Agriculture and Natural Resources Skills and Competencies to Support Workforce Development in Central and North-Central Appalachia

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Introduction

Agriculture and natural resources (ANR) industries are critical to economic stability, environmental stewardship, and community sustainability, particularly in economically distressed regions. Central and North-Central Appalachian communities continue to experience workforce shortages, underemployment, and limited access to specialized training opportunities in ANR-related fields. Higher education institutions can support workforce development through microcredentials and targeted educational programming aligned with evolving workforce skill and competency needs. Understanding workforce-defined ANR competencies can support evidence-based curriculum development and strengthen partnerships among higher education, industry, and workforce systems to enhance career development, support workforce growth, and improve quality of life in Appalachia. This study aligns with priorities identified in the American Association for Agricultural Education (AAAE) National Research Agenda related to workforce preparation and responsive agricultural education programming (AAAE, 2023). The purpose of this study was to identify workforce-defined ANR skills and competencies to inform development of targeted educational programming and microcredentials aligned with workforce needs of the region.

Conceptual Framework

This research is grounded in Human Capital Theory (Shultz, 1961), which suggests that targeted education and training increase workforce productivity, employability, and long-term economic outcomes. Within this framework, microcredentials represent focused investments in workforce-relevant skills that support individual career advancement and regional economic development. This study is also informed by the Roberts and Ball (2009) model for effective agricultural education, which emphasizes alignment among industry needs, educational programming, and societal outcomes. Identifying workforce-prioritized competencies and aligning educational programming accordingly supports development of responsive ANR education systems and workforce-ready graduates. Together, these frameworks support examination of workforce-defined competencies as drivers of curriculum design and microcredential development within ANR education.

Methods

To understand the demands of the current ANR workforce, an extensive list of skills and competencies, also referred to as topics, was compiled from professional and accrediting ANR certification requirements using methods adapted from Easterly et al. (2017) and Sample et al. (2015). The topics were then organized into 13 subject categories including natural resources and environmental sciences, plant and soil sciences, animal sciences, land management, policies and regulations, research and monitoring methods, production methods, human dimensions, management techniques and methods, education and training, personal skills, leadership skills, and communication skills. The Qualtrics survey was distributed to 10,462 individuals across 549 organizations representing academia, consulting, private business, and federal, state, and local government agencies, as well as nongovernmental organizations (Blake, 2024). Respondents ranked the importance of each topic as it relates to their respective ANR career field on a five-point Likert scale with 1 indicating not important and 5 indicating extremely important. Any

topics with a mean of 3 or higher were considered important. A total of 365 employees in ANR-related industries completed the survey (3.3% response rate). Analysis of respondents from Central and North-Central Appalachia (n = 73) was conducted to evaluate regional workforce competency priorities (Appalachian Regional Commission, 2021; U.S. Census Bureau, 2021).

Results

In the natural resources and environmental sciences subject category, top competencies include invasive species (M = 4.01), ecology (M = 3.78), and pesticides (M = 3.71); in plant and soil sciences, top competencies include plant identification (M = 3.89), basic plant and soil relationships (M = 3.88), and basic soil science (M = 3.67), and plant health (M = 3.67); in animal science, top competencies include entomology (M = 3.37), human health (M = 3.35), and forest wildlife (M = 3.23). In land management, top competencies included natural resource management (M = 3.96), land management (M = 3.71), and how to write a management plan (M = 3.54); in policies and regulations, top competencies include state laws and regulations (M = 4.35), federal laws and regulations (M = 4.28), and local laws and regulations (M = 4.03); in research and monitoring methods, top competencies include best management practices (M = 3.86), field sampling methods (M = 3.67), and mapping using GPS and GIS (M = 3.63); in production methods, top competencies were integrated pest management (M = 3.68), pest control methods (M = 3.51), and organic pest control (M = 3.26). In human dimensions, top competencies included public health (M = 3.58), local economy (M = 3.41), and public participation (M = 3.37); in management techniques and methods, top competencies were provide advice and recommendations to natural resources users (M = 3.46), develop policies and procedures for natural resources management programs (M = 3.20), and chemical/fertilizer labeling (M = 3.16); in education and training, top competencies were conservation education (M = 3.79), outreach (M = 3.62), and CPR (M = 3.13). In personal skills, top competencies were being dependable (M = 4.64), behaving ethically (M = 4.54), and working independently (M = 4.46); in leadership skills, top competencies were clear communication (M = 4.43), self-motivation (M = 4.39), and teamwork (M = 4.39); in communication skills; top competencies were strong writing skills (M = 4.01), public speaking (M = 3.83), and customer service (M = 3.81).

Conclusions/Implications

These findings indicate that the Central and North-Central Appalachian ANR workforce requires a blended skill profile that integrates strong applied environmental science knowledge, regulatory and compliance literacy, field-based technical skills, and high-level professional competencies. Workforce demand emphasizes employees who can support ecosystem management, regulatory-compliant operations, applied monitoring and sampling, and science-based management planning within complex policy environments.

Through strategic partnerships, curriculum enhancement, and targeted microcredential development, higher education institutions serving these regions can support long-term workforce development and ANR career pathways. Workforce readiness requires integration of technical science competencies, regulatory literacy, field-based technical training, and professional workforce skills. These findings provide a framework for workforce-aligned curriculum design and microcredential development to support economic development and expand access to ANR career pathways across these Appalachian communities.

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