Ecology, Energy, and Alternative Agriculture: A New Synthesis

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Introduction

This article advances a new synthesis and framework for understanding the relationship between ecology and ecosystem services, energy production, and two forms of agriculture. The choices we make in our agriculture and land management systems impact and influence other structures and outcomes in society such as: the health of our populations; labor and economic issues; energy production, extraction, and consumption; and the over all ecological wellbeing of the biosphere. It is crucial for the future health of all species and our planetary ecosystems that we change the way we extract energy and food from our environments. Our ability to comprehend and act on these connections will foster positive social and ecological changes for generations to come. To do so, our paper traces the development of four major ideas and practices over time: 1) annual tillage agriculture, 2) the application of inanimate energy, specifically fossil fuels (fossilized plants) to agrifood production, 3) alternative agroecological and perennial polycultural approaches (a major part of the solution), and 4) the modern food movement, which is popularizing the larger debate about our agrifood systems (also part of the solution).
While others (i.e. Vaclav Smil, Pimentel and Pimentel, H. T Odum, and The Council for Agriculture Science and Technology) have written about some of these themes and relationships, our attention to annual tillage versus perennial agriculture, as well as the concise, and hyperlinked nature of our article and timeline set it apart. First, we discuss ecosystems and energy, defining key terms that provide a foundation to this framework. Second, we outline the relationship between annual tillage agriculture and fossil fuels (the use of inanimate energy sources). Third, we introduce a range of alternative agroecological approaches and discuss the modern food movement. Finally, we present a hyperlinked, color-coded timeline, which provides an interactive visual for understanding the development, application, and connections between these related fields. Given this format and the intellectual history presented in the timeline, our article is written for the agrifood movement; college students and professors in agriculture, food studies, and related fields, as well as interested members of the public.

Ecosystems and Energy

Understand agriculture holistically requires us to talk about energy and energy production in its varied forms. This in turn means that we need to consider the energetic limitations and opportunities of ecosystems and ecosystem services, which are defined by the availability of rain, temperatures, soil, and sunlight. Photosynthesis uses these factors in various combinations to create smaller or larger quantities of plants and trees, also known as biomass. It is this daily conversion of sunlight, water, and minerals into carbohydrates that lays the foundation of the trophic pyramid of herbivores, predators and diseases. Ecosystem productivity, based on these factors, is known as Net Primary
**Productivity** or NPP. Humans manipulate these factors in order to enhance NPP in our favor. We do this through tilling (tractors, combines, etc.), irrigation, aqueducts, wells, swales, organic and synthetic fertilizers, and greenhouses to name a few important agricultural inventions and design factors. Many of these have been enabled by the application of fossil fuels.

Howard T. Odum, one of the grandfathers of Energetics, coined the term **Emergy**\(^\text{vii}\), which is short for Energy Memory. Emergy is a measure of the qualitative differences and historical inputs between types of energy that are consumed and the direct and indirect transformations needed to convert it into products or services. Emergy is about how energy is created and stored, whether it’s plutonium, fossil fuel, wind, sun or biomass. This in turn, helps us understand energy renewability, wherein some forms of energy (like biomass) are constantly being created and stored through photosynthesis.

A third key element of energy theory is known as **Energy Return on Energy Invested**\(^\text{viii}\) or EROEI, which is defined as how much energy it takes to harness an energy source. For example, when oil was first discovered it took as little as one gallon of gasoline to extract 200 gallons out of the ground\(^\text{ix}\). This EROEI for oil has dropped significantly over the last 50 years as we have exhausted the most accessible fields. We now must spend more energy to access petroleum in extreme environments (like the arctic and deep ocean water sea beds), or extract and process abundant, but less pure sources, like tar sands and pockets of fuel/gas scattered in tight rock formations through processes such as hydraulic fracturing. Regarding the EREOI for biofuels, it has been concluded that the processes used to turn corn, soybeans, sunflowers and other biomass into fuel uses much more energy than the resulting ethanol or biodiesel generates\(^x\).
We urge the reader to explore other important terms and concepts in connection with ecology and food such as: thermodynamics, the metabolic theory of energy, and trophic pyramids, to name a few. The main point here is that healthy ecosystems, ecosystem services, and photosynthetic energy production are the basis for how traditional agricultural societies grow their food.

