

Modeling National Agriculture Teacher Supply and Demand: A Longitudinal Analysis, 2016-2025

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Abstract

The stability of school-based agricultural education (SBAE) depends on a sufficient and well-prepared supply of agricultural educators. This study used 10 years of national workforce data (2016–2025) to examine trends in agriculture teacher supply and demand and estimate the gap between workforce need and supply of newly prepared teachers. Supply data were reported annually by agriculture teacher preparation institutions, and demand data were reported by state agricultural education leaders. Missing values were addressed through interpolation to support longitudinal comparisons. Results indicated the number of program completers declined from a peak of 904 in 2019 to 747 in 2025, although the agricultural education workforce expanded from approximately 12,400 to more than 15,700 teachers. Three findings emerged as particularly important. First, attrition was the dominant source of workforce demand, accounting for most annual staffing needs throughout the study period. Second, only 73% to 80% of program completers entered agricultural education classrooms, reducing the effective supply available. Third, local school districts increasingly relied on alternatively licensed and non-licensed personnel to meet staffing needs, suggesting alternative certification has become a structural component of the agricultural education workforce rather than a supplemental pathway. The estimated annual shortfall grew from 268 positions in 2016 to a peak of 788 positions in 2024 before declining to 542 in 2025. Findings suggest addressing workforce shortages will require coordinated efforts focused on recruitment as well as retention, yield, and the support of alternatively prepared educators.

Introduction

School-based agricultural education (SBAE) prepares students for careers and citizenship through integrated classroom instruction, work-based learning, and student leadership development (Connors & Velez, 2008; Croom, 2008; Kreifels et al., 2025). The continuity and quality of these programs rest on a dependable supply of licensed agricultural educators (Disberger et al., 2022; Norris et al., 2024). For more than half a century, the American Association for Agricultural Education (AAAE) has sponsored a national accounting of the agriculture teacher workforce, and observers have repeatedly described an imbalance between the number of teachers prepared and the number of positions to be filled (Camp, 2000; Kantrovich,

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2010). A shortage of qualified agricultural educators has persisted across at least four decades and remains among the profession's most consequential challenges (Smith et al., 2017).

The contemporary National Supply and Demand Project, conducted continuously since 2014, gathers annual supply data from agriculture teacher preparation programs and annual demand data from state agricultural education leaders (Foster et al., 2025). Although the project is widely cited and serves as the field's most enduring workforce dataset, its findings have historically been disseminated through executive summaries and technical reports rather than peer-reviewed longitudinal analyses. Consequently, although annual reports have documented workforce conditions for decades, no previous peer-reviewed study has synthesized a decade of national data to examine the workforce dynamics underlying agriculture teacher shortages. As a result, the field has lacked a consolidated, scholarly treatment of how the supply of and demand for agricultural educators have moved together over the past decade, the mechanisms contributing to persistent workforce shortages, and how those patterns compare with trends documented in the broader teaching workforce.

Consequences of an unstable agricultural teaching workforce extend beyond staffing. Agricultural education is a complex instructional setting that integrates classroom and laboratory instruction, supervised agricultural experience, and FFA advisement; the preparation required to deliver this three-component model is demanding (Robinson & Edwards, 2012). When vacancies remain open or are filled by individuals without sufficient preparation and support, implementation of SAE, FFA, and laboratory responsibilities may be compromised (Bowling & Ball, 2018; Claflin et al., 2023; Disberger et al., 2022). From a human capital perspective, a persistent teacher shortage represents a double cost (Becker, 1993; Schultz, 1961; Sweetland, 1996). It reduces the returns society realizes on the investment already made in preparing agricultural educators, and it constrains the agricultural human capital that students stand to develop through SBAE programs, including the technical knowledge, leadership capacity, and career readiness that those programs are designed to cultivate (Connors & Velez, 2008; Dyer & Williams, 1997; Kreifels et al., 2025).

The agriculture teacher workforce also presents an empirical puzzle. National analyses of the broader teaching workforce describe contracting demand in many subject areas as student enrollment plateaus, as federal pandemic-era funding sunsets, and as preparation program enrollments recover unevenly (Goldhaber et al., 2026; Satcher et al., 2019). Within agricultural education, by contrast, demand has not contracted in step with these national trends (Kelley et al., 2025; Norris et al., 2024). Programs and positions have continued to expand, intensifying pressure on a preparation pipeline that has not grown commensurately and producing reliance on alternatively licensed and non-licensed personnel at a scale unfamiliar to many other subject areas (Bowling & Ball, 2018; Claflin et al., 2023; Disberger et al., 2022). Understanding the magnitude, sources, and trajectory of this imbalance is essential for the recruitment, preparation, induction, and policy decisions that sustain the profession.

In the sections that follow, we situate the agriculture teacher workforce in wider literature on teacher supply, demand, attrition, and human capital investment; we describe the framework that guides the project; and we synthesize 10 years of data to characterize the agriculture teacher pipeline from 2016 to 2025 and to quantify the recurring shortfall between newly prepared teachers and workforce demand.

Review of Literature

To situate the present analysis, we reviewed scholarship on teacher supply and demand in the broader teaching workforce, the costs and dynamics of attrition, alternative routes to certification, and the agriculture teacher workforce specifically. We organized the review around five strands that motivate the conceptual framing developed in the next section.

Foundations of Teacher Supply and Demand

Teacher supply and demand are best understood not as static counts but as the dynamic interaction of inflows, outflows, and stock (Ingersoll, 2001; Lindsay et al., 2009; Santiago, 2002). On the supply side, the workforce is replenished from several distinct sources: new completers of college-based preparation programs, alternatively certified entrants, teachers retained from the prior year, in-migration of credentialed teachers across state lines, and a reserve pool of individuals who hold credentials but are not currently teaching (Cook & Boe, 2007; Lindsay et al., 2009). On the demand side, workforce need is generated by program growth, enrollment changes, attrition that continually reopens positions, and policy decisions that alter required staffing levels (Goldhaber et al., 2026; Sutch et al., 2016). The shortfall at any point in time reflects the relative magnitude of these flows.

