

# Agricultural and environmental education: a call for meaningful collaboration in a U.S. context

Caitlin Reilly<sup>a</sup> , Kathryn Stevenson<sup>a</sup> , Wendy Warner<sup>b</sup>, Travis Park<sup>b</sup>, Whitney Knollenberg<sup>a</sup>, Danielle Lawson<sup>c</sup> , Sara Brune<sup>a</sup>  and Carla Barbieri<sup>a</sup>

<sup>a</sup>Department of Parks, Recreation and Tourism Management, North Carolina State University, Raleigh, NC, USA;

<sup>b</sup>Department of Agricultural and Extension Education, North Carolina State University, Raleigh, NC, USA;

<sup>c</sup>Department of Recreation, Parks, and Tourism Management and Department of Curriculum and Instruction, The Pennsylvania State University, State College, PA, USA

## ABSTRACT

Blending agricultural education (AE) and environmental education (EE) frameworks is a promising pathway towards the goals of boosting environmental engagement and support for local agricultural systems among broad public audiences. However, thoughtful and intentional collaboration between researchers is needed to facilitate these outcomes. We feel it is important to collapse existing disciplinary walls between AE and EE to effectively reposition both as critical public goods and address inequitable access to environmental and agricultural knowledge among the next generation. In this paper, we outline the historical context for the silos between U.S.-based AE and EE programmatic and research practice. We then present a new collaborative structure for scholars in both fields to work together to build agricultural and environmental literacy in support of environmentally sustainable, economically robust, and socially responsible agroecosystems. Ultimately, we aim to create structures for broader and more collaborative efforts through which to improve agricultural and environmental literacy for new generations of learners.

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## Introduction

Healthy agroecosystems are environmentally sustainable, economically robust, and socially responsible (Peterson et al. 2017). Agriculture is a leading cause of environmental degradation and, by corollary, can be a key area in which to make progress towards environmental sustainability (Peterson et al. 2017; Poore and Nemecek 2018). Healthy agroecosystems require fewer inputs into the land, allowing farmers to conserve natural resources, limit air and water pollution, decrease the use of herbicides and pesticides, and both retain and enrich soil (Peterson et al. 2017; Rosa-Schleich et al. 2019). This creates a positive feedback loop in which healthy ecosystems support environmentally sustainable farming practices and allow for decreased environmental degradation (Rosa-Schleich et al. 2019). Because farmers rely on ecosystem services to help produce the food and fiber products they sell, the benefits of healthy agroecosystems are economic as well as environmental (Rosa-Schleich et al. 2019). Accordingly, investments in sustainable land management and solutions to large-scale environmental issues, like urbanization

**CONTACT** Caitlin Reilly  [cereill3@ncsu.edu](mailto:cereill3@ncsu.edu)  Department of Parks, Recreation and Tourism Management, North Carolina State University, Raleigh, NC 27695, USA

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and climate change, are necessary (Brown and Funk 2008; Cohn et al. 2017). The social impacts of agroecosystems are also important to consider. Thriving agricultural systems prevent scarcity and keep food prices stable, which helps to address food insecurity (Pradhan et al. 2018). These benefits support food equity, which is achieved when all members of a community have access to nourishing and culturally-appropriate food and fiber without exposure to harmful environmental side effects (Smith 2019). In short, developing and maintaining healthy agroecosystems promotes the long-term economic viability of agriculture, environmental sustainability, and the well-being of people.