**Annual Tillage Agriculture and Fossil Fuels**

The second major thread of this succinct synthesis is the long history and development of annual tillage agriculture. Briefly: humans have been cultivating fruit and cereal grains for over 23,000 years\textsuperscript{xii}, although most evidence suggests that agriculture became wide spread in eleven different regions between 11,500 and 10,000 years ago\textsuperscript{xii}. Two early important innovations that advanced annual tillage agriculture were the plow and the use of draft animals (i.e. non-human, animate energy). The history of the plow goes back as far as 6,000 B.C., as its use was wide spread throughout the ancient world, and there were numerous developments regarding this technology over the centuries that have played critical roles in the success of tilling soil and the planting of annual cereal grain crops (wheat, millet, barley, oats, rice, maize, etc.)\textsuperscript{xiv}. While these innovations continued to be refined, new crops and animals were being domesticated, and other sources of energy (e.g. water and windmills) were being developed, the next groundbreaking advancement came with the introduction of fossil fuels and the mechanization of agriculture during the later periods of the industrial revolution.

This is where we can make the connections between ecosystems, energy, agriculture, and fossil fuels (specifically diesel fuel), and the development of synthetic
pesticides and fertilizers, which are produced from petroleum and natural gas respectively. It was healthy ecosystems and the photosynthetic processes that created the carbohydrates that were eventually converted into hydrocarbons or fossil fuel over the past millions of years. The extraction and use of these hydrocarbons form the energetic foundation of our modern agricultural civilization, which burns approximately 37,000 years of those “stored carbohydrates” everyday\textsuperscript{xv}. It cannot be overstated: fossil fuel has been the key enabling agent in our manipulation of agricultural production over the past 200 years. The use of tractors and other mechanized farm equipment along with the application of synthetic inputs (fertilizers and pesticides) has allowed farmers to increase farm size and broad-scale food production per acre. As a result, the average US farmer has gone from feeding 19 people in 1940, to 29 people in 1960, to 155 people today.”\textsuperscript{xvi}. Another way to think about these changes is that in 1900, 38% of the US population were farmers, and by 2000, only 2.6% of the population were farmers\textsuperscript{xvii}. In addition to our farmers, the entire food service industry currently employs 9.3% of the US population. While many view this as progress, the negative ecological and human health impacts of these agrifood and social system changes are significant\textsuperscript{xviii, xix, xx, xxi, xxii, xxiii}.

The scientific community has identified the major issues caused by annual tillage agriculture based on fossil fuels: notably the finite availability of fossil fuels and the larger ecological impactions of anthropocentric climate change\textsuperscript{xxiv}. Thus, the developments of tillage; annual crops; and the plow, coupled with the use of fossil fuel as an accelerant (embodying 500 labor hours/gallon gasoline\textsuperscript{xxv}) have pushed farming methods out of ecological balance. Together, these practices are responsible for creating deserts across much of the planet today\textsuperscript{xxvi, xxvii, xxviii}. This occurs because tillage reduces water storage
capacity and nutrient cycling by breaking down the hydrological cycle in soil, impeding and interrupting the regenerative processes. Specifically, tillage oxidizes soil matter and destroys macro and micro soil life \(^{xxix}\) such as earthworms and mycorrhizal fungi respectively, which are important measures of soil health \(^{xxx, xxxi, xxxii}\).

Our society has also seen the economic implications of the connections between annual tillage agriculture and fossil fuels. Given industrial agriculture’s reliance on fossil fuel, as well as increasing links between the markets in food and fuel driven by biofuel production, the surge in 2008 oil prices led directly to spikes in the price of key foods globally. This in turn sparked food riots in over 40 countries. The negative consequences of annual tillage agriculture’s dependence on fossil fuel is also correlated with an increase in locally produced food, as more people grasp the nexus of ecological and energetic elements in the food system.