Ingersoll (2001) argued persuasively that what is often described as a shortage is more accurately a problem of turnover, because the largest single source of demand in most years is the need to replace teachers who leave rather than the need to staff newly created positions. This reframing reoriented the field from a focus on recruitment alone toward equal attention to retention. National analyses since that work have repeatedly confirmed the centrality of attrition to apparent shortages (Carver-Thomas & Darling-Hammond, 2019; García & Weiss, 2020; Sutch et al., 2019). The most recent post-pandemic analyses indicated that, in the aggregate, teacher supply has begun to recover from a sharp dip earlier in the decade, but persistent shortages remain concentrated in specific subjects, regions, and schools serving high-need populations (Goldhaber et al., 2026; Ingersoll & Tran, 2023). Agricultural education sits within this national context but, as we describe below, departs from it in important ways.

The Costs of Teacher Attrition and Turnover

Attrition is consequential not only because it generates demand but because it imposes real costs on schools, districts, and students (Carver-Thomas & Darling-Hammond, 2019; Disberger et al., 2022; Watlington et al., 2010). Estimates of the direct fiscal cost of replacing a single teacher range widely depending on the instrument used, but the cumulative national expenditure on teacher turnover has been documented in the billions of dollars annually (Carver-Thomas & Darling-Hammond, 2019; Watlington et al., 2010). Watlington and colleagues (2010) emphasized that the financial cost of attrition is compounded by the loss of instructional expertise, classroom management skills, and institutional knowledge, none of which are recovered by hiring a replacement. Each departure also generates organizational disruption that affects colleagues, students, and the stability of program delivery (Carver-Thomas & Darling-Hammond, 2019; Hanushek & Rivkin, 2007).

Early-career attrition is particularly costly because teacher effectiveness rises sharply in the first several years of practice (Rivkin et al., 2005), so a teacher who leaves in years one through three takes with them an investment that has not yet matured (Becker, 1993; Disberger et al., 2022; Sweetland, 1996). From a human capital perspective, this represents a substantial loss of returns on the considerable personal and institutional investment required to prepare a credentialed teacher (Becker, 1993; Sweetland, 1996). Recent linked administrative data show that teachers who leave the profession do not, on average, see dramatic earnings gains in the labor market they enter (Brummet et al., 2025), suggesting exit decisions are often driven by working conditions, family circumstances, or perceived nonpecuniary returns rather than by straightforward wage opportunities. The downstream effect falls on students, whose access to experienced educators declines as programs cycle through inexperienced personnel and whose human capital development depends on consistent instructional quality (Carver-Thomas & Darling-Hammond, 2019; Disberger et al., 2022).

Alternative Routes and Workforce Composition

As traditional preparation pipelines have contracted, schools have increasingly relied on alternative routes to certification and on non-licensed personnel to meet demand. National data indicate nearly one in five public school teachers entered through an alternative route, with the share considerably higher in career and technical fields (National Center for Education Statistics, 2023). Alternative routes have expanded in part because they reduce the upfront human capital investment required for entry into teaching, lowering one barrier identified by human capital theorists as a determinant of supply (Becker, 1993; García & Weiss, 2020).

Research comparing alternatively and traditionally prepared teachers has produced mixed findings on classroom effectiveness, with results sensitive to program design, induction support, and the populations served (Miller et al., 1998). The literature has consistently documented higher early-career attrition for some alternatively certified entrants and has emphasized the importance of induction and mentoring support for both groups (Bowen, 2024; Devier, 2019). The shift toward alternative pathways has specific implications for program delivery in SBAE, where laboratory-based instruction in agricultural mechanics, supervised agricultural experience, and FFA advisement require pedagogical and content preparation that teachers entering through nontraditional routes may not have (Devier, 2019; Robinson & Edwards, 2012). When alternative-route teachers are placed in SBAE positions without these supports, the returns to their preparation investment may be lower, and the human capital students develop through laboratory and leadership components of the program may be diminished.

Gender, Diversity, and Implications for Program Delivery

The demographic composition of new entrants to agriculture teacher education programs has shifted markedly over the past two decades, with women now constituting the majority of program completers (Spiess, 2016). National research suggests women are more likely than men to leave teaching for family or caregiving responsibilities but are also more likely to return after an absence (DeAngelis, 2013; Smith et al., 2025), and work-family conflict is a substantial predictor of turnover intention among agricultural educators specifically (Sorensen et al., 2016, 2017). These patterns suggest structured reentry pathways may represent an additional supply source for the profession (DeAngelis, 2013; Smith et al., 2025) for many women in the profession, the human capital invested in preparation is preserved during a temporary exit and may yield further returns through reentry; structured reentry pathways therefore represent a partially developed supply source for the profession to cultivate.

Diversity by race and ethnicity, by contrast, has remained limited. The agricultural teaching workforce remains predominantly White, in marked contrast to the racial and ethnic composition of the U.S. student population and the broader teacher workforce (Olson, 2023). The compositional gap persists despite decades of recognition that representation matters for student experience and outcomes. Research on the broader teaching workforce indicates that teacher demographics shape student engagement, role-modeling, and persistence in subject-area pathways (Sansone, 2017), and the gap between agricultural educator and student demographics may attenuate the very outcomes SBAE programs are designed to produce. Differential attrition by demographic group can further amplify or attenuate aggregate shortages, and the partial recovery of supply through returning teachers may be unevenly distributed across groups.