Due to the interdependent nature of healthy agroecosystems and environmental sustainability, individuals and communities that are both environmentally and agriculturally literate, are necessary for meaningful change. This change extends beyond simply understanding facts about each subject. Environmental literacy includes the ability to understand science, a feeling of connection to the environment, and the skills and motivation necessary to work towards solutions to environmental problems (Hollweg et al. 2011). Agricultural literacy, a closely related concept, is the ability to understand, think critically about, and communicate key concepts surrounding systems of food and fiber production (Frick, Kahler, and Miller 1991). Although technical and policy solutions exist to support healthy agroecosystems, such as adaptive draining techniques to limit soil and water runoff and incentivized impact mitigation programs that support farmers in making environmentally-friendly investments, the success of these techniques depends on communities that understand, care about, and are motivated to support them (Poore and Nemecek 2018). The need to integrate environmental and agricultural awareness for healthy agroecosystems was eloquently articulated in Wendell's Berry seminal (and polemic at the time) work 'The Unsettling of America' in 1977. His ideas continue to be relevant and call for education and associated research to emphasize the interdependence of agricultural (e.g. food security) and environmental (e.g. climate change) issues to protect environmental sustainability, agricultural economies, and community well-being.

Despite the overlap between environmental and agricultural literacy, associated research efforts are rarely combined, particularly in the United States. The academic silos of these two research fields that are visible in separate journals, conferences, and academic departments may help explain the limited research collaboration between EE and AE scholars. There are certainly exceptions, such as EE literature focused on food justice and garden-based learning (Crosley 2013; Green 2013; Harris and Barter 2015; Swan and Flowers 2015; Walter 2013) and scholarly interest in perceptions of sustainable farming among agricultural educators (Hubert, Frank, and Igo 2000; Muma, Martin, and Shelley 2011; Muma et al. 2010; Raven et al. 2017). However, within U.S. educational contexts, systematic and intentional efforts to bring the EE and AE research communities closer together are largely missing. Discussions around increased collaboration between AE and EE are long-standing, often emphasizing what AE has to gain from EE approaches (Kirts 1990). Using a pragmatic research approach (Monroe, Adams, and Greenaway 2019), combined experience as environmental and agricultural education researchers, and a targeted literature review, we seek to spark increased collaboration by offering our perspective on the historical and political roots of why AE and EE typically operate in silos. In an effort to advance collaborative research we identify potential avenues for increased collaboration, particularly in ways that the field of EE could work to be more inclusive of AE perspectives and practices.

## **The divergence in scholarship reflects distinct histories**

Within a U.S. context, AE and EE have different histories that influence the research content and academic approaches of scholars in both fields. As is likely familiar to readers of this manuscript, EE is largely rooted in environmentalism and aims to equip individuals and communities with the knowledge, skills, and motivations they need to care for the environment (Hungerford

2009). Nature Study, a precursor to environmental education, began in the late 19<sup>th</sup> Century as a way to engage students with science in a hands-on manner (Hubert, Frank, and Igo 2000). EE emerged as a discipline from the nexus of Nature Study and the conservation movement in the latter half of the 20<sup>th</sup> century. It emerged as a response to increasing urbanization and concerns about limited contact with nature among younger generations (Hubert, Frank, and Igo 2000; Hungerford 2009; Stapp 1969). The history of EE, and in many cases environmental conservation more largely, is also closely tied to Aldo Leopold's land ethic which deemphasizes the importance of humans in the environmental landscape and infuses ethical considerations into decisions about land and resource management (Callicott 1999; Leopold 2004; Piccolo 2020).

Modern EE is both interdisciplinary and multidisciplinary, working to improve scientific literacy, foster curiosity, promote positive youth development, and encourage social-emotional learning, though it still centers on environmental stewardship (Hollweg et al. 2011; Krasny 2020; Stern, Powell, and Hill 2014). Examples of current iterations of EE include outdoor science programs like Muddy Sneakers, which covers 5<sup>th</sup> grade North Carolina science standards in outdoor settings (Muddy Sneakers n.d.), the Girl Scout Environmental Stewardship program, which highlights positive youth development and social-emotional learning (Girl Scouts of America n.d.), and Project WET and Project WILD, which provide the framework for classroom-based EE instruction (Association of Fish and Wildlife Agencies n.d.; Project WET Foundation n.d.). These organizations, and most other EE programs, have a common goal of encouraging ecological stewardship and promoting pro-environmental behaviors (Hollweg et al. 2011; Krasny 2020). Although there are efforts among EE practitioners and researchers to move away from an environmentalist framework, a focus on action can be traced to Leopold's land ethic (Piccolo 2020) and Berry's ethic of care (Edmundson and Martusewicz 2013), through foundational texts such as the Tblisi Declaration (UNESCO 1977). It can also be followed through shifting dominant paradigmatic approaches in EE research from behaviorists (Robottom and Hart 1995), to critical approaches (Stapleton 2020), to more recent emphases on community-based and transformative EE research (Hollweg et al. 2011; Hungerford 2009; Krasny 2020; Pavlova 2013).