**Alternative AgroEcological Approaches**

To remedy these crises an alternative agrifood “movement” has been creating new approaches and practices for over a century now \(^{xxxii}\). There is no one movement, but rather a wide-ranging constellation of actors, leaders, scholars, and pioneers in various fields \(^{xxxiv, xxi}\). There are farmers, journalists, chefs, academics, public health and elected officials, and community organizers working to create ecologically and socially just agrifood systems. Farmer and growers, specifically, are creating ecologically sound and energetically productive agricultural methods—the kinds of practices that enhance ecosystem services while providing humans with food, fiber, fodder, and fuel (all various forms of energy). If we understand how nature harnesses and stores energy, and how traditional cultures using
lower levels of energy managed their productivity, we can begin to understand the methods that are ecologically, energetically and culturally productive. This is critical, for it is these types of agrifood production methods that rely on immediate solar Emergy and have a high EROEI.

Alternative Agriculture denotes a wide variety of agrifood production and associated approaches, including sustainable agriculture, Keyline earth and water design and management techniques, restoration agriculture, conservation agriculture, natural farming, biodynamics, agroecology, aspects of integrated pest management and certified naturally grown, the historic understanding of “organic” agriculture, and importantly, permaculture. Some of these approaches overlap with each other and with aspects of annual tillage agriculture. Broadly, these alternative approaches fall under the domain of civic agriculture, a paradigm that is locally oriented in its production, distribution, and consumption, and is based on the best ecological, economic and bioregional practices that place social and cultural values at the center of the food system. This paradigm is interested in cultivating a healthier human-to-human and human-to-Earth relationship. Civic agriculture is critical of and is contrasted with conventional or industrial agriculture, which is oriented towards commodity production for national and global markets.

Alternative Agriculture addresses the negative aspects of annual tillage agriculture, from the destruction of humus to the synthetic inputs we have developed based on this 200-year boon of fossilized sunlight. As more of us come to understand ecosystems and energy production comprehensively, we see more clearly the downsides associated with fossil fuel use. We are using these finite fuels to deforest our land, till the soil, and then add
artificial inputs to enhance fertility. Over time, we see increasing costs and pollution accompanied by declines in overall productivity, resulting in desertification in the most brittle ecosystems (i.e. those without oceanic rainfall). The alternative approaches all attempt to intervene at various points in this decline, whether through integration and proper management of livestock, incorporation of trees and other perennials through agroforestry, or the elimination of tillage in organic agriculture.

**Agriculture, Ecology and Energy Timeline**

The weaving of this synthesis culminates with the color-coded timeline below. This interactive word graphic functions as a web-based encyclopedia, similar to Wikipedia, with links to a wide variety of sources and references, including Wikipedia, peer reviewed articles, foundations, non-profits, PDF copies of text, YouTube videos, and popular news stories. Here, we trace these four major threads over the past 250 plus years, which include the important innovations, inventions, and developments regarding:

1. **Annual Tillage Agriculture and Fossil Fuel Developments**
2. **Evolution, Ecosystems, and Renewable Energy**
3. **Alternative Agroecological Approaches**
4. **Agriculture and Food Movements**

Within our timeline there are important events that are not thematically highlighted, but are listed because they relate to some of these developments. For example, World War II is a watershed event that led to the use of synthetic macronutrients (NPK) and was a precursor to the Green Revolution in the 1960s and 70s. Another example is the development of the Land Grant Universities and Cooperative Extension in the US—which is
primarily related to research and development of annual tillage agriculture, but also to alternative agroecological approaches. The timeline also includes statistics about the changing percentage of farmers in the US labor force.

Finally, we also acknowledge the sheer scope of this synthesis, and recognize that we are taking a broad historical view, where all the details are not fully examined or explained. Plus, given considerations of length, we have chosen to only chronicle those events since the mid-industrial era (late 1700s to the present). This makes sense given the interplay between energy (specifically the use of fossil fuels) and annual tillage agriculture. It is our goal that you read the timeline and keep in mind how these unsustainable or ecologically oriented developments have contributed to the creation of our global civilization today and the issues facing humanity. We ask each reader to consider how he or she can help share and proliferate these alternative agroecological approaches and practices.

1781 – James Watt produces the first steam engine (10 hours power) with continuous rotary motion that would be used in a wide range of industrial manufacturing. This engine could be powered by wood and coal, and would eventually be used to power tractors, thresher, trains, and even cars.

1786 – Andrew Meikle develops the first mechanical, horse powered threshing machine, a precursor to our modern combine harvesters.

1790 – 90% of US labor force are farmers.

1831 – Cyrus McCormick, using his father’s design, invents the horse drawn mechanical grain reaper/harvester.