Working Conditions, Compensation, and Human Capital Returns

Teacher labor market scholarship has consistently identified compensation and working conditions as primary drivers of entry, retention, and exit decisions (Hanushek & Rivkin, 2007). When the lifetime returns to teaching are perceived as low relative to the costs of preparation, fewer individuals enter the profession and more leave it for occupations with higher compensation or more favorable conditions (Becker, 1993; García & Weiss, 2020). Working conditions are not reducible to salary; administrator

support, classroom autonomy, instructional resources, and reasonable workload all shape the nonpecuniary returns to teaching (Hanushek & Rivkin, 2007; Ingersoll, 2001). Recent national analyses indicate working conditions and compensation continue to predict turnover even after the post-pandemic recovery of preparation program enrollment (Goldhaber et al., 2026).

In agricultural education, the competing labor market is unusually visible because agribusiness, production agriculture, the Cooperative Extension Service, and related industry roles draw on the same applicant pool as teacher preparation programs (Brummet et al., 2025; Solomonson et al., 2021; Tummons et al., 2024). Qualitative research with male agricultural education teacher candidates who redirected to industry describes a deliberate comparison of expected returns, working conditions, and family considerations across the teaching and industry options (Tummons et al., 2024). The compensation comparison is particularly sharp because agribusiness employers can offer salaries, benefits, and progression structures that public school districts often cannot match (Igo & Perry, 2019; Tummons et al., 2024). Pathways into and out of agricultural teaching are therefore shaped by the relative attractiveness of these alternatives, by the cost of preparation, and by the working conditions teachers encounter once they enter classrooms.

The Agriculture Teacher Workforce

In agricultural education, scholarship on the workforce has developed alongside the supply and demand project itself. The earliest national accounting efforts can be traced to studies in the 1960s, and contemporary studies by Camp (2000), Kantrovich (2010), and Lawver et al. (2018) have provided systematic descriptions of the pipeline at successive moments in time. These studies have consistently documented an imbalance between supply and demand, an evolving institutional pattern of preparation concentrated in 1862 land-grant universities, and a workforce in which underrepresentation by race and ethnicity has been a persistent concern (Kantrovich, 2010; Lawver et al., 2018).

A growing peer-reviewed literature has examined specific facets of the agriculture teacher workforce in greater depth. Researchers have explored why agricultural educators leave classrooms (Solomonson et al., 2021; Sorensen et al., 2016) and why some return to them (Smith et al., 2025); how work-family conflict shapes turnover intention (Sorensen et al., 2017); how gender intersects with preparation and movement (Spiess, 2016; Tummons et al., 2024); and how alternative certification routes interact with the SBAE context (Bowen, 2024; Robinson & Edwards, 2012). This study contributes to the literature by providing a consolidated, decade-long longitudinal account of supply, demand, and the shortfall between them, situated within the broader teaching workforce and grounded in human capital theory.

Conceptual and/or Theoretical Framework

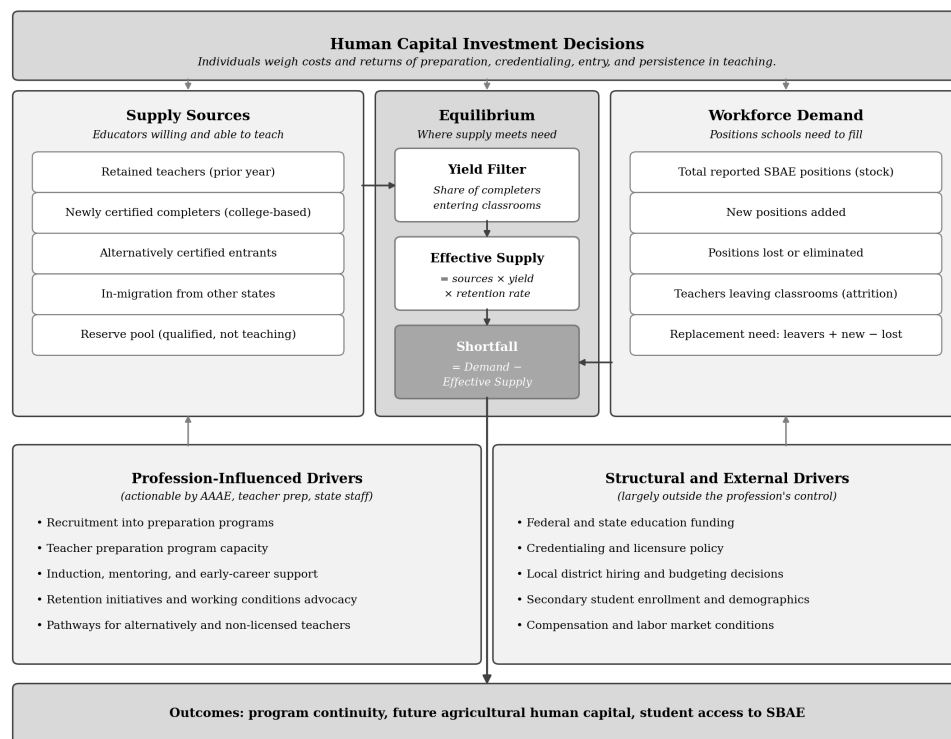
We framed this study using human capital theory and the supply-and-demand model that has guided the National Supply and Demand Project. Human capital theory (Becker, 1993; Schultz, 1961; Sweetland, 1996) treats education, training, and professional experience as forms of capital that increase worker productivity and economic value. From this perspective, the decision to enter, persist in, or leave teaching reflects an individual's assessment of the lifetime returns to the investment in preparation and credentialing relative to the costs and to the returns available in alternative occupations (Becker, 1993; Igo & Perry, 2019; Sweetland, 1996). The framework provides two complementary lenses on the agriculture teacher workforce. The first is the supply of teachers, which depends on whether sufficient individuals find the projected returns to teaching attractive enough to invest in preparation and to remain in the profession (Hur et al., 2024). The second is the future agricultural human capital of students, which depends on consistent access to qualified, prepared teachers; persistent shortages and high turnover reduce that access and may attenuate the human capital that SBAE programs are designed to develop (Disberger et al., 2022; Norris et al., 2024).