Though many AE practitioners and researchers undoubtedly identify strongly with Berry's ethic of care, the practice of AE in the United States is largely vocational. The field emerged in the 1800s predominantly as a method of producing new generations of farmers and agricultural professionals (Hubert, Frank, and Igo 2000; Powell, Agnew, and Trexler 2008; True 1929). The Smith-Lever Act of 1914 formalized early AE efforts into the U.S. Cooperative Extension system designed to educate farmers about new practices and align the research of faculty at land-grant institutions with the needs of those working in agricultural production (National Institute of Food and Agriculture n.d.-a). 4-H, a highly popular national AE program, was originally devised to reach farming families by educating rural youth about developments in agricultural knowledge and new forms of technology (4-H n.d.). The Smith-Hughes Act of 1917 established federal support for agricultural education in public schools (Camp and Crunkilton 1985). In 1928 the Future Farmers of America (FFA), today's National FFA Organization, arose out of school-based AE (Camp and Crunkilton 1985). Even today, AE is deeply tied to the culture of rural America and is focused on building knowledge of and support for agricultural livelihoods (Hubert, Frank, and Igo 2000; Kovar and Ball 2013; Mayer and Mayer 1974; Powell, Agnew, and Trexler 2008).

Starting in the 1970s, agricultural educators began to recognize the importance of increasing the public's understanding of agricultural systems as a means to foster broad public support for agriculture (Frick, Kahler, and Miller 1991; Hubert, Frank, and Igo 2000; Kovar and Ball 2013; Mayer and Mayer 1974; Powell, Agnew, and Trexler 2008). While there are many efforts within AE to develop programs focused on improving public agricultural literacy, there is still a significant deficit in knowledge and awareness of agricultural issues among the general population (Hubert, Frank, and Igo 2000; Kovar and Ball 2013, Powell, Agnew, and Trexler 2008). As a result, there have been many calls to expand AE programming to reach broader audiences (Frick,

Kahler, and Miller 1991; Hubert, Frank, and Igo 2000; Kovar and Ball 2013; Mayer and Mayer 1974; Powell, Agnew, and Trexler 2008), including calls to borrow more holistic approaches from EE (Kirts 1990). For example, some longstanding AE programs like 4-H and the National FFA Organization have shifted their programs to emphasize leadership development, engaged learning, and the flexible application of participants' skills in a variety of careers beyond production agriculture such as teachers, scientists, health professionals, and veterinarians (4-H n.d.; National FFA Organization n.d.). Even within these efforts, popular conceptions of AE remain closely tied to career and technical education as well as to large-scale, conventional production agriculture (Kovar and Ball 2013; Mayer and Mayer 1974; Powell, Agnew, and Trexler 2008).

The substantial differences in the historical purposes and development of AE and EE are still visible in the current scholarship of both academic fields. For example, AE often relies on technological solutions to resource management problems that facilitate economies of scale (e.g. increased yields) rather than advocating for limits to consumption, as is more typical in EE frameworks (Lytos et al. 2020). Arguably, this emphasis on technocratic solutions in AE is reflective of larger trends in agricultural research in general, which are heavily influenced by private industry, powerful agricultural lobbies, and entrepreneurial values and incentives within research institutions (Vanloqueren and Baret 2009). Perhaps not surprisingly, AE research tends to take a pragmatic approach, often with goals linked to vocation or building understanding of, and support for, the agricultural industry (Croom 2008). In contrast, EE research arguably more often includes critical or transformative approaches, focused on highlighting critiques of how EE may fall short in supporting its stated goals (Blumstein and Saylan 2007) or suggesting ways for education to create restorative approaches in human-natural systems (Bellino and Adams 2017; Gough and Robotom 1993).

