

**Digging Up Soil Instruction: Identifying High School Curriculum Standards that Support
Soil Science Instruction and Food Production**

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Introduction

Soil is one of the world's limited and non-renewable resources (Stringer, 2014). Soil health is vital to the agricultural industry, yet it is impacted by several unique challenges, such as erosion, water pollution, and nutrient depletion (Wang et al., 2026). Several agricultural innovations, such as no-till farming, cover cropping, and biochar amendments have sought to address these challenges by improving soil health and maximizing biodiversity (USDA, n.d.). Because soil health has a direct impact on food security and agricultural viability, it is vital to teach youth about the importance of soil science and conservation practices as they impact food production and the agricultural industry. Further, in addition to teaching soil science principles, providing hands-on instruction that relates to soil health promotes knowledge retention and interest (Kolb, 1984; Wang et al., 2026). Thus, in alignment with the American Association for Agricultural Education (AAAE, 2023) research value, "Advancing Public Knowledge of AFNR Systems," we sought to examine high school teaching standards designed to support curriculum delivery related to soil science.

Purpose & Research Objectives

The purpose of this study was to identify and evaluate high school curriculum standards associated with soil science and conservation practices that supported lessons related to food and/or agricultural production. The following objectives guided this study:

- RO1: Identify Next Generation Science Standards (NGSS, 2026) that support soil science lessons related to food production and/or the agricultural industry.
- RO2: Identify Agricultural, Food, and Natural Resources (AFNR; The Council, 2025) standards that support soil science lessons related to food production and/or the agricultural industry.
- RO3: Compare NGSS and AFNR standards to describe crosscutting themes.

Method

We conducted a qualitative content analysis (Creswell, 2012) of NGSS and AFNR curriculum databases to identify high school standards that supported soil science instruction as they related to food production and/or the agricultural industry. A content analysis enabled us to identify and evaluate recurring themes within the NGSS and AFNR standards. Identified standards ranged from Environmentally Sustainable Systems (ESS), Natural Resource Systems (NRS), Plant Systems (PS), to Earth and Space Science (ESS). We used the PRISMA framework (Page et al., 2021) to retain standards that we inductively coded associated performance indicators (i.e., beginning, intermediate, and advanced) to identify common themes (Creswell, 2012). To begin the analysis, we first searched both curriculum databases using "soil" as the keywords. We then narrowed the search by excluding any standard that did not specifically relate to food production and/or the agricultural industry. Finally, we inductively coded the retained standard titles and performance indicators to identify (RO1 and RO2) and compare (RO3) existing themes.

Findings

For RO1, we identified seven NGSS standards using the keyword “soil.” We excluded three standards because they did not explicitly relate to food production or the agricultural industry (e.g., removed standards related to volcanic matter, oceanography, and soil chemistry), resulting in four retained standards: *HS-ESS2-2*, *HS-ESS2-6*, *HS-ESS2-7*, and *HS-ESS3-2*. For RO2, we identified 40 AFNR standards using the keyword “soil.” We excluded 34 standards for their lack of direct connection to food production or the agricultural industry (e.g., removed standards related to pH of growing media, soil chemistry, volcanos, rivers, and soil texture). We retained 6 standards: *PS.01.04.05.a*, *PS.01.03.01.a*, *PS.01.04.05.c*, *FPS.04.01.01.b*, *ESS.03.02.02.c*, and *AS.08.01.01.a*. For RO3, we compared the 10 retained standards (NGSS = 4; AFNR = 6) to identify crosscutting themes in the performance indicators. The primary themes across both curriculum databases were soil health, soil management, biodiversity, natural resources, and soil conservation. In these standards, soil health emerged as the foundational element of the retained standards.

Conclusions, Implications, and Recommendations

The findings of this study demonstrate the importance of agricultural education in both NGSS and AFNR curriculum. While we identified numerous standards that supported soil science instruction, only 10 explicitly allowed for instruction related to food production and the agricultural industry. Certainly, teachers can apply agricultural principles to different elements in the excluded standards ($n = 37$); however, if a school district’s administration is particular about standard use and instructional materials, there is not many to select that relate specifically to food production ($n = 10$). As a result, we recommend providing professional development resources to both general science and agricultural science teachers regarding standards that support instruction connecting soil science with the agricultural industry. Additionally, because of soil health’s impact on food production (Stringer, 2014), it is vital that teachers and preservice teachers are aware of crosscutting themes in the NGSS and AFNR databases, particularly as teachers seek to provide instruction about the impact of soil health on society. Supported by Kolb (1984), the nature of these standards also supports hands-on lessons and teaching activities which could further support student interest and engagement with the course material.

The retained standards also illustrate that sustainable soil management, agricultural productivity, and food production rely on healthy soil. Because soil health plays such an impactful role in food security, we recommend that school districts and teachers increase efforts to teach students about different innovations in soil management for the agricultural industry, such as crop rotation, cover cropping, low- or no-till farming, in all science classrooms, not just agricultural education courses. Specific innovations such as biochar and other soil amendments could be helpful to include in teacher professional development lessons so they could potentially expose their high school students to similar soil management practices. Finally, it is critical to the agricultural industry to have an incoming workforce that is passionate, informed, and eager to improve soil health. As a result, we recommend that social and behavioral scientists collaborate with soil scientists to investigate if increased access to soil science principles impact students’ career choices and trajectories.

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