Building on this theoretical grounding, we adapted the supply and demand model used in prior project reports (Lawver et al., 2018; adapted from Lindsay et al., 2009) and refined it to separate the elements the profession can act upon from the structural conditions that operate largely outside the field's control (see Figure 1). Supply is replenished from five sources: teachers retained from the prior year, newly certified completers of college-based preparation programs, alternatively certified entrants, certified teachers migrating from other states, and a reserve pool of qualified individuals not currently teaching. Workforce demand reflects the stock of reported positions and the flows that change it: new positions added, positions lost, and teachers leaving classrooms. The interface between supply and demand operates through a yield filter, the rate at which completers enter classrooms. Only effective supply, the product of sources and yield, meets demand. When effective supply falls below demand, a shortfall results.

Two sets of contextual drivers shape the equilibrium. Profession-influenced drivers, including recruitment, preparation program capacity, induction and mentoring, retention initiatives, and pathways for alternatively prepared teachers, are amenable to coordinated action by AAAE, by teacher preparation programs, and by state agricultural education staff. Structural and external drivers, including federal and state funding, credentialing and licensure policy, local district hiring decisions, secondary student enrollment and demographics, and labor market compensation, lie largely outside the profession's direct control. Recognizing this distinction is analytically and practically important: a shortfall driven by a structural factor calls for a different response than one driven by an actionable factor. We operationalized each element of the model with the corresponding project measures described in the Methodology.

Figure 1

Conceptual Framework of School-Based Agricultural Education Supply and Demand Grounded in Human Capital Theory



Note. Framework adapted from Lindsay et al. (2009) and Lawver et al. (2018) and extended with human capital theory (Becker, 1993; Schultz, 1961; Sweetland, 1996). Contextual drivers are partitioned by the profession's capacity to act on them.

Purpose and Research Objectives

The purpose of this study was to describe the national supply of and demand for school-based agricultural education teachers from 2016 to 2025 and to estimate the recurring shortfall between newly prepared teachers and workforce demand. Four objectives guided the analysis:

1. Describe the supply of agricultural educators, including program completers, institutional sources, and completer demographics.
2. Describe the yield of program completers, defined as the proportion who entered agricultural education positions.
3. Describe the demand for agricultural educators, including workforce size, program growth, attrition, and reliance on alternatively licensed and non-licensed hires.
4. Estimate the annual demand metric and the resulting shortfall across the study period.

Methodology

Data in this manuscript are part of the larger National Supply and Demand Project of the American Association for Agricultural Education, an ongoing annual study of the agriculture teacher workforce (Foster et al., 2025). This manuscript focuses specifically on the longitudinal teacher supply and demand from 2016 to 2025. Other components of the project have addressed demographic composition of program completers and periodic assessment of teacher preparation program capacity (Lawver et al., 2018).

We employed a descriptive, longitudinal census design appropriate for monitoring workforce trends across a defined population rather than a probability sample. The project, reviewed and determined to be exempt by the Office for Research Protections at Pennsylvania State University, aimed to enumerate the institutions that prepare agricultural educators and the states that employ them; the design therefore prioritizes comprehensive coverage and year-over-year comparability.

Two populations were studied. The supply population comprised agriculture teacher educators at all United States institutions known to offer preparation leading to agricultural education licensure. The supply frame was originally developed from AAAE membership and updated annually as programs were identified or discontinued; it ranged from 100 to 109 institutions during the study period. The demand population comprised the agencies responsible for school-based agricultural education in each state, Puerto Rico, and the U.S. Virgin Islands, represented by state supervisors and executive secretaries. The demand frame included up to 52 reporting units.

Supply and demand data were collected with instruments refined across successive iterations of this legacy study. A panel of expert agricultural educators reviewed and revised items to establish content validity, and reliability was judged appropriate for descriptive workforce reporting (Lawver et al., 2018). Instruments were administered online through Qualtrics following the tailored design method (Dillman et al., 2014), including a schedule of reminder contacts to reduce nonresponse.

Supply data describing the prior academic year were requested annually from institutions, and demand data describing the current year were collected each fall from state agencies. Response rates were generally strong: supply response rates ranged from 75% to 100%, and demand response rates ranged from 79% to 98% across the study period. Because the project enumerates known populations, these rates reflect the participation of identified institutions and states rather than sampling fractions.

We summarized supply and demand measures descriptively by year, institution type, AAAE region, and demographic category. Yield was calculated as the number of completers employed in agricultural education divided by the total number of completers.

Because annual response rates varied across institutions and reporting units, reported values alone could not be directly compared across years for some national totals. To support longitudinal analyses, we generated interpolated estimates for selected aggregate measures, including total teachers, total programs, and total completers. Interpolation procedures followed established methods of the National Supply and Demand Project (Foster et al., 2025) and were used solely to create a more complete and comparable national trend series. Interpolated values are clearly identified throughout the manuscript and should be interpreted as estimates rather than observed counts. Because the study primarily examined long-term workforce trends rather than year-specific fluctuations, interpolation was appropriate to support cross-year comparisons. Reported values are presented alongside interpolated estimates whenever possible to maintain transparency.