Another difference centers on the fields' respective views of nature and the way they understand the role of the natural world and its resources. For instance, EE scholars tend to place an intrinsic value on nature and focus on aesthetic appreciation and recreational enjoyment (Fraser, Gupta, and Krasny 2015; Hubert, Frank, and Igo 2000). This orientation echoes the core ideas of nature and wilderness conservation, which have been central to mainstream environmentalism since the Nature Study movement in the 1800s, and is often still visible in environmental education scholarship and practitioner-focused communication today (Crosley 2013). For example, the environmental aesthetics framework that some EE scholars support seeks to promote connection to nature through deep relationship building with natural landscapes based on an eco-centric model that places equal weight on the needs of humans and the health of the environment (Carlson 2009; Yi 2019). The EE orientation to the natural world stands in contrast to the more utilitarian relationships reflected in AE scholarship, which tend to focus on agricultural career preparedness over connection to nature (Hubert, Frank, and Igo 2000; Kovar and Ball 2013; Mayer and Mayer 1974; Powell, Agnew, and Trexler 2008). Preparation for the workforce as the central goal of AE is partially rooted in the Smith-Hughes Act of 1917, which provided the foundation for the National FFA Organization in addition to affording opportunities for vocational teacher training to prepare students across the U.S. for jobs in industry and agriculture (Willis 2017). An increased concentration on standardized testing within the U.S. educational system has led some AE researchers to reframe the central purpose of the discipline as a supplement to core curriculum academic material in some cases (Dailey, Conroy, and Shelley-Tolbert 2001), but overall the field remains ingrained in the world of vocational training (Harder, Place, and Scheer 2010; Suvedi, Ghimire, and Millenbah 2016).

Other notable differences are the emphasis on action in each field as well as the primary audiences for educational initiatives. Though EE scholarship continues to debate the degree to which action is among its goals, most scholars recognize that environmental literacy extends beyond knowledge and skills to include affective and behavioral components (Hollweg et al. 2011; Krasny 2020; Stapp 1969; Wheaton et al. 2018). Many EE scholars advocate encouraging civic engagement and activism among learners (Hollweg et al. 2011; Krasny 2020; Wheaton et al.

2018). A key aspect of this approach is that environmental literacy scholarship is focused on equipping all members of a community with the knowledge, dispositions, skills, and motivations needed to promote an environmentally sustainable future (Cole 2007; Hollweg et al. 2011). Although AE scholarly frameworks have also broadened beyond content knowledge (Mars and Ball 2016; Trexler 2013; Vallera and Bodzin 2016), their on-the-ground efforts are often still focused primarily on technical knowledge and skills (Bellah, Dyer, and Casey 2004; Colbath and Morrish 2010). Furthermore, AE is not widely incorporated into public education, but rather tends to reach audiences largely composed of students with prior interest in agriculture (Bellah, Dyer, and Casey 2004; Colbath and Morrish 2010). As a result, there is a continued call for researchers to create a viable framework for practitioners to be able to promote agricultural literacy among the broader public (Colbath and Morrish 2010; Doerfert 2011; Hess and Trexler 2011; Meischen and Trexler 2003; Pense and Leising 2004; Roberts, Harder, and Brashears 2016).

