



Today's Students, Tomorrow's Bioeconomy Professionals

Kathleen M. Saul, John H. Perkins, Laura Reusche and Rajinder Peshin¹

The Evergreen State College, Olympia, WA, USA

¹*Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha, Jammu, India*

E-mail: kmsaul@comcast.net

Abstract: This paper reflects on the outcomes of a student-centered workshop held during the Indian Ecological Society International Conference, held at Punjab Agricultural University, Ludhiana, Punjab, 12 – 15 November 2024. The students' workshop was a follow-up on the topics developed in the Symposium on "Agriculture, Climate Changes, and Energy Transitions: Building Capacity to Maintain Yields of Innovative Agrifood Systems" held during the conference. Its major purpose was to encourage discussions among conference participants about specific research agendas and potential teaching plans. Students worked in groups of four to five to provide ideas for improving teaching and learning and ideas for future research. They consistently mentioned a need to grasp the practical application of their classroom studies. Most of the research ideas focused on conservation or enhancement of resources used in agriculture and many involved cross-disciplinary topics, such as the expansion of data analysis technologies to promote resilience for agricultural communities. The results parallel the principles outlined as key to a bioeconomy, outlined by the Food and Agriculture Organization of the United Nations.

Keywords: Agriculture, Agrifood systems, Bioeconomy, Climate change, Ecology, Education, Farmers, Knowledge, Sustainability

Consider: According to the United Nations, globally, nearly 1 in 10 people went hungry in 2022 and 2.4 billion people (almost 30% of the population) experienced moderate to severe food insecurity (United Nations 2024).

Consider: Despite food insecurity in parts of the world, the average per capita consumption has increased steadily since the 1960s, a trend that is expected to continue in Asia and Africa (Pomeroy et al., 2023).

Consider: Modern agrifood systems emit roughly one-third of anthropogenic greenhouse gas emissions (Crippa et al., 2021). How can we make the transition to a clean energy future while preserving agricultural livelihoods and maintaining agricultural yields?

Consider: About 60% of the inputs to the global economy could, in theory, be produced biologically by substituting biologically based materials for fossil fuels in the production of energy, chemicals, and the like (Chui et al., 2020, p. vi).

Facts like these have led researchers, policymakers, educators, business-people, farmers, and other stakeholders to propose replacing current economic and agricultural systems with a sustainable, circular "bioeconomy." According to the Food and Agriculture Organization of the United Nations (FAO), the bioeconomy can be thought of as "the production, utilization, conservation, and regeneration of biological resources, including related knowledge, science, technology, and innovation, to provide sustainable solutions (information,

products, processes and services) within and across all economic sectors and enable a transformation to a sustainable economy" (FAO 2022, p. 1). The incorporation of traditional and local knowledge along-side that of scholars can help generate new ideas in the realms of plant and animal health, food production, and the environment.

According to the FAO, the first principle of a bioeconomy is that it should support food and nutrition security (FAO 2021). At the same time, natural resources must be conserved and enhanced (Principle 3). Appropriate, efficient, and effective use of resources will then strengthen local communities and promote environmental resilience (Principles 4, 5, 8 and 9).

We must then ask the question: Are today's university-level students being adequately prepared to participate in a bioeconomy?

MATERIAL AND METHODS

We had the opportunity to get a glimpse into the readiness of students during a workshop at the Indian Ecology Society International Conference held in Ludhiana, Punjab, on 13 November 2024. This year's conference focused on the intersection of climate change, energy use, and agriculture. The students attending the symposium on "Agriculture, Climate Changes, and Energy Transitions: Building Capacity to Maintain Yields of Innovative Agrifood Systems" were invited to participate in the workshop. Fifty-one of the

- Model crop growth under climate stress
- Probe the soil-water relationship at field scale under different cropping systems
- Map genetics of wild and traditional varieties
- Introduce climate-resistant genes into already established crops
- Improve stress tolerance using plant-growth-promoting rhizobacteria (PGPR) microbes

Principle 4: Make Communities Healthier, More Sustainable, and Harness Social and Ecosystem Resilience (4)

- Explore conservation practices for various geographic, climate, and soil combination scenarios
- Understand the impact of declining tree cover on agricultural regions

Principle 5: Rely on Improved Efficiency in the Use of Resources and Biomass (3)

- Recycle food and agricultural waste
- Utilize methanotrophs in paddies to reduce emissions of methane

Principle 7: Make Good Use of Existing Relevant Knowledge and Proven Sound Technologies and Good Practices and, Where Appropriate, Promote Research and Innovations (9)

- Integrate modern, local, and traditional ecological knowledge as a basis for climate mitigation
- Harness understanding of geography and traditional farming practices for sustainable food production

Principle 10: Promote Cooperation, Collaboration and Sharing Between Interested and Concerned Stakeholders in all Relevant Domains and at all Relevant Levels (12)

