Sustainable agriculture

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Sustainable agriculture is farming in sustainable ways based on an understanding of ecosystem services, the study of relationships between organisms and their environment. It has been defined as "an integrated system of plant and animal production practices having a site-specific application that will last over the long term", for example:

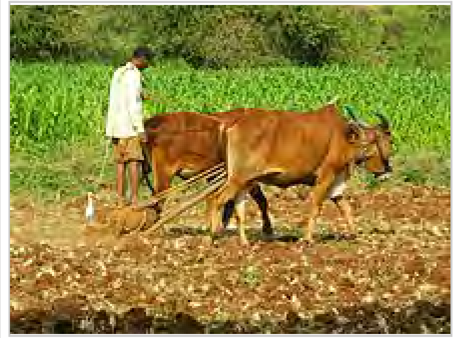
- Satisfy human food and fiber needs
- Enhance environmental quality and the natural resource base upon which the agricultural economy depends
- Make the most efficient use of non-renewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls
- Sustain the economic viability of farm operations
- Enhance the quality of life for farmers and society as a whole[1]

Contents

History of the term

The phrase was reportedly coined by the Australian agricultural scientist Gordon McClymont.[2] Wes Jackson is credited with the first publication of the expression in his 1980 book *New Roots for Agriculture*.[3] The term became popularly used in the late 1980s.[4]

Farming and natural resources



Traditional farming methods had zero carbon footprint.

Sustainable agriculture can be understood as an ecosystem approach to agriculture.[5] Practices that can cause long-term damage to soil include excessive tilling of the soil (leading to erosion) and irrigation without adequate drainage (leading to salinization). Long-term experiments have provided some of the best data on how various practices affect soil properties essential to sustainability. In the United States a federal agency, USDA-Natural Resources Conservation Service, specializes in providing technical and financial assistance for those interested in pursuing natural resource conservation and production agriculture as compatible goals.

The most important factors for an individual site are sun, air, soil, nutrients, and water. Of the five, water and soil quality and quantity are most amenable to human intervention through time and labor.

Although air and sunlight are available everywhere on Earth, crops also depend on soil nutrients and the availability of water. When farmers grow and harvest crops, they remove some of these nutrients from the soil. Without replenishment, land suffers from nutrient depletion and becomes either unusable or suffers from reduced yields. Sustainable agriculture depends on replenishing the soil while minimizing the use or need of non-renewable resources, such as natural gas (used in converting atmospheric nitrogen into synthetic fertilizer), or mineral ores (e.g., phosphate). Possible sources of nitrogen that would, in principle, be available indefinitely, include:

1. recycling crop waste and livestock or treated human manure
2. growing legume crops and forages such as peanuts or alfalfa that form symbioses with nitrogen-fixing bacteria called rhizobia
3. industrial production of nitrogen by the Haber process uses hydrogen, which is currently derived from natural gas (but this hydrogen could instead be made by electrolysis of water using electricity (perhaps from solar cells or windmills)) or
4. genetically engineering (non-legume) crops to form nitrogen-fixing symbioses or fix nitrogen without microbial symbionts.

The last option was proposed in the 1970s, but is only recently becoming feasible.[6][7] Sustainable options for replacing other nutrient inputs (phosphorus, potassium, etc.) are more limited.

More realistic, and often overlooked, options include long-term crop rotations, returning to natural cycles that annually flood cultivated lands (returning lost nutrients indefinitely) such as the flooding of the Nile, the long-term use of biochar, and use of crop and livestock landraces that are adapted to less than ideal conditions such as pests, drought, or lack of nutrients.

Crops that require high levels of soil nutrients can be cultivated in a more sustainable manner if certain fertilizer management practices are adhered to.

Nationwide food producers require vast amounts of land and soil to produce food at an accelerated rate. This diminishes the nutrients in the soil and decimates the idea of sustainable agriculture, which is best built through local, regional agricultural methods.

Water

In some areas sufficient rainfall is available for crop growth, but many other areas require irrigation. For irrigation systems to be sustainable, they require proper management (to avoid salinization) and must not use more water from their source than is naturally replenishable. Otherwise, the water source effectively becomes a non-renewable resource. Improvements in water well drilling technology and submersible pumps, combined with the development of drip irrigation and low-pressure pivots, have made it possible to regularly achieve high crop yields in areas where reliance on rainfall alone had previously made successful agriculture unpredictable. However, this progress has come at a price. In many areas, such as the Ogallala Aquifer, the water is being used faster than it can be replenished.