Demand and shortfall estimates were calculated using procedures established in previous National Supply and Demand Project reports (Lawver et al., 2018). Consistent with teacher labor market research, demand was conceptualized as the number of teaching positions requiring staffing each year. Accordingly, the annual demand metric was calculated as:

$$\text{Demand Metric} = \text{Teachers Leaving} + \text{New Positions} - \text{Positions Lost}$$

This calculation captures workforce replacement needs generated by teacher attrition and program expansion while accounting for positions permanently eliminated from the system. The demand metric therefore reflects staffing demand rather than student enrollment demand.

To estimate the adequacy of traditional teacher preparation pathways to meet workforce needs, an annual shortfall estimate was calculated as:

$$\text{Shortfall} = \text{Demand Metric} - \text{Program Completers Employed in Agricultural Education}$$

This approach estimates the gap between workforce demand and the effective supply of newly prepared agricultural educators entering school-based agricultural education positions. Because some vacancies may remain unfilled, be staffed temporarily through emergency or alternative licensure pathways, or be eliminated due to an inability to recruit qualified personnel, the resulting shortfall estimates should be interpreted as conservative indicators of workforce need rather than exact measures of unmet demand.

Findings

Supply of Agricultural Educators

The number of program completers reported by agriculture teacher preparation institutions is presented in Table 1. Reported output numbered 772 completers in 2016, rose to a decade peak of 904 completers in 2019, and then declined to 747 by 2025, the lowest figure of the period. Across the same interval, the reported teaching workforce expanded substantially, a divergence we examine under the third objective. Between 80 and 101 institutions reported supply data each year, representing 75% to 100% of the supply frame.

Table 1*Program Completers and Reported Agricultural Education Positions, 2016 to 2025*

<i>Year</i>	<i>Completers (raw)</i>	<i>Completers (interpolated)</i>	<i>Positions (raw)</i>	<i>Teachers (interpolated)</i>
2016	772	774	11,557.5	12,412.5
2017	723	776	12,690.0	12,842.0
2018	873	913	13,827.0	13,617.0
2019	904	970	13,189.5	13,821.5
2020	897	975	13,253.5	13,968.5
2021	785	908	13,349.0	14,288.0
2022	854	936	14,516.0	14,711.0
2023	861	885	14,756.0	15,047.0
2024	781	842	14,990.0	15,454.0
2025	747	832	15,273.0	15,716.0

Note. Interpolated values adjust for differential annual response and support comparison across years.

Supply was concentrated in a small number of institution types (Table 2). The 1862 land-grant universities remained the primary source of new agricultural educators throughout the period, although their reported output declined from 452 completers in 2016 to 390 in 2025. Non-land-grant institutions were the second largest source and proved comparatively resilient, reporting 303 completers in 2016 and 329 in 2025. The 1890 historically Black land-grant universities reported consistently low and volatile output, ranging from a high of 21 completers in 2020 to a low of 3 in 2024. Private institutions contributed minimally, producing between 0 and 4 completers in the years they reported.

Table 2*Program Completers by Institution Type, Selected Years*

<i>Institution type</i>	<i>2016</i>	<i>2019</i>	<i>2022</i>	<i>2025</i>
1862 land-grant	452	510	463	390
1890 land-grant	17	12	8	10
Non-land-grant	303	378	375	329
Private	0	0	2	1

Note. Counts reflect completers for whom institution type was reported and may differ from the totals in Table 1.

The demographic composition of the completer pool shifted over the period (Table 3). Female completers outnumbered male completers throughout, and the disparity widened markedly. In 2016, women accounted for 516 of 772 (66.8%) completers, roughly two to one. By 2025, women accounted for 600 of 747 (80.3%) completers and men for only 143, a ratio approaching four to one. A small number of completers reported a nonbinary gender identity beginning in 2019. The completer pool remained predominantly White across all years. Completers identifying as Hispanic increased from 41 in 2016 to a high of 90 in 2024 before declining to 54 in 2025, whereas those identifying as African American or Black remained few, ranging from 4 to 22 annually.

Table 3*Gender of Program Completers, Selected Years*

<i>Gender</i>	<i>2016</i>	<i>2019</i>	<i>2022</i>	<i>2025</i>
Female	516	668	638	600
Male	256	236	215	143
Nonbinary		0	0	2
Total	772	904	854	747

Note. Nonbinary identity was not collected before 2019.

Yield of Program Completers

Not all program completers entered SBAE classrooms. Among 2025 completers, 539 accepted in-state positions and 56 accepted out-of-state positions, while the remainder pursued other paths, including graduate study ($n = 27$), agribusiness ($n = 32$), the Cooperative Extension Service ($n = 15$), production agriculture ($n = 4$), and teaching subjects other than agriculture ($n = 36$). Calculated yield, the proportion of completers employed in agricultural education, ranged from 0.73 to 0.80 in the interpolated national series and varied modestly by region (Table 4). Because yield consistently fell below 1.0, the effective new supply available to schools was substantially smaller than the raw completer count.

Table 4*Yield of Program Completers by AAAE Region, 2025*

<i>Region</i>	<i>Completers</i>	<i>Employed in-state</i>	<i>Employed out-of-state</i>	<i>Yield</i>
North Central	209	140	26	0.79
Southern	384	282	24	0.80
Western	152	117	6	0.81
National (interpolated)	832	606	62	0.80

Note. Yield = completers employed in agricultural education $\div$ total completers.

Demand for Agricultural Educators

In contrast to the contracting supply pipeline, demand for agricultural educators grew steadily (see Table 1). The reported workforce increased from approximately 11,558 positions in 2016 to 15,273 in 2025, and interpolated estimates placed the workforce at 15,716 teachers across 9,869 programs by 2025. States documented 264 new programs against 66 programs lost in 2025, and 353 new positions against 143 positions eliminated. States also reported 3,207 middle school agricultural programs in 2025, the first year this category was formally enumerated.