Our brief discussion does not seek to represent all aspects of either AE or EE. There are many examples, particularly outside of a U.S. context, that emphasize connections between agriculture, the environment, and other 'core' academic topics, particularly within education for sustainable development (Pavlova 2013). Similarly, there are numerous examples of education that draw on more agroecological frameworks rather than technocratic ones, which lend themselves well to blending ethics of care that are generally centered in EE with the goals of promoting food security inherent to AE (Vanloqueren and Baret 2009). It is our perspective, however, as researchers associated with major land-grant institutions, that these collaborations are not the dominant method in mainstream U.S. education systems or associated research in these contexts (Kumar 1996).

## **Toward increased collaboration**

While the fields of AE and EE may sustain different focal areas, each has valuable contributions for mutual improvement in increasing the public's literacy on agricultural and environmental topics. Furthermore, continuing to work in academic silos is preventing real progress towards a widespread understanding of agricultural and environmental literacy as essential public goods. EE scholarship has a strong tradition of employing ecological perspectives that encompass interactions between natural and social systems (Kollmuss and Agyeman 2002; Newhouse 1990) and targeting affective outcomes to ensure that learning leads to action (Hollweg et al. 2011; Krasny 2020; Stapp 1969; Wheaton et al. 2018). This integrated approach to problem-solving could be a valuable contribution to AE, which seeks to incorporate broader environmental stewardship and ecosystem management topics into curricula that were historically focused on more agriculture-specific content (Doerfert 2011; Roberts, Harder, and Brashears 2016). Notably, this possibility has been highlighted in AE circles for decades (Kirts 1990), and both AE and EE scholars are working to build holistic research agendas that more effectively incorporate social systems into their analyses (Spielmaker, Pastor, and Stewardson 2014; Monroe, Andrews, and Biedenweg 2008). While both fields have some established frameworks for doing so, a collaborative approach would serve to elevate both efforts.

AE scholarship's focus on applied knowledge and skills has important lessons for EE. AE research frameworks are grounded in the realities of food and fiber production, the challenges associated with managing resources, and the hardships of feeding people on a daily basis (Barbieri, Mahoney, and Butler 2008; Brown and Funk 2008; Poore and Nemecek 2018; Powell, Agnew, and Trexler 2008; Rosa-Schleich et al. 2019). This perspective could benefit EE research in terms of anchoring the visions of environmentalists to the tradeoffs inherent in conserving healthy agroecosystems while also feeding a growing global population (Peterson et al. 2017; Rosa-Schleich et al. 2019). Similarly, seeking out the more utilitarian perspectives of AE scholarship may push EE scholars to think outside of their academic comfort zones in ways that

allow their messaging to resonate beyond a scholarly community that is fairly homogenous in its approach to understanding the natural world (Cole 2007). There is strong support within EE to magnify the field's reach and diversify learners and environmental frameworks (Corcoran and Sievers 1994; Lewis and James 1995; Potter 2009), but there is less momentum among scholars for an EE movement that considers work-based or utilitarian relationships with nature on equal footing with more traditional environmental lenses.

Educators and scholars in both fields are looking to expand their audiences to improve environmental and agricultural literacy among wider segments of the population (Cole 2007; Crosley 2013; Harris and Barter 2015; Hubert, Frank, and Igo 2000; Kovar and Ball 2013; Powell, Agnew, and Trexler 2008; Saul 2000). EE researchers have the opportunity to increase public support for environmental literacy initiatives by contextualizing issues like climate change to be relevant to a variety of audiences, especially groups who have been historically left out of mainstream environmentalism (Cole 2007; Crosley 2013; Harris and Barter 2015; Saul 2000). Increasing outreach to AE communities could serve to broaden current efforts to diversify the field. AE also recognizes the need to broaden engagement beyond their traditional audience (Hubert, Frank, and Igo 2000; Mars and Ball 2016; Powell, Agnew, and Trexler 2008; Trexler 2013). AE scholars have repeatedly identified that most people do not know where their food comes from and that continuing to develop agricultural educators among the same segments of the population does nothing to reach the members of the public who need agricultural literacy the most (Frick, Kahler, and Miller 1991; Hubert, Frank, and Igo 2000; Kovar and Ball 2013; Powell, Agnew, and Trexler 2008). Building bridges between the EE and AE research communities may provide an avenue to identify common scholarly goals as well as reach audiences that are not typically associated with each field.