- Adapt technologies to capture real-time farm conditions and climate data

Most ideas for research underscored the need for the conservation, protection, and enhancement of agricultural resources in the face of climate change. Even when not called out specifically, the research topics suggested cross-disciplinary approaches, such as combining computer science modeling with plant and soil sciences or understanding the impact of carbon emissions on agricultural practices. Students suggested the need for developing agricultural practices that also contribute to the resilience of the rural economy in the face of a changing climate (combining Principle 3: Support Competitive and Inclusive Economic Growth, and Principle 4: Make Communities Healthier and More Sustainable). Students also stressed the need to incorporate both modern and traditional knowledge systems. As with the teaching and learning ideas, the topics reflected a growing awareness that we must appreciate agriculture as part of a large, complex system—we cannot isolate agriculture, its inputs or its impacts, from the world around it.

It is an integral part of the bioeconomy.

Concluding Thoughts

When the organizers of this workshop first conceived of this session as part of a larger conference, we did not know how student participants would react. Would they be interested? Concerned? Would they participate?

We discovered they were indeed interested and concerned. These students would soon be entering the workforce of trained professionals supporting farmers and agricultural production and they wanted to ensure that they and their fellow students had the skills necessary to meet the challenges ahead. The political, economic, and environmental landscape will be very different from that of even one decade ago.

To revisit the question that prompted this paper: Are today's university-level students being adequately prepared to participate in a bioeconomy? They will be if we listen to them. Two good places to start would be to: 1. Incorporate more hands-on experience, field trips, and interactions with farmers in the areas of agricultural institutions, and 2. Expand interdisciplinary approaches to agricultural education and research.

We are reminded of the words of Jawaharlal Nehru:

A University stands for humanism, for tolerance, for reason, for the adventure of ideas and for the search of truth. It stands for the onward march of the human race towards ever higher objectives.

REFERENCES

- Chui M, Evers M, Manyika J, Zheng A and Nisbet T 2020. The Bio Revolution: Innovations Transforming Economies, Societies, and Our Lives. McKinsey Global Institute.
- Crippa M, Solazzo E, Guizzardi D, Monforti-Ferrario F, Tubiello FN and Leip A 2021. Food systems are responsible for a third of global anthropogenic GHG emissions. *Nature Food* 2: 198-209.
- Farm Bureau n.d. *Fast Facts About Agriculture & Food*. <https://www.fb.org/newsroom/fast-facts>
- Food and Agriculture Organization of the United Nations (FAO) 2021. Aspirational principles and criteria for a sustainable bioeconomy. Rome, Italy. <https://openknowledge.fao.org/handle/20.500.14283/cb3706en>
- Food and Agriculture Organization of the United Nations (FAO) 2022. Sustainable Bioeconomy and FAO: Project Brief. Rome, Italy. <https://openknowledge.fao.org/items/740411e9-8f5d-4cd7-9785-72ab848515fc>
- Freer TJ 2015. *Modernizing the Agricultural Education and Training Curriculum*. pp 1-25. https://innovate.cired.vt.edu/wp-content/uploads/2015/09/Thematic-Study-Modernizing-AET-Curriculum_112415_-FINAL.pdf
- Magagula B and Tsvakirai CZ 2020. Youth perceptions of agriculture: influence of cognitive processes on participation in agripreneurship, *Development in Practice* 30(2): 234-243. <https://doi.org/10.1080/09614524.2019.1670138>
- Ministry of Finance 22 July 2024. Agriculture Sector has Registered an Average Annual Growth Rate of 4.18 Percent over the Last Five Years: Economic Survey. <https://pib.gov.in/PressReleasePage.aspx?PRID=2034943>

Kimmerer RW 2002. Weaving traditional ecological knowledge into biological education: A call to action. *Bioscience* **52**(5): 432-438. [https://doi.org/10.1641/0006-3568\(2002\)052\[0432:WTEKIB\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2002)052[0432:WTEKIB]2.0.CO;2)

Robinson L 2024. Top Challenges for Modern Agriculture in 2024. *Verdesian*. <https://vlsci.com/blog/top-issues-in-agriculture-2024/>

Pomeroy, James, Davey Jose, Amy Tyler, Paul Bloxham and Jamie Culling 2023. *The Future of Food: Can we meet the needs of 9bn*

people? HSBC Global Research. <https://www.research.hsbc.com/C/1/1/320/WgCK7Wv>

United Nations Department of Economic and Social Affairs 2024. *Sustainable Development Goals Report 2024*. United Nations. New York.

Valley W, Wittman H, Jordan N, Ahmed S and Galt R 2017. An emerging signature pedagogy for sustainable food systems education. *Renewable Agriculture and Food Systems*. DOI: 10.1017/S1742170517000199.

Received 05 May, 2025; Accepted 30 September, 2025