When asked why positions were eliminated, states most frequently cited the absence of an available teacher. In 2025, the lack of a teacher accounted for 39 lost positions, exceeding losses attributed to declining enrollment ($n = 37$) or funding reductions ($n = 29$). The shortage thus functioned not only as an unmet hiring need but also as a direct cause of program loss.

Attrition was a substantial and growing driver of demand (Table 5). The number of teachers leaving agricultural education classrooms rose from 721 in 2016 to an interpolated peak exceeding 1,100 from 2022 through 2024 before easing to 762 reported departures, or 993 interpolated, in 2025. Retirement was the leading single reason for departure ($n = 165$ in 2025), but career migration was collectively larger: in 2025, 138 teachers left for agribusiness, 81 moved to teach other subjects, 42 entered school administration, and 60 cited caregiving responsibilities.

Table 5*Reported Reasons Teachers Left Agricultural Education, Selected Years*

<i>Reason</i>	<i>2016</i>	<i>2019</i>	<i>2022</i>	<i>2025</i>
Retirement	201	149	179	165
Agribusiness	112	76	157	138
Teaching another subject	53	63	129	81
Caregiving	31	21	62	60
Terminated	81	71.8	37	56
School administration	41	33	41	42
Production agriculture	51	23	41	35
Moved out of state	28	24	62	31
Other reasons	97	69	108	84
Unknown	26	92	85	70
Total	721	621.8	901	762

Note. Other reasons include extension, adult education, agricultural education leadership, postsecondary, continued education, personal health, death, and unspecified other categories.

To meet demand that traditional supply could not satisfy, districts relied increasingly on non-traditional sources (Table 6). In 2025, states reported hiring 322 alternatively licensed teachers and 175 non-licensed individuals on a temporary or emergency basis. Among the non-licensed hires, 66 came directly from agribusiness, 43 held general education degrees without an agricultural background, 28 were agriculture graduates without pedagogical preparation, and the remainder came from other sources.

Table 6*Reported Sources of Non-Licensed Hires, Selected Years*

<i>Source</i>	<i>2016</i>	<i>2019</i>	<i>2022</i>	<i>2025</i>
Agribusiness	33	21	68	66
Education (general, degreed)	22	26	43	43
Agriculture graduate	20	18	40	28
Education graduate	4	0	5	4
Retired	0	0	5	3
Other graduate	0	11	3	1
Other	0	10	2	13
Unknown	0	2	14	17
Total	80	88	210	175

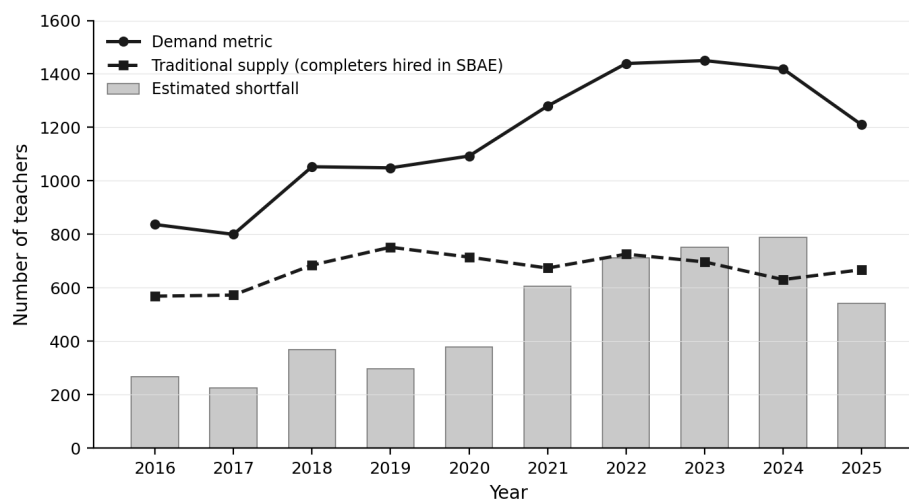
Demand Metric and Estimated Shortfall

Combining attrition, new positions, and lost positions yielded the annual demand metric, against which the supply of completers entering agricultural education was compared to estimate the shortfall (Table 7; Figure 2). The interpolated demand metric rose from 837 teachers in 2016 to a peak of 1,450 in 2023 before moderating to 1,210 in 2025. Because the supply of completers employed in agricultural education remained between roughly 570 and 750 teachers annually, demand exceeded supply in every year. The estimated shortfall grew from 268 positions in 2016 to a peak of 788 in 2024, then eased to 542 in 2025. Figure 2 illustrates the persistent and widening gap between demand and traditional supply across the period.

Table 7*Estimated Demand Metric and Shortfall (Interpolated), Selected Years*

Component	2016	2019	2022	2025
New positions	260	306	444	359
Positions lost	143	120	129	142
Teachers leaving	720	862.8	1,124	993
Demand metric	837	1048.2	1,439	1,210
Completers in SBAE	569	700	726	668
Shortfall	268	348.2	713	542

Note. Demand metric = teachers leaving + new positions – positions lost. Shortfall = demand metric – completers employed in school-based agricultural education (SBAE). All values are interpolated.

Figure 2*Demand, Traditional Supply, and Estimated Shortfall, 2016 to 2025*

Note. Values are interpolated. Traditional supply is the number of program completers employed in agricultural education (in-state plus out-of-state).