1834 - John Avery and Hiram Abial Pitts develop (patented in 1837 in the US) the steam-powered thresher.

1837 – John Deere produces polished, steel cast ploughs for sale.
1840 – 69% of US labor force are farmers.
- 5% of US Energy is derived from coal


1850 – 1855 – Henry Bessemer develops a process for the mass production of steel, an important material for manufacturing steam engines, rail lines, tractors, plows, and other industrial machines.

1859 – The discovery of Drake’s Oil Well in Cherrytree Township, Pennsylvania, helps to kick-start the United States oil rush, and the use of petroleum as a fossil fuel.

1861 – 1865 – United States Civil War reduces access to “free” animate energy (slave labor) in agriculture.

1862 – The Morrill Act establishes the Land Grant Institutions in the United States, creating universities in each state that focus on agriculture and the mechanical arts establishing affordable liberal arts education for the masses.

1866 – Ernst Hackle coins the term Ecology or Ökologie (in German), referring to the scientific study and analysis of the interactions among organisms and their environment.

1870s – The phosphate fertilizer industry begins. Today, most phosphate fertilizer is created through the acidification of apatite from phosphate rock. Phosphate is a finite resource.

1875 – Eduard Suess, an Austrian geologist coins the term biosphere to refer to the conditions promoting life on Earth, including key parts such as flora, fauna, minerals and matter cycles (hydrology, nitrogen, etc.) The term biosphere was popularized by Vladimir Vernadsky in his 1926 publication *The Biosphere*.

1877 – Karl Möbius coins the term biocenosis, also known as biotic community or ecological community.

1880 – 49% of US labor force are farmers.

1887 – The Hatch Act establishes agricultural experiment stations in each state. The Tuskegee Institute (founded by Booker T. Washington in 1881) was a model for these stations and was under the direction of George Washington Carver for 47 years.

1890 – The Second Morrill Act establishes and expands Land Grant programs in the southern states (without much funding as previous programs in the north).
1892 – Gasoline/Petrol powered farm tractor is invented by John Froelich.

1892 – Julius Hensel, a German agricultural chemist publishes Macrobiotic; wherein he suggests that disease is a result of a lack of mineral substances. In 1893 he publishes Bread from Stones, exploring the application of rock dust to soils to increase mineral availability.

1899 – Henry Chandler Cowles formulates the idea of primary succession, an important piece of ecological succession.

1900 – 38% of US labor force are farmers.

- 50% of US Energy is derived from Coal

1902 - The chemical process for making nitric acid (HNO₃) is developed and patented by Wilhelm Ostwald. Nitric acid is the main raw material for most fertilizer production. The Ostwald process is closely associated with the Haber process.

1909 – Fritz Haber and Carl Bosch successfully demonstrate the artificial process for creating ammonia, the key ingredient for making various forms of synthetic nitrogen such as anhydrous ammonium nitrate (NH₄NO₃) and urea (CO(NH₂)₂). The Nitrogen (N), Phosphorus (P), and Potassium (K) fertilizer package (NPK), along with fossil fuels is one of the key inputs of industrial agriculture. Widespread use of these chemicals begins post WWII.

1911 – Franklin Hiram King, know as the father of soil science, publishes Farmers of Forty Centuries, or Permanent Agriculture in China, Korea, and Japan, which is one of the first books to promote the idea sustainable agriculture. King’s work informs the field of crop ecology, a precursor to agroecology.

1914 – The Smith Lever Act of 1914 further establishes the cooperative agricultural extension services, which are then connected to the Land Grant University System.

1914 – 1918 – World War I

1920 - 27% of US labor force are farmers.

1917 – Henry Ford introduces the Fordson farm tractor, which by 1923 had captured 77% of the United States market.

1924 – Rudolf Steiner, the founder of Biodynamics, begins to present his ideas in a series of eight lectures, titled Agriculture Course. This approach strives to create a diversified, balanced farm ecosystem that generates its own health and fertility. Preparations made from fermented manure, minerals, and herbs restore and harmonize the vital life forces of the farm. Biodynamic applications work in cooperation with the subtle influences of the wider cosmos on soil, plant and animal health.
1926 – Jan Smuts, South African author, publishes *Holism and Evolution*, coining the term holism, referring to the idea that systems, be it ecological, physical, biological, chemical, social, economic, mental, etc. should be understood as wholes, not as a collections of parts.