One limitation to collaboration is the common misconceptions from outsiders that plague both fields. Because agricultural systems often operate at large scales and have significant impacts on ecosystems, those who identify primarily with environmental fields tend to view the AE research community as part of the problem rather than part of the solution to environmental issues (Cleveland et al. 2016; Donahue 1994; Sharp and Adua 2009). Agricultural scholars may similarly dismiss EE researchers as unrealistic and lacking a comprehensive understanding of what it means to balance food and fiber production with the needs and burdens (e.g. food insecurity, urban sprawl) of a growing population (Chilson 1997; Jorgensen 2011). For example, advocating for environmentally-friendly farming techniques such as integrated pest management may sound like a sustainable solution but such practices are not always profitable or may not be feasible at large scales (Bewsell and Kaine 2005; Drost et al. 1996; Jarvis, Wilkins, and Pain 1996; Kabir and Rainis 2014). EE scholars may not have the practical agricultural knowledge needed to weigh those costs and benefits effectively, thus the need to close the gap between disciplines.

As previously mentioned, both fields also have socially problematic aspects of their scholarly histories and commonly accepted disciplinary frameworks. Thus, we suggest that by facing these problems together, AE and EE might find common ground. For example, both AE and EE often accept funding from large corporations whose agendas cause harm to both agroecological systems and human communities (Nicole 2013; Prete and Cournil 2019). The National FFA Organization has an ongoing relationship with Monsanto under Bayer Crop Sciences (FFA n.d.; National FFA Foundation n.d.). While Monsanto uses some language around sustainability, they have long been a primary enemy for many environmentalists; yet they remain a core supporter of AE in the United States (Prete and Cournil 2019). Similarly, corporations like Duke Energy remain a major funding source for environmental research and sustainability programs while also acting as a Goliath opponent for many energy and environmental justice advocates in the southeastern United States (Duke Energy 2020; NC WARN n.d.; Nicole 2013). Although environmentalists often critique industrial agricultural practices (Mitchell 2020), and more conservative viewpoints often associated with agricultural communities (Roper 2020), EE is not exempt from

similar criticisms. In many cases, environmental scholars and organizations are only just beginning to account for the compromises made by environmentalists to advance their cause that had detrimental impacts on vulnerable and marginalized populations including women, indigenous communities, people of color, and LGBTQ+ groups (Asdal 2003; Gaard, Estok, and Oppermann 2013; MacGregor 2017; Meyer 2001; Sturgeon 2009). For example, we as co-authors write this essay as members of land grant institutions. Though our particular institutions and those similar to ours are proud of our emphasis on community engagement (Sherwood 2004), we also come from a troubled history of stolen Native land with which we have yet to reckon (Fanshel 2021). While many forms of EE and AE do not accept corporate funding and actively work to combat oppressive and exclusionary histories, the fields at large need to engage with these issues to move forward.

By working together, both AE and EE will be better equipped to engage with restorative justice lenses and improve norms in scholarship and practice moving forward. This type of commitment may help both AE and EE to achieve their goals when it comes to representing the diversity of the communities they aim to serve in the demographics of their practitioners and program participants, something they have both struggled with historically (James and McAvoy 1992; Lavergne et al. 2012; Taylor 2015; Warren and Alston 2007). This shared problem could be a timely opportunity to brainstorm and develop collaborative solutions rather than continuing to individually identify a lack of diversity as an issue and striving separately to create genuinely inclusive environments in mainstream AE and EE organizations. For example, agricultural and environmental educators could create collaborative avenues to recruit participants, practitioners, and scholars from underrepresented identities. They could also use their combined expertise to design culturally responsive curricula that highlight the connections between agricultural systems and environmental management and potential career pathways requiring an understanding of both the technical aspects of production and the broader concepts of environmental sustainability. Improving collaboration between the AE and EE fields, both in terms of research focus and the practitioner culture stemming from the prevailing scholarship, may help to improve our collective academic investigation, deepen our practice, and ultimately allow us to build healthier agroecosystems through promoting agriculturally and environmentally literate communities.

