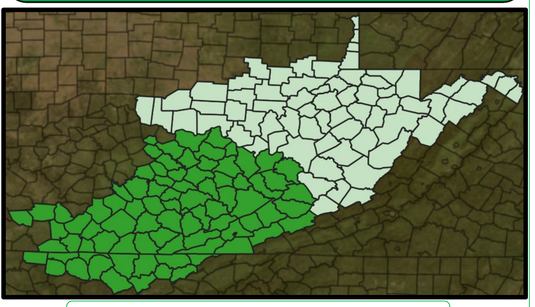
AGRICULTURE AND NATURAL RESOURCES SKILLS AND COMPETENCIES TO SUPPORT WORKFORCE DEVELOPMENT IN CENTRAL AND NORTH-CENTRAL APPALACHIA

NATURAL RESOURCES & EARTH SCIENCES
National Institute of Food and Agriculture
U.S. DEPARTMENT OF AGRICULTURE

Hannah R. Blake, M.S. | Autumn N. Starcher-Patton, Ph.D.
Marshall University, Huntington, WV

Introduction

Central & North-Central Appalachia



Central Appalachia | North-Central Appalachia

Workforce shortages and underemployment persist in Central and North-Central Appalachia.

PURPOSE:

- Identify agriculture and natural resources (ANR) skills and competencies prioritized by employers and professionals
- Targeted microcredentials and aligned education can strengthen regional ANR workforce and improve quality of life.

Conceptual Framework

HUMAN CAPITAL THEORY

Investments in education and training increase workforce productivity, employability, and economic outcomes.

ROBERTS & BALL MODEL

Alignment among industry needs, educational programming, and societal outcomes leads to effective agricultural education.

Methods

- Qualtrics survey sent to 10,462 email addresses from 549 unique organizations
- Ranked importance of ANR skills & competencies using 5-point Likert scale
- 365 respondents (3.3% response rate)
- Topics with mean ≥3.0 considered important
- Data analysis & heatmaps created in Excel

Analysis focused on Central and North-Central Appalachia (N=73).

THIS PROJECT WAS APPROVED BY MU IRB #2033482. SURVEY INSTRUMENT BASED ON EASTERLY ET AL. (2017) AND SAMPLE ET AL. (2015).

Results

Mean importance (1 = Not Important, 5 = Extremely Important)
M = 3.0 | M = 4.0 | M = 5.0 | (M < 3.0 not shown)

Environmental & Biological Systems	ENVIRONMENTAL SCIENCE (3.70)	MICROORGANISMS (3.21)	PLANT HEALTH (3.67)	SOIL FERTILITY AND AMENDMENTS (3.10)
	FOREST ECOLOGY (3.49)	NUTRIENT SCIENCE (3.07)	PLANT IDENTIFICATION (3.89)	SOIL ORGANIC MATTER (3.01)
	FOREST HEALTH (3.49)	PESTICIDES (3.71)	PLANT NUTRITION (3.11)	SOIL PHYSICAL PROPERTIES (3.11)
	FOREST HYDROLOGY (3.11)	PH (3.38)	PLANT PATHOLOGY (3.23)	SOIL SAMPLING (3.28)
	NATURAL RESOURCES & ENVIRONMENTAL SCIENCE	FOREST SCIENCE (3.38)	RARE, THREATENED, AND ENDANGERED SPECIES (3.45)	PLANT PHYSIOLOGY (3.03)	SOIL-WATER RELATIONSHIPS (3.51)
	AGRICULTURAL SCIENCE (3.51)	FUNGAL PESTS (3.14)	**PLANT & SOIL SCIENCES**	PLANT PROPAGATION (3.18)	**ANIMAL SCIENCE**
	AQUATIC ECOLOGY (3.14)	GENERAL BIOLOGY (3.70)	BASIC PLANT AND SOIL RELATIONSHIPS (3.88)	SOIL BIOLOGY (3.18)	ANIMAL ECOLOGY (3.21)
	CLIMATE CHANGE (3.47)	GROUNDWATER AND SURFACE WATER CONTAMINATION (3.53)	BASIC SOIL SCIENCE (3.67)	SOIL CHEMISTRY (3.14)	ANIMAL HEALTH (3.11)
	COMPUTER SCIENCE (3.05)	HYDROLOGIC CYCLE (3.21)	FOREST SOILS (3.23)	SOIL CLASSIFICATION (3.06)	ENTOMOLOGY (3.37)
	CONSERVATION BIOLOGY (3.67)	DISEASE PATHOGENS AND VECTORS (3.52)	PLANT ANALYSES AND INTERPRETATION (3.03)	SOIL CONTAMINATION (3.18)	FOREST WILDLIFE (3.23)
	ECOLOGY (3.78)	INVASIVE SPECIES (4.01)	PLANT ECOLOGY (3.44)	SOIL ECOLOGY (3.10)	HUMAN HEALTH (3.35)

