Biodiverse agriculture for a changing climate

PRACTICAL ACTION
Technology challenging poverty

Climate change will bring enormous and unpredictable changes to agriculture which will affect global food supplies and disproportionately impact on the poor. Emissions of greenhouse gases from agriculture, largely from intensive systems, contribute significantly to global warming.

Worldwide, millions of small-scale food producers, organic growers and researchers have demonstrated that biodiverse systems of production provide opportunities for mitigating and adapting to climate change. These methods sustain and replenish the natural resources that are essential for food production.

The Climate Challenge

The impact of greenhouse gases on global climate is beyond doubt. Agriculture accounts for around 30% of all greenhouse gas emissions from human activity. Land use change, driven by industrial production methods, accounts for more than half of agricultural emissions.[1] Intensive livestock rearing and fertilizer use dominate the remainder, making agriculture responsible for around half of all methane and 60% of all nitrous oxide emissions[2], both of which have far greater global warming impact than carbon dioxide.[3] While contributing to climate change, agricultural production will also be profoundly affected by it. Millions of farmers throughout the world will suffer, including the 370 million rural poor who live in areas highly vulnerable to climate change impacts.[4]

Climate change will multiply extreme weather events such as heavy rains, flooding, hurricanes and drought. It will gradually change seasons, altering the distribution, timing and growth of plants, animals and fish, and the spread of diseases. Sea level rise will affect the viability of coastal land.[5] As 80% of global agricultural land is rain-fed, changing rainfall patterns and water depletion could have devastating consequences.[6]

Conventional industrial agriculture relies heavily on fossil fuel. Mineral fertilisers, for example, are energy intensive to produce and also generate 19% of all human-induced nitrous oxide emissions.[7] Fertiliser usage is projected to rise 37% by 2030.[8] Energy assessments reveal that conventional crop rotations generate the equivalent of nearly three times more carbon dioxide than the same crops produced using organic methods.[9] At the same time, chemical dependant large-scale monocultures undermine biodiversity, leading to increased vulnerability to environmental change.[10]

By contrast, at least 1.4 billion traditional farmers, pastoralists and artisanal fishers, and many more gardeners and organic farmers, have thrived by developing biodiverse production systems that draw on and replenish natural resources. These systems depend on and sustain agricultural biodiversity, comprising seeds, livestock breeds and aquatic organisms, as well as predators, pollinators and soil micro-organisms which together improve productivity.[11] Characterised as agroecology, these sustainable production systems provide opportunities for mitigating and adapting to climate change.

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Farmers using composting techniques (shown above), botanical pest controls, legume planting, animal manure and water harvesting have raised soil quality, reduced erosion, improved nutrition and increased yields by 60 to 195%.[12]

The importance of agricultural biodiversity in production systems

Local knowledge, experience and culture shape and conserve agricultural biodiversity, defined by the Food and Agriculture Organisation of the UN (FAO) as the 'variety and variability of animals, plants and micro-organisms which are necessary to sustain key functions of the agro-ecosystem in support of food production and food security.'[13]

Research from field-scale trials and laboratory studies confirms how biodiverse agriculture conserves the environment and delivers high and dependable yields.[14] Monoculture yields can appear large when measured for a particular crop per hectare, yet on mixed farms the whole farm output per year is greater, less dependant on favourable weather conditions and more sustainable in the long term.[15]

Mitigating climate change with biodiverse agriculture

Enhancing agricultural biodiversity has significant potential to mitigate the impacts of greenhouse gases. Reflecting on nearly three decades of research, a recent report from the US Rodale Institute concluded that implementing 'established, scientifically researched and proven' biodiversity based farming would change agriculture from a global warming contributor to an inhibitor.[16]

Examples of how biodiverse agriculture can mitigate climate change include:

- increasing soil biodiversity to build soil organic matter, capturing carbon
- using diverse leguminous crops to fix nitrogen in the soil, reducing the need for chemical fertilizers
- introducing perennial crops to store carbon below ground
- planting temporary vegetative cover between successive crops to reduce nitrous oxide emissions by extracting unused nitrogen.[17]

International Livestock Research Institute

Organic grass-fed beef requires 50% less fossil energy than conventional grain-fed systems, while organic crop production generates the equivalent of 65% less carbon dioxide than industrial methods.[18]

Adapting to climate change through biodiverse agriculture

Our ability to understand much of what climate change will bring in a particular location is hampered by uncertainty in climate projections. Future rainfall patterns are understood least well, presenting a significant challenge for food production.[19]
Where climate change impacts can be identified with certainty, targeted vulnerability reduction may form part of an adaptation strategy. This includes enhancing agricultural biodiversity both on land and in water. For example, it may be necessary to protect depleted fish populations if warming seas risk a collapse in stocks. However, dealing with uncertainty requires resilience and adaptive capacity.[20]