Conclusions and Discussion

This longitudinal analysis documents a persistent and widening mismatch between the supply and yield of newly prepared agricultural educators and workforce demand. Although the existence of a shortage is not a new finding, this study provides a decade-long perspective on the workforce dynamics shaping the resulting annual shortfall. Three findings were particularly consequential. First, workforce demand was driven primarily by teacher attrition rather than program expansion. Second, a substantial proportion of program completers never entered school-based agricultural education classrooms, reducing the effective supply available to schools. Third, increasing reliance on alternatively licensed and non-licensed hires indicates that alternative certification has become a structural feature of the agricultural education labor market. Viewed through a human capital lens, these findings connect patterns in agricultural educator supply, completer yield, workforce demand, and the resulting shortfall. Elements of the human capital lens provide a better picture of why the shortage persists despite continued investments in teacher preparation and highlight challenges in workforce formation, deployment, and retention rather than recruitment alone.

Comparing Project Findings with National Benchmarks

The supply and demand patterns documented in this analysis differ in important respects from those reported for the broader U.S. teaching workforce. National analyses describe contracting demand in many subject areas as student enrollment plateaus and federal pandemic-era funding sunsets (Goldhaber et al., 2026), whereas the agricultural education workforce reported here grew by approximately one-third across the decade. National attrition estimates derived from the Schools and Staffing Survey and the National Teacher and Principal Survey place annual teacher turnover at roughly 16% (Carver-Thomas & Darling-Hammond, 2019; National Center for Education Statistics, 2024); the interpolated attrition rate implied by these project data (teachers leaving divided by reported teachers) tracks closely with the national figure in most years. Demographic patterns also diverge. Although women have constituted a slight majority of the U.S. teacher workforce for decades (National Center for Education Statistics, 2023), the agriculture teacher education program completer pool moved from a roughly two-to-one female-to-male ratio in 2016 to a four-to-one ratio in 2025, a rate of feminization that outpaces the broader teacher pipeline.

Understanding the Workforce Dynamics Underpinning the Agriculture Teacher Shortfall

Although multiple factors contribute to workforce shortages, the data suggest four interrelated dynamics account for much of the persistent gap between the supply of newly prepared agricultural educators and workforce demand: teacher attrition, losses in yield before classroom entry, continued program expansion, and increasing reliance on alternative certification pathways.

Consistent with broader teacher labor market research (Ingersoll, 2001), attrition was the dominant driver of workforce demand in SBAE. Across the study period, most annual demand resulted from replacing teachers who exited classrooms rather than staffing newly created positions. In 2025, states reported 993 interpolated departures, accounting for approximately 82% of the annual demand metric. Taken together, these findings indicate that the agriculture teacher shortage is fundamentally a retention challenge as much as a recruitment challenge. While increasing the number of program completers remains important, substantial reductions in workforce shortages are unlikely without corresponding improvements in teacher retention and career longevity.

Attrition represents the loss of investments already made in teacher preparation, induction, and professional development while simultaneously removing instructional expertise and program leadership from the profession. Consequently, retention efforts – especially during the early career years – may provide returns comparable to, or greater than, recruitment efforts alone.

A second contributor to workforce shortages is the gap between program completion and workforce entry. Across the decade, only 73% to 80% of completers entered school-based agricultural education, leaving approximately 20% to 25% of newly prepared educators outside the intended workforce. In 2025 alone, an estimated 164 completers did not enter SBAE classrooms. Although many pursued graduate education or related careers, these yield losses substantially reduced the effective teacher supply. Consequently, increasing the proportion of completers who choose classroom teaching may represent one of the profession's most efficient opportunities to strengthen workforce capacity.

The shortage is further intensified by continued growth of school-based agricultural education. Unlike many subject areas experiencing stable or declining enrollment-driven demand, agricultural education continued to expand throughout the study period, increasing from approximately 12,400 teachers in 2016 to more than 15,700 in 2025. This expansion reflects the strength of agricultural education but also intensifies workforce shortages because demand continues to outpace traditional preparation capacity. The data suggest that workforce planning efforts should consider not only replacing departing teachers but also ensuring that growth targets remain aligned with available workforce capacity.

The findings also highlight the profession's increasing reliance on alternatively licensed and non-licensed educators to meet demand. In 2025 alone, states reported hiring 322 alternatively licensed teachers and 175 non-licensed individuals, representing a substantial proportion of new hires. These pathways have become increasingly important for maintaining program continuity when traditionally prepared teachers are unavailable. Findings indicate alternative certification has evolved from a supplemental workforce strategy into a structural component of the agricultural education labor market.

This shift has important implications for teacher preparation and workforce development. Alternative pathways redistribute portions of teacher development from preservice preparation into induction and early-career professional learning, increasing the importance of mentoring, instructional coaching, and sustained professional development after entry into the classroom. As states continue to rely on these pathways, their effectiveness will depend on recruiting individuals with strong agricultural expertise and developing systems that support their pedagogical growth and long-term retention. As the traditional teacher preparation pipeline continues to face capacity constraints, strengthening the systems that support alternatively prepared educators may become as important to long-term workforce stability as expanding traditional preparation pathways.

Implications of a Changing Workforce Composition

Two compositional shifts warrant particular attention. The first is the widening gender disparity of completers. Research suggests that female agriculture teachers face heightened work-family conflict and are more likely than male agriculture teachers to leave for caregiving responsibilities, though they are also more likely to return (DeAngelis, 2013; Smith et al., 2025; Sorensen et al., 2016). This pattern implies that a sizable share of the investment in preparing women for SBAE is preserved during temporary exits and can be recovered through structured reentry, but only if reentry pathways are visible and supported. The composition shift therefore implies both a higher likelihood of temporary exits and, with appropriate supports, a higher likelihood of reentry, and it suggests that program delivery, including laboratory-based instruction in agricultural mechanics, supervised agricultural experience, and FFA advisement, may be reshaped by the preparation, interests, and working conditions of an increasingly female workforce.