Management & Regulation	EMS* PLANNING AND IMPLEMENTATION (3.14)	NUTRIENT MANAGEMENT (3.18)	WETLAND RESTORATION AND MANAGEMENT (3.10)	PESTICIDE ACT OF 1990 (3.26)
	EMS* IMPLEMENTATION AND OPERATION (3.06)	SOIL AND WATER CONSERVATION (3.44)	WILDLIFE MANAGEMENT (3.12)	STATE LAWS AND REGULATIONS (4.35)
	ENVIRONMENTAL REMEDIATION (3.06)	SOIL MANAGEMENT (3.28)	**POLICIES & REGULATIONS**	**RESEARCH & MONITORING METHODS**
	EROSION AND SEDIMENT CONTROL (3.35)	STREAMBANK STABILIZATION (3.10)	CLEAN WATER ACT (CWA) (3.66)	BEST MANAGEMENT PRACTICES (3.86)
	FARM MANAGEMENT (3.13)	SUSTAINABLE FOREST MANAGEMENT (3.25)	ENDANGERED SPECIES ACT (ESA) (3.43)	FIELD SAMPLING METHODS (3.67)
	LAND MANAGEMENT	FARMLAND PRESERVATION (3.06)	SUSTAINABLE RESOURCE MANAGEMENT PLANS (3.29)	FEDERAL INSECTICIDE, FUNGICIDE AND RODENTICIDE ACT (FIFRA) (3.28)	GROUNDWATER AND SURFACE WATER COLLECTION METHODS (3.03)
	AGRICULTURAL SITES (3.21)	FOREST RESTORATION (3.11)	WATER ISSUES (3.26)	FEDERAL LAWS AND REGULATIONS (4.28)	LAND CLASSIFICATION (3.01)
	AGRICULTURAL WATER (3.21)	HOW TO WRITE A MANAGEMENT PLAN (3.54)	WATER QUALITY AND MANAGEMENT (3.46)	LOCAL LAWS AND REGULATIONS (4.03)	MAPPING USING GPS AND GIS (3.63)
	CROPLAND, RANGELAND, AND FIELD MANAGEMENT (3.07)	LAND MANAGEMENT (3.71)	WATER RESOURCES (3.42)	NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) (3.45)	REMOTE SENSING USING GPS AND GIS (3.35)
	ENVIRONMENTAL AND AGRICULTURAL APPLICATIONS OF SOIL BIOLOGY (3.06)	LAND USE PLANNING (3.40)	WATERSHED MANAGEMENT (3.22)	NATURAL RESOURCES POLICY (3.73)	RESEARCH METHODS (3.32)
	ENVIRONMENTAL MANAGEMENT (3.38)	NATURAL RESOURCE MANAGEMENT (3.96)	WEED MANAGEMENT (3.31)	OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA) (3.25)	SOIL ANALYSES AND INTERPRETATION (3.08)