Strengthening resilience

Resilience refers to the capacity to absorb or cope with the shocks and stresses of climate change. It reflects the need to sustain yields from land and sea in the face of weather-related events and gradual temperature variations. For example, healthy biodiverse soils are resilient, retaining moisture in a drying climate; diverse ecosystems can adapt to new pests or increased pest numbers; and livelihoods can be insulated through less dependence on external inputs. Two key practices for resilience are:

- selecting and breeding locally-adapted crop varieties, animal breeds and fish species for resistance to disease or pests, and planting a range of varieties to insure against different weather conditions[21]
- using biodiverse agriculture to build soil organic matter through crop rotation, composting, green manures and cover crops, which enriches the soil for better yields, drought-resistance, and absorption of excess rainfall.[22]

Building adaptive capacity

Adaptive capacity is an active process that involves the ability of individuals or communities to modify and transform practices in response to climate change. Critical elements include:

- agricultural biodiversity as an asset that enables adaptation of food species to a changing environment[23]
- accessible information on short, medium and long term weather and climate projections[24]
- self-reliance and local knowledge, with opportunities to learn, innovate and make decisions in response to climate change information.[25]

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A 21 year farm system trial has demonstrated the importance of using diversity to improve soil organic matter. The diverse fields outperformed the conventionally fertilised fields in four out of five drought years, and produced significantly better yields in severe drought conditions.[26]

Obstacles to sustaining agricultural biodiversity

Since the 1960s there has been international recognition of the loss of agricultural biodiversity as a serious problem.[27] Today, while it continues to decline, its importance to climate change is also recognised. As the head of the Convention on Biological Diversity states, 'we cannot forget that biodiversity conservation is part of the solution to climate change.'[28]

Industrial agriculture exerts a powerful influence on policy, research and agricultural strategies.[29] A small number of transnational corporations control the main agricultural inputs of seeds, genetically-engineered crops, pesticides and fertilizers.[30] The drive for profits by agribusiness, food and commodity corporations dominates agricultural research and development, investment and trade policies and so inhibits the growth of more equitable and diverse food systems. International treaties on intellectual property rights (IPRs) protect corporate interests over seeds, breeds and biological processes, while national legislation rarely protects farmers' rights over locally-developed plant varieties, undermining the seed-saving and exchange necessary to increase agricultural biodiversity.[31]

Adaptive and resilient biodiverse agriculture requires policies and funds for innovation in knowledge-intensive rather than external input-intensive systems. In contrast, current policy and research focus is on industrial agriculture, extinguishing local knowledge and driving out diversity through the narrow selection of crops, breeds and aquatic species for short-term efficiency and profit.[32]

'Two decades of observations reveal resilience to climate disasters to be closely linked to levels of farm biodiversity.'
Altieri and Koohafkan 'Enduring farms' (2008)

Recommendations

To cope with climate change and to avoid environmental collapse, the recent global review on the future of agriculture, the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), found that research and policy attention should be paid to biodiverse agricultural practices. The review highlighted the need for investment and public research in low-input and organic systems, biological substitutes for agrochemicals, site-specific cultivars, local seed systems and reduced dependency on fossil fuels.[33]

Globally, small-scale farmers are calling for the implementation of the 'food sovereignty' policy framework. Food sovereignty offers an alternative to globalised industrial agriculture, placing food providers and consumers, rather than corporate agribusiness, at the heart of decision making. It seeks to return control over all aspects of agricultural biodiversity to local food providers, building on their knowledge and skills to develop localised, biodiverse food production systems.[34]

Policy, research and investment efforts supportive of agricultural biodiversity should involve:

- Implementing laws, policies and practices to promote food sovereignty and support small-scale producers and localised biodiverse food production
- Changing priorities in research and development towards practices and technologies that promote biodiverse agriculture and farmer to farmer information sharing
- Changing attitudes and philosophies of decision makers, scientists and others to support biodiverse agriculture
- Regulating the influence of corporations that dominate the agricultural input sector
- Challenging existing laws and regulatory frameworks that prevent small-scale farmers and communities from developing, saving, exchanging and selling seeds, livestock breeds and fish species.

For a full paper with supporting references visit www.practicalaction.org.uk

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Cover picture: Seed varieties to be sown by farmers in Sri Lanka. Practical Action/Zul

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