Rebuilding Ecological Function in Corn Production Through Polycultures

Alyssa Reyes

Oregon State University

SNR 530: Ecological Principles of Sustainable Natural Resources

December 2025

Rebuilding Ecological Function in Corn Production Through Polycultures

Conventional corn production relies heavily on monoculture design. Monoculture is the agricultural practice of cultivating one crop species over a large section of land and often involves monocropping, which is the annual repetition of the same crop cycle. Monoculture is a practice that contradicts fundamental ecosystem functions and principles such as reducing biodiversity and resource utilization efficiency (Jensen et al., 2020; Nicholls et al., 2016). Polyculture involves the simultaneous cultivation of two or more crops in the same space, breaking the monoculture practice in conventional agriculture (Mota-Cruz et al., 2025). The polyculture approach shifts conventional agriculture towards an agroecological framework that relies on enhancing natural ecological processes in combination with agriculture for sustainable crop production.

Current Component of Production and Unsustainability

The component of conventional corn production proposed for change is the reliance on monoculture, creating ecological degradation locally and beyond, including human health and global changes (Mota-Cruz et al., 2025; Abbas et al., 2021; Nicholls et al., 2016). Deviating from natural ecosystems by replacing diverse plant communities with artificially supported homogenous crop communities results in simplified systems that can't support complex functions for ecosystem services unlike natural ecosystems (Nicholls et al., 2016)

The unsustainability of monocultures in conventional agriculture arises partially because of loss of biodiversity causing vulnerability to disease and climate variability, and negative impacts by external inputs such as fertilizers. Without plant diversity, the diversity of insects, soil organisms, and other fauna declines, disrupting the complex interactions that maintain ecosystem balance (Nicholls et al., 2016). Simplification caused by monocultures eliminates self-regulation capabilities found in natural ecosystems, which can lead to frequent and serious ecological imbalances. Crops in monocultures are more susceptible to pests and vulnerable to climatic variability due to their homogeneity (Nicholls et al., 2016). Eliminating the natural balance that a diverse ecosystem provides, monocultures need supplementary external inputs such as herbicides, insecticides, bactericides, and fertilizers (Belete & Eshetu Yadete, 2023). Not only do monocultures simplify ecosystem processes but monocropping depletes the soil of nutrients, making the soil less productive over time, and therefore requires the use of synthetic fertilizers to replace lost nutrients (Belete & Eshetu Yadete, 2023). The use of synthetic

fertilizers can lead to negative externalities such as eutrophication in ecosystems like watersheds and 13.4% of agriculture's total Greenhouse Gas (GHG) emissions (Abbas et al., 2021; Belete & Eshetu Yadete, 2023; Jensen et al., 2020).

Ecological Premise for Change

Polyculture aims to strengthen the weakened ecological functions caused by monocultures, by improving biodiversity and reducing the need for external inputs that have unintended consequences. Key ecological principles that polyculture supports include enhanced nutrient cycling, and increased biodiversity, therefore bettering ecosystem regulation. Polyculture enhances resource utilization efficiency, for example, intercropping corn with a legume creates a complimentary nitrogen use relationship (Jensen et al., 2020). Increasing vegetation diversity creates a natural buffer against pests and disease, replacing the need for chemical inputs such as pesticides, herbicides, and bactericides (Nicholls et al., 2016). Further, above ground biodiversity supports below ground biodiversity through increased ecological complexity which can promote the growth of Arbuscular Mycorrhizal Fungi (AMF) which is vital for nutrient absorption, improving soil structure and enhancing plant resistance to pests and disease (Guo, 2024).

Impacts and Feasibility

The shift from monoculture to polyculture requires an initial economic investment but supports long-term sustainability. Sánchez et al. (2022) states that average profits are higher in polyculture compared to monoculture. The benefits and costs of diversification are driven by several factors including crop commodity. Mota-Cruz et al. (2025) estimates a 33% increase in gross profits with 19-36% less fertilizer use. Sánchez et al. (2022) also discusses the social benefits of crop diversification that include sustainable livelihoods and nutritious diets alongside conservation and climate mitigation.

Conclusion

Polyculture offers an ecologically grounded alternative to the unsustainable practices of conventional monoculture corn production. Polyculture strengthens nutrient cycling, enhances pest regulation and rebuilds soil health without relying on external inputs by diversifying vegetation and restoring complex functions of natural ecosystems. Shifting monocultures to diversified crop systems reestablishes regulation processes, increases productivity, and enhances sustainability.

References

Abbas, A., Zhao, C., Ullah, W., Ahmad, R., Waseem, M., & Zhu, J. (2021). Towards Sustainable Farm Production System: A Case Study of Corn Farming. *Sustainability*, *13*(16), 9243. https://doi.org/10.3390/su13169243

Belete, T., & Eshetu Yadete. (2023, December 14). *Effect of Mono Cropping on Soil Health and Fertility Management for Sustainable Agriculture Practices: A*. ResearchGate; unknown. https://www.researchgate.net/publication/376521787_Effect_of_Mono_Cropping_on_Soil_Health_and_Fertility_Management_for_Sustainable_Agriculture_Practices_A

Guo, X. (2024). *Effects of Arbuscular Mycorrhizal Fungi and Corn Stover Application on Corn Growth and Nutrient Uptake*. EDP Sciences. https://doi.org/10.1051/e3sconf/202456103024

Jensen, E. S., Carlsson, G., & Hauggaard-Nielsen, H. (2020). Intercropping of grain legumes and cereals improves the use of soil N resources and reduces the requirement for synthetic fertilizer N: A global-scale analysis. *Agronomy for Sustainable Development*, *40*(1). https://doi.org/10.1007/s13593-020-0607-x

Mota-Cruz, C., Casas, A., Ortega-Paczka, R., Perales, H., Vega-Peña, E., & Bye, R. (2025). Milpa, a Long-Standing Polyculture for Sustainable Agriculture. *Agriculture, 15*(16), 1737. https://doi.org/10.3390/agriculture15161737

Nicholls, C., Altieri, M., & Vasquez, L. (2016). Agroecology: Principles for the Conversion and Redesign of Farming Systems. *Journal of Ecosystem & Ecography*, *01*(s5). https://doi.org/10.4172/2157-7625.s5-010

Sánchez, A. C., Kamau, H. N., Grazioli, F., & Jones, S. K. (2022). Financial profitability of diversified farming systems: A global meta-analysis. *Ecological Economics*, *201*, 107595. https://doi.org/10.1016/j.ecolecon.2022.107595