1927 – Charles Eaton publishes *Animal Ecology*, where he popularizes the terms *Food Web* (originally coined by Pierce in 1912 and Victor Shelford in 1913), *Food Cycles*, and *Food Chains*, which formed the basis for Raymond Lindeman’s future work on Trophic-Dynamics in ecology.

1928 – K.H.W. Klages formally links agronomy and ecology in his publication: *Crop ecology and ecological crop geography in the agronomic curriculum*. This is the beginning of the discipline *Agroecology*.


1929 – J. Russell Smith publishes *Tree Crops: A Permanent Agriculture*, one of the pioneering books that examines the use of trees for food, soil conservation, and sustainable agriculture.

1930 – The Rodale Inc. Publishing Company is created by J.I. Rodale, one of the founders of the organic agriculture movement who was inspired by the work of Sir Albert Howard.

1932 – Max Kleiber’s work on basal metabolic rate regarding animal and plant metabolisms lays the foundation for the *Metabolic Theory of Ecology*, which at the ecosystem level explains the relationship between temperate and total biomass production.

1935 – Arthur Tansely, a British ecologist, proposes the term *Ecosystem*. The ecosystem concept is then adopted by Eugene Odum and his brother Howard T. Odum, two important figures in the history of biology, ecology, and energetics.

1938 – Dr. William Albrecht, a soil scientist and agronomist, publishes *Loss of Soil Organic Matter and Its Restoration* wherein he a makes the direct connection between soil quality, food quality, and health.

1939 – Evelyn Barbara Balfour, a founder of the organics movement, creates the Haughley Experiment at New Bells Farm in England. This is the first long-term, side-by-side scientific comparison of organic and chemical-based farming methods. In 1943 she publishes *Living Soils*.

1939 – Weston Price, a dentist by training, publishes *Nutrition and Physical Degeneration*. This book is based on Price's travels around the world and his investigations into the diets and nutrition of traditional societies. He concludes that processed (refined) flour, sugar, and vegetable fats (key aspects of the modern
Western Diet are the main causes of nutritional deficiencies, dental issues, and health problems in western societies.

1939 – 1945 – World War II

1940 – Sir. Albert Howard, one of the founders of Organic Agriculture publishes An Agriculture Testament, which explores soil fertility and the importance of composting at a time where synthetic inputs where on the rise.

1940 – 18% of US labor force are farmers.

1942 – J.I. Rodale begins to publish the Organic Farming and Gardening Magazine.

1942 – Raymond L. Lindeman publishes The Trophic-Dynamic Aspect of Ecology, related to the movement and transfer of energy through the food chain.

1944 – Ruth Stout pioneers a year-round mulching method, reducing or eliminating the need for tilling, plowing, irrigating, spraying, sowing cover crops, weeding, cultivating, or amending soil. These methods are described in her 1963 publication, Gardening Without Work: For the Aging, the Busy & the Indolent, which has influenced modern approaches such as Lasagna Gardening as touted by Patricia Lanza.

1947 – The Rodale Institute, a 501(c)3, non profit is created by J. I. Rodale with the mission of supporting research into organic agriculture.

1949 – Aldo Leopold publishes A Sand County Almanac, putting forth the idea of a Land Ethic, that "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."

1950 – 12.2% of US labor force are farmers.

1950 – 1970 – The Green Revolution (officially launched in Mexico with private funding from the United States). The title is a misnomer, as these practices focus on the development and of high-yielding cereal grain varieties, an expansion of irrigation infrastructure, the modernization of management techniques, and the agribusiness distribution of hybridized seeds and their accompanying synthetic fertilizers, and pesticides to farmers.

1952 – Edward S. Hyams, publishes Soil and Civilization, a historical review that examines and attributes the decline of civilizations with the destruction or loss of nutrients and organic matter of the soils they depended upon for food.

1953 – The Australian Keyline Plan, is published P.A. Yeoman, The Keyline Design is an over-arching land and water management technique which is now widely used in Permaculture and Restoration Agriculture approaches.
1953 – Eugene P. Odum, an American Ecologist, publishes *Fundamentals of Ecology* (with his brother Howard T. Odum). Throughout his life, E. Odum integrated an understanding of energy flows (i.e. Ohm's Law, Thermodynamics, Energese, Energetics) into agroecology systems. This work lays the foundation for the development of Permaculture.