*EMS=Environmental Management Systems

Professional Workforce Skills	BEING INNOVATIVE (3.93)	FOLLOW INSTRUCTIONS (4.31)	**LEADERSHIP SKILLS**	LABOR MANAGEMENT (3.07)
	BEING OPEN TO FEEDBACK (4.35)	OBSERVATION SKILLS (4.44)	ACCOUNTING AND BUDGETS (3.36)	MANAGE A PUBLIC PARTICIPATION PROCESS (3.17)
	BEING ORGANIZED (4.31)	PHYSICAL FITNESS (3.25)	ACTIVE LISTENING (4.17)	MANAGE A COLLABORATIVE PROCESS (3.54)
	BEING RECEPTIVE TO CHANGES (4.25)	POSITIVITY (4.04)	ASSERTIVENESS (3.57)	MANAGE CONFLICT (3.76)
	COMPUTER PROFICIENCY (4.00)	PROBLEM SOLVING SKILLS (4.38)	CLEAR COMMUNICATION (4.43)	OVERSEE PROGRAMS (3.64)
	PERSONAL SKILLS	CREATIVE (3.47)	READING COMPREHENSION (4.24)	COMPLAINT PROCESS AND POTENTIAL OUTCOMES (3.54)	RISK MANAGEMENT (3.39)
	ABSTRACT THINKING (3.63)	DATA ANALYSIS AND INTERPRETATION (3.71)	RECORD KEEPING SKILLS (4.13)	CONFIDENCE (3.83)	SELF-MOTIVATION (4.39)
	ATTENTION TO DETAIL (4.42)	DATA ENTRY (3.54)	TAKING INITIATIVE (4.15)	CRITICAL THINKING (4.31)	SHOWING EMPATHY (3.85)
	BEHAVE ETHICALLY (4.54)	DEMEANOR UNDER PRESSURE (4.06)	TIME MANAGEMENT SKILLS (4.30)	DECISION MAKING (4.24)	STRATEGIC PLANNING (3.81)
	BEING DEPENDABLE (4.64)	DETECT PROBLEMS (4.00)	WORK INDEPENDENTLY (4.46)	HIRING AND TRAINING STAFF (3.58)	TAKING INVENTORY (3.35)
	BEING FOCUSED (4.32)	FLEXIBILITY (4.21)	WORK OUTDOORS FOR EXTENDED PERIODS (4.01)	INTERNAL AUDITING PLANNING AND PREP, AUDIT SKILLS, AND TECHNIQUES (3.01)	TEAMWORK (4.35)

Human & Applied Systems	ORGANIC PEST CONTROL (3.26)	PUBLIC PARTICIPATION (3.37)	PROGRAM EVALUATION (3.06)	**COMMUNICATION SKILLS**
	PEST CONTROL METHODS (3.51)	RURAL COMMUNITY DYNAMICS (3.21)	PROVIDE ADVICE AND RECOMMENDATIONS TO NR* USES (3.46)	BRANDING, MARKETING, PUBLIC RELATIONS, & PROMO MARKETING (3.17)
	HUMAN DIMENSIONS	WORKER HEALTH AND HYGIENE (3.14)	QUALITY CONTROL (3.04)	CUSTOMER SERVICE (3.81)
	AGRICULTURAL DEVELOPMENT (3.01)	**MANAGEMENT TECHNIQUES & METHODS**	**EDUCATION & TRAINING**	DEALING WITH CRISIS (3.75)
	ETHICS (3.33)	CHEMICAL/FERTILIZER LABELING (3.16)	CONSERVATION EDUCATION (3.79)	EVENT PLANNING (3.21)
	INCREASING EXPECTATIONS FOR PUBLIC PARTICIPATION (3.20)	DEVELOP POLICIES AND PROCEDURES FOR NR* MANAGEMENT PROGRAMS (3.20)	CPR (3.13)	PUBLIC SPEAKING (3.83)
	PRODUCTION METHODS	LOCAL ECONOMY (3.41)	FACILITIES AND EQUIPMENT MAINTENANCE (3.03)	OUTREACH (3.62)	STRONG WRITING SKILLS (4.01)
	INTEGRATED PEST MANAGEMENT (3.68)	PUBLIC HEALTH (3.58)	OCCUPATION HEALTH AND SAFETY PROCEDURES (3.01)	WORKPLACE HAZARDS AND PROTECTIVE MEASURES (3.04)	TECHNICAL AND SCIENTIFIC COMMUNICATIONS (3.75)

