Perennial Polyculture: An Ancient Method of Sustainable Food Production

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Perennial Polyculture is the practice of growing perennial plants in diverse and intermingled groups of species. This is in contrast to the practice of annual monoculture, which entails growing either a single species or multiple segregated species of annual crops. Annual monocultures have been the dominant practice across the globe for their ability to produce high yields of nutrients in a short amount of time. Unfortunately, the practice brings with it a multitude of ecological and economic pitfalls that lead to faltering production. As climate change progresses, this puts food security at risk. Perennial polyculture has the potential to be a sustainable alternative to traditional industrialized annual agriculture that provides stability to our food production in the wake of a changing climate.

Climate change is projected to have major negative impacts on global food production. Some of these major climate driven challenges include higher temperatures, higher frequency/severity of drought, increased rates of soil erosion, diminished water availability, as well as the salinization of arable land (Nabhan et al., 2020). On a global scale, these impacts may seem small in the first half of the 21st century, but they are projected to get progressively worse after that (Altieri et al., 2015). Developing lowland countries are going to feel the effects before the developed mid-highland countries due to climatic, socio-economic, and technological conditions (Altieri et al., 2015). These impacts will undoubtedly lead to an increase in food prices, higher rates of malnourishment, and more frequent social upheaval (Altieri et al., 2015).

It doesn’t help that these challenges are actually exacerbated by our current agricultural practices. Food production systems currently account for 19%-29% of the world's greenhouse gas emissions (Nabhan et al., 2020), and annual monocultures contribute to widespread environmental degradation in the forms of nutrient pollution, soil erosion, and the decline of life on earth (Kreitzman et al., 2022). Modern practices are a major driver for a reduction in worldwide biodiversity and ecosystem loss. About 38% of the Earth's surface is made up of land used for crop production and livestock grazing (Delaney & Wettberg, 2023). Currently, 80% of the world's arable land is being used to grow a "handful of crop commodities" (Altieri et al., 2015), and we are currently only cultivating about 150 of the 30,000 edible species of angiosperms (Delaney & Wettberg, 2023). Approximately 60% of all cropland is dedicated to growing wheat, maize, rice, and potatoes (Altieri et al., 2015). All of this has resulted in a more homogenous landscape that altered the habitats of fungi, insects, and birds that benefited from the previously interlinked ecosystems supported by hundreds of thousands other plant species (Delaney & Wettberg, 2023).

Having a food production system that is reliant on such a homogenous subset of genera leads to an even increased amount of instability to our economy and global food supply. The fact that high genetic uniformity among crop plants leads to an increase in pest and disease outbreaks has been seen in the epidemic of the southern corn leaf blight, which resulted in a loss of about 1 billion dollars and about 18.5 trillion calories (Altieri et al., 2015). Other historical examples include the Irish Potato Famine, the Great Bengal Famine of India, and when France had the entirety of its grapevine wiped out by insects until a cultivated species from the U.S. was introduced (Altieri et al., 2015). Even with the persistent use of pesticides, we still see major yield loss. In 1995, the world used about 4.7 billion pounds of pesticides, yet yield loss for most crops still comes to about 20%-30% due to pests alone (Altieri et al., 2015). It is clear that annual monocultures do not have the ecological defenses required to withstand the pressures of climate change, and if nothing is done there is an increased risk of food and economic instability.

The inevitability of these issues has had many citizens, farmers, and researchers looking for an alternative practice of food crop production. While current dominant practices lead to pollution and production instability, perennial polycultures are a much more sustainable method of production. Soil health is one ecological factor that sees large benefits. Due to the nature of perennial crops, the land they grow on does not need to be tilled each year. This is in contrast to annual crops that need yearly or even seasonal tillings and replantings due to the death after harvest. Farms practicing perennial polyculture saw an improvement to soil structure, soil carbon storage, soil erosion, soil fertility, and carbon cycling (Kreitzman et al., 2022). Perennial polycultures are an intentional practice of functional biodiversity that lead to benefits in these areas as well. Perennial polyculture farms had increased rates of vegetation, insect, fungi, and bird diversity when compared to annual monocultures (Kreitzman et al., 2022). Perennial polycultures also had an increased diversity of pollinating and pest controlling species (Kreitzman et al., 2022). This demonstrates the potential for these systems to be self-sustaining, which is a common motivational outcome among those who are active in this practice (Kreitzman et al., 2021).