1960 – 8.3% of US labor force are farmers.  
– Petroleum surpasses coal as primary global energy source.

1961 – Julia Child, Louisette Bertholle, and Simone Beck publish *Mastering the Art of French Cooking*, introducing and creating a demand for high quality food in America at a time when our national cuisine emphasized hot dogs and apple pie. Marion Nestle considers this investigative book one of the roots of the modern food movement.

1962 – Rachel Carson publishes *Silent Spring*, where she systematically reviews the negative impacts and misuses of pesticides such as DDT. This book and Carson’s activism helped galvanize the counterculture, the modern environmental movement, and inspired deep ecology and ecofeminism. Furthermore, the modern environmental movement is a precursor to the food movement of today.

1965 – W. Tischler publishes the first full book on Agrarökologie, which translates to Agricultural Ecology. See article on the history of Agroecology here.

1967 – Alan Chadwick, a student of Rudolf Steiner and proponent of the French Intensive Method of gardening, establishes a student garden and apprentice-training program at the University of California, Santa Cruz. Chadwick’s lectures and teachings have influenced many contemporary students, including John Jeavons, who went on to develop Biointensive Agriculture.


1968 – P.A. Yeoman publishes *Water For Every Farm: A Practical Irrigation Plan For Every Australian Property* complementing and building on his previous work

1968 – Garrett Hardin publishes *Tragedy of the Commons*, wherein he describes the social, economic, and ecological dilemmas regarding the use of shared-resources. The paper describes how individuals acting independently based on their own self-interests end up depleting common resources (fertile soil, clean air and water, fish stocks, grazing land, etc.). Hardin popularized the work of William Forster Lloyd, an English economist, who published *Two Lectures on the Checks to Population* in 1833.

1970 – Norman Borlaug, one of the fathers of the Green Revolution, wins the Nobel Peace Prize and is credited with saving billions of people from starvation.
1970 – 4.6% of US labor force are farmers.

1971 – Alice Waters opens Chez Panisse, a restaurant in Berkeley California, which specializes in organic and locally grown produce. The award winning restaurant and chef are recognized as founders of the modern food movement.

1972 – James Lovelock and Lynn Margulis propose the Gaia Hypothesis, the theory that all organisms interact and are connected with their environment (both the organic and inorganic components) Thus, the Earth is a synergistic self-regulating, complex system that maintains and perpetuates the conditions for life on the planet.

1972 – Ecology Action, begins a Biointensive Agriculture research and education project under the direction of John Jeavons in Palo Alto California.

1973 – Arne Naess coins the phrase Deep Ecology, an ecological philosophy that places value on living beings regardless of their economic utility to humans and calls for radical restructuring of modern human societies based on these ethics.

1975 – Alan Smith publishes research in Australia documenting the links between tillage and soil infertility and pointing to the mechanisms by which wild soils maintain fertility and cultivated soils destroy it. This work helps to inform Permaculture approaches to non-tillage farming and gardening.

1976 – One Straw Revolution is published by Masanobu Fukuoka. This lays out the tenets of Natural Farming, or Do Nothing Farming, which aims to work with the complexities of nature and has influenced the development of permaculture.

1976 – Wes Jackson creates the Land Institute, a not-for-profit research, education, and policy organization in Salina, Kansas with the goal of developing agricultural systems based on perennial crops that work with the ecological stability of the prairie ecosystem.

1976 – Orie L. Loucks publishes Emergence of Research on Agro-Ecosystems, a review of existing research on the subject.

1977 – Wendell Berry publishes The Unsettling of America, which explores the theme that the health of the land and the people are inseparable.

1978 – Bill Mollison and David Holmgren publish Permaculture One, a synthesis of applying ecological principals to energy, agriculture, engineering, water, topography and habitat to create human dwellings and eventually human-scale communities.

