



The Global Food System: Sustainable Alternatives to Industrial Agriculture



Brian Koch
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Advisors: Derek Larson & Jean Lavigne

Abstract

A functioning food system should produce food effectively and sustainably. The current global food system relies unsustainably on industrial agriculture. Alternative techniques could solve the issues of unsustainable production. Six agro-ecological farming methods were evaluated through environmental, social, and economic lenses which specifically addressed environmental degradation, human health, and the educational and communal importance of small scale farming. These techniques would promote sustainability by improving soil health and integrity and enhancing biodiversity within cropping systems, improving human health by producing various types of crops necessary for dietary needs, and promoting small, community-based farms. Analysis concludes that certain agro-ecological farming techniques promote sustainability in these ways while some may not. Although each agro-ecological farming technique may be integrated in various parts of the world, major barriers for each technique revolve around costs; specifically, for transitioning current systems to sustainable systems; which include costs for machinery and other equipment.

Outline of Six Agro-Ecological Techniques

Organic Agriculture	Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity.
Hydroponics	A soil-less system that consists of not using soil as substrate for crop production.
Perennial Agriculture	Perennial agriculture revolves around species that are able to regrow and continue to reproduce grains, seeds, fruits, and biomass after a single harvest.
Integrated Pest Management	IPM strategies rely on natural mortality factors such as natural enemies and weather and seeks out control tactics that disrupt these factors as little as possible.
Aquaponics	A technique for combining hydroponics and aquaculture in a system that cultivates plants in recirculated water. Aquaponics agriculture recirculates water from a fish take through a vegetable grow bed.
No-Till Agriculture	No-till is a tillage system in which crop residue is left on the soil and the soil is left undisturbed from prior harvest to no-till planting, except for nutrient injection.

Table 1: Outline of the definitions and practices of the six proposed agro-ecological techniques.

Methods

An evaluation of six agro-ecological farming techniques (organic, hydroponics, perennial, integrated pest management, aquaponics, and no till agriculture) provided a means to critique sustainable farming systems in comparison with industrial agriculture. A matrix scaling system was constructed to compare each of the proposed techniques could improve or degrade within the specific criteria: environmental degradation, human health, and farm size. The status quo was the baseline at three for each criteria. Environmental degradation must be improved by signs of soil health, biodiversity, and drastic reductions in chemical applications must be exhibited to score a four and a five or six if significant signs are shown. To score above a three for human health, improvements in crop biodiversity and signs of decreased chemical applications must be observed. To score above a three, small farm sizes smaller than conventional systems must be promoted. To score a five or six, drastic reductions must be observed. Cost was determined by total input costs such as machinery, seeds, and equipment necessary to begin system. To score over a three, total input costs must be lower than the average price range of conventional systems. To score over five means that overall costs are significantly lower than conventional systems. To score difficulty of implementing each system, comparison of barriers to implement such as infrastructure, necessary equipment, costs, or land required were utilized. To score a four means that infrastructure, equipment, costs, or land played a significant role in implementing. Scoring above a four means that the difficulty of implementing is easily achievable, as one or two factors may be halting implementation.

Grading of Six Proposed Agro-Ecological Farming Techniques

	Environmental Degradation	Human Health	Farm Size	Cost	Difficulty	Total Score
Organic	5	5	5	6	6	27
Hydroponics	6	5	5	3	4	23
Perennial	4	4	4	3	4	19
IPM	5	5	3	5	6	24
Aquaponics	6	5	5	3	4	23
No-Till	4	4	4	2	5	17

Table 2: Matrix Scaling System Grading Each Proposed Agricultural Technique by Environmental Degradation, Human Health, Farm Size, Cost, and Difficulty of Implementation.

Results

- The Green Revolution spurred the beginning of industrialized agriculture, an unsustainable system which utilizes chemicals, monoculture, degrades the environment, human health, and promotes large-scale farming
- Six agro-ecological agricultural techniques analyzed provide environmental, social, and economic benefits
- Implementation of these techniques provides potential to increase biodiverse crop production, improve soil integrity, increasing resource security, and promote food security
- Environmental degradation has been shown to decrease with the integration of various agro-ecological techniques by increasing biodiversity, improving soil health, and minimizing the use of chemicals
- Agro-ecological techniques beneficially impact human health by producing an array of crops, providing benefits to diet, and reducing the use of chemicals to produce crops
- Promoting small-scale farming may serve as an educational benefit for farmers and communities
- Cost is an underlying barrier for each of these systems, especially integration or transforming current farming techniques
- Holistic knowledge of alternatives is a barrier that may halt the research and production of these systems of agriculture.

Recommendations

- Organic Agriculture**—Areas in North America, Africa, Asia, and Europe have shown an increase in biodiversity in crops, thus improving human health, promoting smaller farms, while reducing overall costs.
- Hydroponics and Aquaponics**—Integration within urban environments (abandoned infrastructure, greenhouses, skyline rooftops) decrease degradation, promote biodiversity within cropping systems, drastically decrease size of operations, but doing so is capital intensive.
- No-Till Agriculture**—Viable in most parts of the world. Spain has shown improvements in biodiversity and degradation loss, which promotes better health, but still promotes large scale farming with a capital intensive transition from conventional systems.
- Integrated Pest Management**—Senegal, Mali, Burkina, and Benin—areas in which degradation has decreased, biodiverse crop options have been promoted, but has no effect on farm size, and cost varies significantly.
- Perennial Agriculture**—Sri Lanka has shown signs of increased biodiversity, improvement of overall health due to array of crops, but small scale farming was not promoted and capital cost is greater than conventional systems.