## Promoting collaboration

There are many potential avenues for breaking down silo walls and promoting meaningful collaboration among AE and EE scholars that will generate real progress in the scholarship and practice of both fields. Our recommendations focus on pathways to engage the AE and EE scholarly communities as that is where we are positioned as academic scholars. However, we hope that our call for collaboration is heard at all levels including academic research, university-level education, extension efforts, school-based curricula, and informal programming. In the authors' opinion, the central premise of any collaboration between AE and EE should be the consideration of agricultural and environmental literacy as intricately connected public goods critical to the education of the next generation of informed and engaged decision-makers. Literacy related to food systems and the environment is necessary to make sound decisions about personal health, growth of local economies, and community well-being. Specifically, we outline three key pathways for future intersections of the fields which result in goals related to reciprocal learning, collaborative research, and practitioner engagement. These overarching goals, as well as underlying objectives and examples of action, are represented in [Figure 1](#). Across all three of these goals, we call for those in the AE and EE communities to push for increased diversity at all levels and incorporate restorative justice lenses into their scholarship and practice.

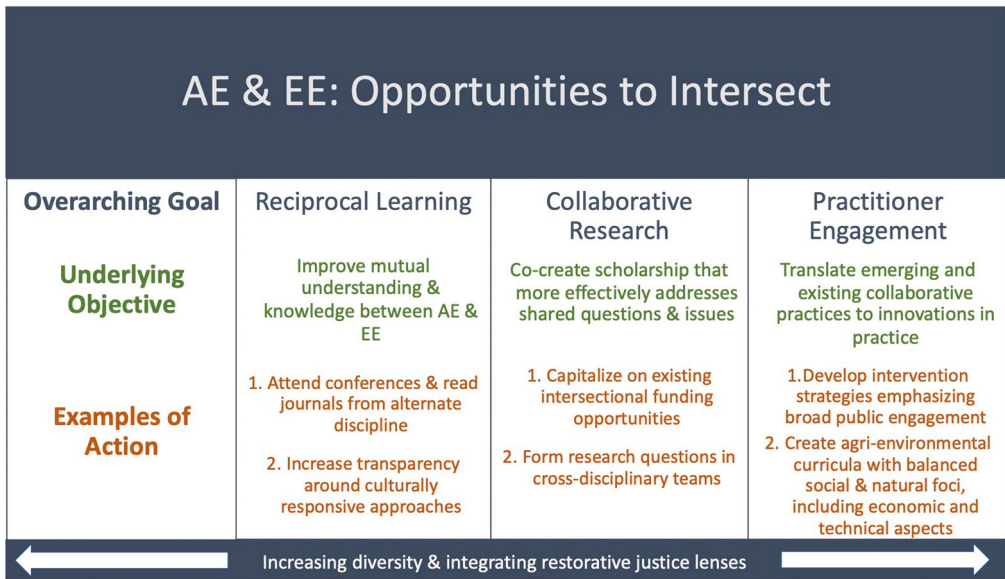


Figure 1. Schematic representing opportunities for the intersection of environmental and agricultural education fields at multiple levels.

To support collaboration, scholars should work to learn about what other fields are doing and take steps to share their findings in expanded academic communities. This reciprocal learning could include attending academic and practitioner-focused conferences in one another's fields to offer guidance on common challenges or to learn about potential solutions to obstacles faced in one's own work. There are also abundant possibilities for developing new collaborative endeavors that fully merge AE and EE worlds such as conferences that actively recruit from both audiences and create space for increased communication among AE and EE communities. Scholars should also look for opportunities to publish in the journals of one another's fields to share promising practices and receive feedback on their field-specific perspective. Ideally, EE and AE scholars should also co-author publications. This partnership would allow publications to cater to the concerns of both fields and emphasize connections between environmental and agricultural research paradigms, ultimately working to emphasize the interdependence of the fields.