1980 – The U.S. Supreme Court case of Diamond v. Chakrabarty is the first time that genetic material of a living organism is patented for a bacterium that is capable of digesting crude oil. This opens the gates for the genetic patenting of seeds by agribusiness.
1980 – **3.4% of US labor force are farmers.**

1980 – **Bill Mollison** begins teaching the *Permaculture Design Certification (PDC)*, a globally adapted 72 hour training in sustainable living and homesteading founded in agro-ecological principles. It is designed to go “viral” by being “open sourced,” and encourages certificate holders to teach and share their knowledge. This process accelerates the dissemination of knowledge, bypassing other entrenched methods of information transmission such as our land grant and agribusiness systems of agriculture. This was designed to create a global grass roots movement that could address humanities most pressing issues of energy, ecology and food production.


1982 – Andrew Jevons and Bill Mollison teach PDC at Evergreen State College in Olympia Washington, US.

1984 – **Bullock Brothers** begin offering PDC at their homestead in Orcas Island, Washington.

1986 – **The Slow Food Movement** begins in Italy, under the organization Agricola, as a protest to the opening of McDonalds near the Spanish steps in Rome. Under the direction of the Founder and President **Carlo Petrini**, Slow Food focuses on local and organic production, and is contrasted with the industrial, globalized fast food model.

1987 – **M.A. Altieri** publishes *Agroecology: the scientific basis of alternative agriculture*. Altieri defines Alternative Agriculture as any approach to farming that attempts to provide sustained yields through the use of ecologically sound management technologies. This is one of the earliest mentions of Alternative Agriculture.

1987 – **Robert Hart**, an English philosopher, coins the term (earlier in the 80s) and publishes a pamphlet on *Forest Gardens*. This begins to popularize the term for multi-story perennial polycultures adapted to the temperate zone from his studies of traditional tropical agriculture. His 1991 book, *Forest Gardening*, expands this thesis.

1988 – **Bill Mollison** publishes *Permaculture: A Designers Manual*, which is aimed at teaching and implementing these principles globally, in various ecosystems around the planet.

1988 – **Alan Savory** and **Jodi Butterfield** publish *Holistic Management: A New Framework for Decision Making*. This thesis outlines a systems-thinking approach for managing resources and using livestock to reverse desertification and restore the world’s grassland soils, which are a major sink for atmospheric carbon.

1988 – **Marion Nestle** is appointed Chair of Nutrition, Food Studies, and Public Health at
New York University (she stayed in this role until 2003). In 1996, along with food consultant Clark Wolf, she founded the Food Studies program at New York University. In 2002 she publishes Food Politics: How the Food Industry Influences Nutrition and Health and with many other later publications she is a huge influence on the food movement.

1989 - In Grave Danger of Falling Food, a documentary film written and directed by Tony Gailey and Julian Russell focuses on Permaculture, featuring Bill Mollison, who suggests Permaculture is a solution to food security.

1990 - Stephen Gliessman, one of the modern pioneers of Agroecology, publishes Agroecology: researching the ecological basis for sustainable agriculture.

1990 – 2.6% of US labor force are farmers.

1991 - The collapse of The Soviet Union forces Cuba to adopt more sustainable farming practices based on limited fossil fuels, synthetic fertilizers, and other industrial methods. Cuban agriculture is a model for agroecological practices.

1991- The term Ecovillage is coined by Robert Gilman and is defined as “human-scale full-featured settlement in which human activities are harmlessly integrated into the natural world in a way that is supportive of healthy human development, and can be successfully continued into the indefinite future.” Ecovillages draw heavily from Permaculture practices.

1991- Global Gardener documentary film series airs in Australia and helps to popularize Mollison’s ideas on Permaculture.

1995 – Sydney W. Mintz publishes, Sweetness and Power: The Place of Sugar in Modern History, which examines the history of European colonialism, slavery, and sugar production. Marion Nestle considers this investigative book to be one of the roots of the modern food movement.

1996 – Alice Waters creates the Chez Panisse Foundation and the Edible Schoolyard Program at the Martin Luther King Middle School in Berkeley, California. She helps to raise the issues of school lunch reform and universal access to healthy, organic foods to the national level. Marion Nestle considers Waters and her work an essential part of the beginning of the modern food movement.

1996 – Mark Shepard starts New Forest Farm in Viola WI, a 106-acre, Keyline designed, perennial farm.
1999 – Thomas Lyson coins the term Civic Agriculture, referring to a new agricultural paradigm that is locally oriented in its production, distribution, and consumption, and based on best ecological, social, economic and bioregion practices.