*NR=Natural Resources

Top 5 Competencies Across All ANR Industries

- BEING DEPENDABLE
- BEHAVING ETHICALLY
- WORK INDEPENDENTLY
- OBSERVATION SKILLS
- CLEAR COMMUNICATION

Implications

CURRICULUM

- Strengthen applied environmental science instruction
- Increase regulatory and compliance literacy coverage
- Emphasize ecosystem management and monitoring skill
- Integrate interdisciplinary ANR workforce competencies

TEACHING

- Incorporate field-based technical training experiences
- Use applied monitoring and sampling activities
- Provide problem-based regulatory and management scenarios
- Develop professional communication and workforce skills

WORKFORCE DEVELOPMENT

- Expand ANR-focused microcredential opportunities
- Align curriculum with regional workforce demands
- Build partnerships with industry and community organizations
- Support workforce pathways and economic development in Appalachia

This work is supported by the Capacity Building Grants for Non Land Grant Colleges of Agriculture, grant no. 2024-70001-43662/project accession no. 1032775, from the U.S. Department of Agriculture, National Institute of Food and Agriculture. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and should not be construed to represent any official USDA or U.S. Government determination or policy.

KEY TAKEAWAY

A workforce-ready Appalachian ANR pipeline requires integrated environmental science knowledge, regulatory literacy, field-based technical skills, and targeted workforce partnerships to support sustainable regional economic and environmental development.

References

American Association for Agricultural Education. (2023). *AAAE research values*. https://aaaeonline.org/resources/Documents/FOR%20ONLINE%20(8.5%20x%2011)%20-%20AAAE%20Research%20Values.pdf
Appalachian Regional Commission. (2021). *Subregions in Appalachia*. https://www.arc.gov/map/subregions-in-appalachia/
Blake, H.R. (2024). *Agriculture and natural resources microcredentials to support workforce development in southwestern West Virginia* (Publication No. 1870) [Master's thesis, Marshall University]. Marshall Digital Scholar.
Easterly, R. G., Warner, A. J., Myers, B. E., Lamm, A. J., & Telg, R. W. (2017). Skills students need in the real world: Competencies desired by agricultural and natural resources industry leaders. *Journal of Agricultural Education, 58*(4), 225–239. https://doi.org/10.5032/jae.2017.04225
QGIS. (2019). *LTR Solothurn* (Version 3.44.10). Free Software Foundation, Inc. https://qgis.org/resources/hub/
Roberts, T. G., & Ball, A. L. (2009). Secondary agricultural science as content and context for teaching. *Journal of Agricultural Education, 50*(1), 81-91. https://doi.org/10.5032/jae.2009.01081
Sample, V. A., Bixler, R. P., McDonough, M. H., Bullard, S. H., & Snieckus, M. M. (2015). The promise and performance of forestry education in the United States: Results of a survey of forestry employers, graduates, and educators. *Journal of Forestry, 113*(6), 528–537. https://doi.org/10.5849/jof.14-122
Schultz, T. W. (1961). Investment in Human Capital. *The American Economic Review, 51*(1), 1–17. http://www.jstor.org/stable/1818907
U.S. Census Bureau. (2021). *Central Appalachia*. https://www.census.gov/library/visualizations/2021/demo/central-appalachia.html
U.S. Census Bureau. (2025). *TIGER/Line Shapefiles* [2025] ["tl_2025_us_county"]. https://www2.census.gov/geo/tiger/TIGER2025/, retrieved 1 May 2026.
U.S.G.S. (2026). *The National Map*. ["USGSImageryOnly"(MapServer)]. https://basemap.nationalmap.gov/arcgis/rest/services, retrieved 1 May 2026.