While there is no doubt that perennial polycultures are a more sustainable practice, there are concerns with productivity and yield amounts. The crops that dominate the current agricultural landscape have been chosen for their ability to produce a high amount of nutrients in a short timespan. Perennial alternatives to some of these staples, namely grains and legumes, have had trouble reaching yield amounts that are capable of sustaining our current demands (Loomis, 2022). However, there has been an increased effort lately to create hybrids of perennial crops of these types through random mutagenesis as well as genome editing (Chapman et al., 2022). This process may take longer than it took to create high yielding annual hybrids due to perennials having a longer generation time (Chapman et al., 2022). The length required to create these hybrids has some researchers claiming that it may be more beneficial to focus on "sustainable intensification," which aims to increase the yields of existing farm lands while also implementing principles of sustainability to conserve ecological health (Cassman & Connor, 2022). These criticisms and suggestions seem to be rooted in maintaining the current dietary status quo. One reason why the demand for grains and legumes is so high is due to our diets. Currently the average diet includes more grain than is recommended, and 40% of maize yield goes to feeding livestock for meat consumption (Delaney & Wettberg, 2023). Livestock is another sector of agriculture that suffers from many of the same homogeneity issues that crop productions face, with 14 species of animal providing 90% of all eaten animal protein (Altieri et al., 2015). Incorporating perennial polycultures effectively as a replacement requires more than just switching out existing staples for perennial crops. It also requires a radical change to our diets, methods of distribution, land use management methods, and relationships with food.

There are examples of perennial polycultures being a viable system of production capable of sustaining a population. It has historically been widely practiced throughout the world. The ensete gardens of southern Ethiopia are one example of this system supporting the livelihoods of a society. Today 18-20 million people rely on ensete as a staple crop (Peveri, 2021). Ensete is a perennial root shooter crop that produces underground corms that can be consumed after fermentation (Peveri, 2021). The plant also produces a number of by-products that can be used to create fibers, fodder, medicine, and building materials (Peveri, 2021). Farmers use ensete as the backbone for their complex agricultural systems that also incorporate other perennials, annuals, and livestock (Peveri, 2021). These ensete gardens have also proven to be resilient in the face of extreme weather events. In the 1970s and 80s, Ethiopia suffered a drought induced famine. Those who were more greatly affected lived in the northern parts of the country, where there was a reliance on traditional cereal grains. However, those who lived in southern Ethiopia were less affected, since the supply of ensete remained abundant (Peveri, 2021). The methodologies of ensete cultivation are traditional and have a history of over 10,000 years (Peveri, 2021). Polycultures have also been found to amply supply ancient civilizations on other continents. Joya de Cerén was an ancient village in El Salvador that was abandoned and buried due to volcanic eruption. When uncovered, researchers found a snapshot of a civilization that illustrated the flora they grew, collected, stored, and utilized (Slotten et al., 2020). Findings demonstrate that their diets were diverse, nutritious, and that their food systems relied on a biodiverse method of gardening that took advantage of polycultures (Slotten et al., 2020). These examples provide a good demonstration of the protections that perennial polycultures can offer under ecological stress, as well as provide wellness to the livelihoods of those who practice. There is a growing movement among indigenous communities in the U.S. and Australia to return to these methods that had largely been lost during the European invasion.

Climate change has motivated many researchers to find a more sustainable method of food production. Perennial polycultures show a great amount of promise, especially when combined with other practices such as landscape mosaics and urban agroforestry. Annual monocultures add to the existing climate issues and stand vulnerable to major ecological collapses. Although current nutrient yields coming from perennial polycultures seem to be low, most studies have been conducted on farms that are young. One of the benefits of polyculture systems is that they are projected to increase in productivity as they age. More controlled studies using older farms would be beneficial to furthering our understanding. These practices are not new, they have just been forgotten due to an agricultural industry that is driven by profits and quick turnover without remaining conscious of the land they are extracting from.

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