2001 – Michael Pollan publishes Botany of Desire, a book that is made into a documentary film in 2009, which shows what we have done and are currently doing regarding plant genetic selection and cultivation.

2001 – Eric Schlosser, publishes Fast Food Nation: Dark Side of the American Meal, which traces the evolution of the fast food industry alongside larger social changes in America, including the automobile, suburbanization, industrial meat packing, and agricultural immigrant labor. Marion Nestle considers this investigative book to be one of the roots of the modern food movement.

2002 – The United States Department of Agriculture publishes the National Organic Standards, the rules and regulations outlining the certification and process for labeling farms and their products "organic.”

2003 – David Homgren publishes Permaculture: Principles and Pathways Beyond Sustainability, synthesizing much of the work of previous sustainability pioneers into a comprehensive energy analysis. It contains action plans and case studies guided by 12 new Permaculture Principles and works in conjunction with Mollison’s Ethics and Principles, to create a symbiotic, productive future, beyond sustainability.

2004 – Morgan Spurlock produces Super Size Me, a documentary film that highlights the negative health issues associated with a 30–day McDonalds only diet.

2005 – Dave Jacke and Eric Toensmeier publish an expansive, two-volume set: Edible Forest Gardens, which lays out the art and science of putting plants together in wood-land-like patterns, using the theory and practice of temperate climate permaculture.

2005 – Charles C. Mann publishes 1491: New Revelations of the Americans before Columbus and highlights the role that the Europeans had in creating the modern Amazonian Tropical Jungle through the collapse of the First South American Civilizations, who were not longer present to tend the forest. The book also draws attention to the first Amazonian practices of creating Terra Preta and the application of charcoal to soils.

2005 – The term locavore (or localvore) is coined by Jessica Prentice, referring to someone who eats food within a 100 miles of where they live.

2005 – T. Colin Campbell and Thomas M. Campbell II publish the China Study. This report details the results of a 20 year study that examines the relationship between animal protein (animal products) consumption and chronic illnesses such as cancer, diabetes, and heart disease. This book and its authors are featured in the 2001
documentary film production of *Forks Over Knives*, which makes the case for whole food, plant based diets (*veganism*).

2006 – **Michael Pollan** publishes the *Omnivores Dilemma*. Along with later books, such as *In Defense of Food* (2008), and *Food Rules* (2009), Pollan examines the health and environmental implications of our modern western diets and points the finger at those who set the rules for our agrifood system (e.g. politicians, USDA, FDA, and agribusinesses).

2007 – **Joel Salatin** publishes *Everything I Want To Do Is Illegal: War Stories From the Local Food Front*, which highlights issues within our industrial food system from the perspective of a small-scale farmer. Along with previous and later publications, as well as documentaries, Salatin has become one of the farmer faces of the modern food movement.

2008 – The documentary film *King Corn* is produced, which examines the production of corn and the negative influences it has on American society. The film highlights the role that government subsidies play in encouraging the growing of corn.

2007 – **Stephen Gliessman** publishes the textbook *Agroecology: The Ecology of Sustainable Food Systems*, which is a college-level introductory overview of the field.

2009 – The documentary film *Food Inc.* is produced, featuring Michael Pollan, Eric Schlosser, and Joel Salatin among others. The film draws attention to the many issues inherent in our modern agrifood system and has helped galvanize the food movement.

2009 – First **US Carbon Farming Course** was held in Tennessee, training people in methodologies that sequester carbon, building humus to revert climate change. Teachers and support include Dr. Elaine Ingham, Joel Salatin, Eric Toensmeier, and Holistic Management International.

2012 – **Peter Bane** publishes *The Permaculture Handbook: Garden Farming for Town and Country*, an analysis of the opportunities and methods for transforming American suburban households and landscapes into productive microfarms as a response to food and economic insecurity and the decline of cheap fossil energy.

2013 – **Mark Shepard** publishes *Restoration Agriculture: Real World Permaculture for Farmers*, wherein he draws upon Russell’s *Tree Crops*, P.A. Yeoman’s Key-line design, Masonabu’s *One Straw Revolution*, and Molison and Holmgren’s Permaculture approach, to outline broad-acre techniques for perennial agriculture. Shepard’s New Forest Farm in Wisconsin is an example of these methods.
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