The second is the growing reliance on alternatively licensed and non-licensed hires, which exceeded one-third of new hires in 2025. This pathway has prevented widespread program collapse, but it raises questions about preparation in the core practices of SBAE. Preparation questions are closely tied to retention because non-traditionally prepared teachers often require additional induction support to develop the pedagogical content knowledge that traditional preparation provides (Bowen, 2024; Devier, 2019; Robinson & Edwards, 2012). The effectiveness of alternative-route preparation depends critically on whether the profession invests in the induction infrastructure that allows preparation to translate into effective practice.

The Cost of Early-Career Turnover

Although the project does not directly measure the fiscal cost of turnover, the findings have implications for understanding those costs. Teacher effectiveness generally increases in the first several years of practice (Rivkin et al., 2005), and the financial cost of replacing a teacher includes recruitment, induction, and productivity losses that the profession absorbs each time a teacher exits early (Watlington et al., 2010). With more than 900 teachers leaving SBAE classrooms in the most recent year and a meaningful share of new hires entering through nontraditional routes, early-career attrition represents a significant loss to the profession. Sustaining effective induction and mentoring is therefore not only a retention strategy, but a fiscal one.

Strengths and Limitations

The principal strength of this study is its scope. It draws on a national population sustained for more than a decade with consistent procedures. Several limitations temper interpretation. Response rates varied across years and reporting units, and although interpolation improves comparability, interpolated totals are estimates rather than counts. Some categories, such as middle school programs, were enumerated only recently, limiting analysis. The fiscal cost of turnover is implied rather than measured, and regional variation, while documented for 2025 yield, was not modeled across the full period. Finally, the descriptive design supports identifying trends and associations but not causal inference.

Human Capital Interpretation of the Findings

Viewed collectively through a human capital lens, the agriculture teacher shortage reflects both structural workforce pressures and profession-influenced challenges in human capital formation, deployment, and retention. Although some drivers—including retirement patterns, district hiring decisions, state funding structures, and broader labor market conditions—remain largely outside the direct control of the profession, several of the most consequential factors identified in this study, including completer yield, preparation capacity, induction support, and the development of alternatively prepared teachers, represent areas in which coordinated professional action may improve workforce outcomes. Teacher preparation programs continue to develop new human capital, but declining program completer numbers and yield losses constrain workforce formation and deployment, while attrition removes experienced human capital faster than it can be replenished. Continued program expansion further increases demand for qualified educators, and alternative certification pathways increasingly serve as mechanisms for developing and deploying workforce capacity outside traditional preparation systems. Framed in this way, the agriculture teacher shortage is not simply a staffing problem but a challenge of sustaining the profession's human capital infrastructure. Addressing that challenge requires coordinated efforts to strengthen recruitment, improve the deployment of prepared teachers into classrooms, support retention and reentry, and ensure that alternatively prepared educators receive the mentorship and professional development necessary for long-term success. The recommendations that follow are organized by the stakeholders most directly positioned to influence these workforce dynamics.

Recommendations

Teacher education programs should strengthen the quantity and quality of the agriculture teacher pipeline through coordinated efforts that address recruitment, preparation, and workforce entry. Continued recruitment remains essential, particularly among populations underrepresented in agricultural education and individuals with prior agricultural industry experience. At the same time, preparation programs should continue expanding authentic teaching experiences that reflect the full scope of SBAE responsibilities, strengthen candidates' readiness for the profession's unique demands, and identify strategies to improve completer yield into classroom teaching. Given the increasing reliance on alternative certification pathways, agriculture teacher educators should also collaborate with state leaders to develop accessible bridge curricula and induction supports that help alternatively prepared educators develop pedagogical expertise while maintaining consistent expectations for instructional quality.

State SBAE leaders and professional associations should prioritize coordinated induction and workforce development efforts that strengthen teacher retention across all preparation pathways. Mentorship and professional development will become increasingly important as alternatively licensed teachers comprise a larger share of the workforce. State leaders should also continue monitoring workforce trends through systematic data collection and use these findings to inform strategic planning, resource allocation, and collaborative workforce initiatives with teacher preparation programs.

Policymakers should view agriculture teacher workforce development as a long-term investment in educational capacity rather than a short-term staffing challenge. Sustained support for agriculture teacher preparation, induction, mentoring, competitive compensation, and reentry pathways can strengthen workforce stability while maximizing the return on public investments in teacher development. Because workforce shortages reflect both structural conditions and profession-influenced factors, policies that simultaneously expand preparation capacity and improve teacher retention are likely to have the greatest long-term impact.

Future research should continue expanding understanding of the agriculture teacher workforce by examining both individual career decisions and broader workforce systems. Qualitative and mixed-methods studies exploring why prepared teachers do or do not enter SBAE, experiences of alternatively licensed educators, and factors influencing teacher retention and reentry would provide important context for the longitudinal trends identified in this study. Comparative analyses examining workforce outcomes across preparation pathways and states may also identify promising practices that improve recruitment, deployment, and retention.

Continued refinement of the National Supply and Demand Project also presents opportunities for future scholarship. Linking workforce data with licensure, employment, and preparation records could improve estimates of completer yield, career trajectories, and workforce mobility while supporting more sophisticated longitudinal analyses of the agricultural education labor market.

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Artificial intelligence (AI) tools were used solely to improve the clarity and readability of the manuscript and to assist in verifying the accuracy and consistency of citations. All research design, data analysis, interpretation, and final content were conducted and reviewed by the authors, who take full responsibility for the manuscript.

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The data supporting the findings of this study are publicly available through the National Agricultural Teacher Supply and Demand Project and may be accessed at <https://nsd.aaaeonline.org/>.

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