To co-author publications, scholars should collaborate from the beginning of the process and jointly develop research questions. This effort will not only support collaborative research production, but will also work to combat the misconceptions of one another's fields. One example might be to combine expertise to develop learning structures that move beyond singular engagement with small-scale, closed food systems (e.g. school garden programs) and expand the scope of analysis to include the large-scale agricultural structures that feed our nation and the world. This expanded framework for examining food systems could benefit from the accumulated knowledge (content, methodologies, and practices) of AE experts related to engaging students in learning about global food systems in tangible and meaningful ways as well as that of EE scholars embedded in global sustainability efforts. This complementary expertise could yield innovative approaches that are arguably necessary for addressing complex challenges like global food security in the context of a changing climate (Brown and Funk 2008; Cohn et al. 2017). To do so, it is critical that EE and AE communities develop joint strategic research plans outlining shared goals and design pathways for examining questions that will contribute to both fields.

In addition to working together to identify joint research questions, seeking joint support for our work may offer expansive opportunities benefitting both fields. For instance, funding opportunities may expand when AE and EE communities work together. One notable example



is the National Collaborative for Research on Food, Energy, and Water Education project which has received funding through the National Science Foundation and the US Department of Agriculture by emphasizing connections between EE and AE approaches (National Collaborative for Research on Food, Energy, and Water Education n.d.). Additionally, the National Institute of Food and Agriculture (NIFA) has national funding priorities that include climate variability and change, water, and sustainable bioenergy, which can potentially bridge gaps between agricultural and environmental sciences (National Institute of Food and Agriculture n.d.-b). NIFA is a major funding resource that remains underutilized among EE researchers and provides opportunities to engage with agricultural research communities. Collaborations between AE and EE are necessary to address urgent and complex problems and are well-positioned to answer the identified needs of funding resources that remain largely untapped by our respective communities. However, we must revisit academic structures that penalize rather than incentivize collaborative research if we wish to succeed in bridging AE and EE scholarly communities.

Both AE and EE strive to bridge connections between research and practice. Increased interconnectivity in AE and EE research would also spark practitioner engagement. Scholars and practitioners from both fields could partner to develop shared agri-environmental curricula or learning intervention strategies for use in both formal and non-formal educational settings. This could include a planned dual approach to increasing public literacy in which the EE community outlines the broad implications of climate change while AE provides specific examples of how changes in global climate will have an impact on the everyday lives of average people through food and fiber production. Similarly, while water quality can often feel like an abstract issue for students, agriculture provides clear and tangible examples of water usage and opportunities to mitigate impacts on aquatic systems. Because we all engage in and depend on agricultural systems, this framing also provides an opportunity to foster positive action beyond common recommendations such as turning off the faucet and purchasing reusable water bottles.

The ultimate goal of this collaboration is to increase the impact of these two interrelated disciplines by broadening research and practice, amplifying educational efforts, and increasing advocacy and support for overall agroecosystem health. Environmental and agricultural literacy are both functional educational outcomes that are essential to creating a new generation of engaged and informed decision-makers and no effort should be spared to make these critical public goods accessible to students across sociodemographic divides. A reframing of environmental and agricultural literacy as co-dependent and essential public goods could only serve to strengthen arguments pushing for equitable access to AE and EE for students as part of public education. Increased collaboration with AE scholars is an important step we can take as an EE research community towards meeting this goal.

## Declaration of interest statement

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## ORCID

Caitlin Reilly  <http://orcid.org/0000-0003-2111-0586>

Kathryn Stevenson  <http://orcid.org/0000-0002-5577-5861>

Danielle Lawson  <http://orcid.org/0000-0002-6326-2257>

Sara Brune  <http://orcid.org/0000-0001-7385-6000>

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