooper, A. W., & Graham, D. L. (2001). Competencies needed to be successful county agents and county supervisors. *Journal of Extension, 39*(1), Article 1RIB3. https://www.joe.org/joe/2001february/rb3.php

Clemons, C., Lindner, J. R., Murray, B., Cook, M. P., Sams, B., & Williams, G. (2018). Spanning the gap: The confluence of agricultural literacy and being agriculturally literate. *Journal of Agricultural Education*, *59*(4), 238–252. https://doi.org/10.5032/jae.2018.04238

Cosby, A., Manning, J., Power, D., & Harreveld, B. (2022). New decade, same concerns: A systematic review of agricultural literacy of school students. *Education Sciences*, *12*(235), 1–21. https://doi.org/10.3390/educsci12040235

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* Pearson.

Dale, C., Robinson, J. S., & Edwards, M. C. (2017). An assessment of the agricultural literacy of incoming freshmen at a land-grant university. *NACTA Journal*, *61*(1), 7–13. https://www.jstor.org/stable/10/2307/90004098

Dillman, D. A. (2000, June). Procedures for conducting government-sponsored establishment surveys: Comparisons of the total design method (TDM), a traditional cost-compensation model, and tailored design. In *Proceedings of American statistical association, second international conference on establishment surveys* (pp. 343–352).

Donaldson, J. L., Graham, D. L., Arnold, S., Taylor, L. K., & Jayaratne, K. S. U. (2022). Extension education trends and research needs: Views from professionals and faculty. *Journal of Agricultural Education*, *63*(3), 73–82. https://doi.org/10.5032/jae.2022.03073

Diaz, J., Kumar Chaudhary, A., Jayaratne, K. S. U., & Warner, L. A. (2019). Program evaluation challenges and obstacles faced by new Extension agents: Implications for capacity building. *Journal of Extension, 57(*4), Article v57–4a1. https://www.joe.org/joe/2019august/a1.php

Franz, N., & McCann, M. (2007). Reporting program impacts: Slaying the dragon of resistance. *Journal of Extension, 45*(6), Article 4FEA1. https://www.joe.org/joe/2007 december/tt1.php

Funk, C., & Kennedy, B. (2016). Americans' views about and consumption of organic foods. https://www.pewresearch.org/science/2016/12/01/americans-views-about-and-consumption-of-organic-foods/

Gay, K. D., Owens, C. T., Lamm, A. J., & Rumble, J. N. (2017). Assessing public issues, knowledge, and needs of Extension agents in Florida. *Journal of Extension*, *55*(1), 1–11. https://tigerprints.clemson.edu/joe/vol55/iss1/24

Hand, S. S. (2020). *Bridging the divide: Understanding the agricultural literacy of Georgia consumers* (Doctoral dissertation, University of Georgia). https://www.proquest.com/docview/2411688289?pq-origsite=gscholar&fromopenview =true

Harder, A., Place, N. T., & Scheer, S. D. (2010). Towards a competency-based Extension education curriculum: A Delphi study. *Journal of Agricultural Education, 51*(3), 44–52. https://www.doi.org/10.5032/jae.2010.03044

Judd-Murray, R., Warnick, B. A., Longhurst, M., Coster, D. C., Spielmaker, D. M., & Stewart, C. D. (2019). *Development and validation of an agricultural literacy instrument using the National Agricultural Literacy Outcomes* [Ph.D. Dissertation]. https://digitalcommons.usu.edu/etd/7562/

Kovar, K. A., & Ball, A. L. (2013). Two decades of agricultural literacy research: A synthesis of the literature. *Journal of Agricultural Education*, *54*(1), 167–178. https://doi.org/10.5032/jae.2013.01167

Kurtzo, F., Edgar, L. D., Edgar, D. W., Graham, D. L., & Russell, M. (2019). Exploring communication tendencies of program facilitators. *Journal of Applied Communications*, *103*(1), 1–17. https://doi.org/10.4148/1051-0834.1415

Kutilek, L. M., Gunderson, G. J., & Conklin, N. L. (2002). A systems approach: Maximizing individual career potential and organizational success. *Journal of Extension, 40*(2), Article 2FEA1. https://tigerprints.clemson.edu/joe/vol40/iss2/3

Lakai, D., Jayaratne, K. S. U., Moore, G. E., & Kistler, M. J. (2014). Identification of current proficiency level of Extension competencies and the competencies needed for Extension agents to be successful in the 21st century. *Journal of Human Sciences and Extension*, *2*(1), 71–89. https://doi.org/10.54718/UUTF8010

Longhurst, M. L., Judd-Murray, R., Coster, D. C., & Spielmaker, D. M. (2020). Measuring agricultural literacy: Grade 3-5 instrument development and validation. *Journal of Agricultural Education*, *61*(2), 173–192. https://doi.org/10.5032/jae.2020.02173

Mars, M. M., & Ball, A. L. (2016). Ways of knowing, sharing, and translating agricultural knowledge and perspectives: Alternative epistemologies across non-formal and informal settings. *Journal of Agricultural Education*, *57*(1), 56–72. https://www.doi.org/10.5032/jae.2016.01056

Martin, M. J. (2011). *Influence of human resource practices on employee intention to quit* (Publication No. 16680) [Doctoral dissertation, Virginia Tech]. https://vtechworks.lib.vt.edu/handle/10919/28424

Pauley, C. M., McKim, A. J., & Hodbod, J. (2019, May 21–24). Rethinking resilience: Applications for the social sciences of agriculture, food, and natural resources [Peer-reviewed paper]. *Annual National Research Conference of the American Association for Agricultural Education*. Des Moines, IA.

Reilly, C., Stevenson, K., Warner, W., Park, T., Knollenberg, W., Lawson, D., ... & Barbieri, C. (2022). Agricultural and environmental education: a call for meaningful collaboration in a U.S. context. *Environmental Education Research*, 1–13. https://doi.org/10.1080/13504622.2022.2040431

Specht, A. R., McKim, B. R., & Rutherford, T. (2014). A little learning is dangerous: The influence of agricultural literacy and experience on young people's perceptions of agricultural imagery. *Journal of Applied Communications, 98*(3), 63–74. https://doi.org/10.4148/1051-0834.1086

Spielmaker, D. M., & Leising, J. G. (2013). *National agricultural literacy outcomes*. Utah State University, School of Applied Sciences & Technology. https://www.agclassroom.org/get/doc/NALObooklet.pdf

Spielmaker, D. M., Pastor, M., & Stewardson, D. M. (2014). A logic model for agricultural literacy programming. *Proceedings of the 41st annual meeting of the American Association for Agricultural Education*. Snowbird, UT. https://agliteracy.org/research/logic.cfm

Van Driel, J. H., & Berry, A. (2012). Teacher professional development focusing on pedagogical content knowledge. *Educational Researcher*, *41*(1), 26–28. https://doi.org/10.3102/0013189x11431010

Vidgen, H. (2016). *Food literacy: Key concepts for health and education*. Routledge.