Several steps must be taken to develop drought-resistant farming systems even in "normal" years with average rainfall. These measures include both policy and management actions:

1. improving water conservation and storage measures,
2. providing incentives for selection of drought-tolerant crop species,
3. using reduced-volume irrigation systems,
4. managing crops to reduce water loss, and
5. not planting crops at all.[8]

Indicators for sustainable water resource development are:

- Internal renewable water resources. This is the average annual flow of rivers and groundwater generated from endogenous precipitation, after ensuring that there is no double counting. It represents the maximum amount of water resource produced within the boundaries of a country. This value, which is expressed as an average on a yearly basis, is invariant in time (except in the case of proved climate change). The indicator can be expressed in three different units: in absolute terms (km^3/yr), in mm/yr (it is a measure of the humidity of the country), and as a function of population (m^3/person per year).
- Global renewable water resources. This is the sum of internal renewable water resources and incoming flow originating outside the country. Unlike internal resources, this value can vary with time if upstream development reduces water availability at the border. Treaties ensuring a specific flow to be reserved from upstream to downstream countries may be taken into account in the computation of global water resources in both countries.
- Dependency ratio. This is the proportion of the global renewable water resources originating outside the country, expressed in percentage. It is an expression of the level to which the water resources of a country depend on neighbouring countries.
- Water withdrawal. In view of the limitations described above, only gross water withdrawal can be computed systematically on a country basis as a measure of water use. Absolute or per-person value of yearly water withdrawal gives a measure of the importance of water in the country's economy. When expressed in percentage of water resources, it shows the degree of pressure on

water resources. A rough estimate shows that if water withdrawal exceeds a quarter of global renewable water resources of a country, water can be considered a limiting factor to development and, reciprocally, the pressure on water resources can affect all sectors, from agriculture to environment and fisheries.[9]

Soil

Soil erosion is fast becoming one of the world's severe problems. It is estimated that "more than a thousand million tonnes of southern Africa's soil are eroded every year. Experts predict that crop yields will be halved within thirty to fifty years if erosion continues at present rates."[10] Soil erosion is not unique to Africa but is occurring worldwide. The phenomenon is being called *peak soil* as present large-scale factory farming techniques are jeopardizing humanity's ability to grow food in the present and in the future. Without efforts to improve soil management practices, the availability of arable soil will become increasingly problematic.

Walls built to avoid water run-off

Some soil management techniques

- No-till farming
- Keyline design
- Growing windbreaks to hold the soil
- Incorporating organic matter back into fields
- Stop using chemical fertilizers (which contain salt)
- Protecting soil from water run-off (soil erosion)

Phosphate

Phosphate is a primary component in the chemical fertilizer which is applied in modern agricultural production. However, scientists estimate that rock phosphate reserves will be depleted in 50–100 years and that peak phosphorus will occur in about 2030.[11] The phenomenon of peak phosphorus is expected to increase food prices as fertilizer costs increase as rock phosphate reserves become more difficult to extract. In the long term, phosphate will therefore have to be recovered and recycled from human and animal waste in order to maintain food production.

Land

As the global population increases and demand for food increases, there is pressure on land resources. Land can also be considered a finite resource on Earth. Expansion of agricultural land decreases biodiversity and contributes to deforestation. The Food and Agriculture Organisation of the United Nations estimates that in coming decades, cropland will continue to be lost to industrial and urban development, along with reclamation of wetlands, and conversion of forest to cultivation, resulting in the loss of biodiversity and increased soil erosion.[12]

Energy for agriculture

Energy is used all the way down the food chain from farm to fork. In industrial agriculture, energy is used in on-farm mechanisation, food processing, storage, and transportation processes.[13] It has therefore been found that energy prices are closely linked to food prices.[14] Oil is also used as an input in agricultural chemicals. Higher prices of non-renewable energy resources are projected by the International Energy Agency. Increased energy prices as a result of fossil fuel resources being depleted may therefore decrease global food security unless action is taken to 'decouple' fossil fuel energy from food production, with a move towards 'energy-smart' agricultural systems.[14] The use of solar powered irrigation in Pakistan has come to be recognized as a leading example of energy use in creating a closed system for water irrigation in agricultural activity.[15]

Economics

Socioeconomic aspects of sustainability are also partly understood. Regarding less concentrated farming, the best known analysis is Netting's study on smallholder systems through history.[16] The Oxford Sustainable Group defines sustainability in this context in a much broader form, considering effect on all stakeholders in a 360 degree approach

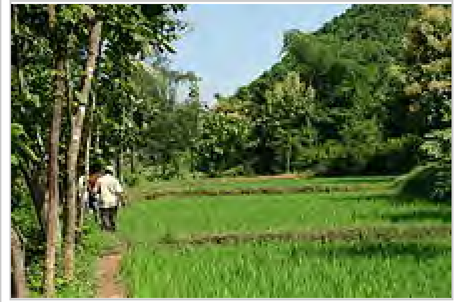
Given the finite supply of natural resources at any specific cost and location, agriculture that is inefficient or damaging to needed resources may eventually exhaust the available resources or the ability to afford and acquire them. It may also generate negative externality, such as pollution as well as financial and production costs. There are several studies incooperating these negative externalities in an economic analysis concerning ecosystem services, biodiversity, land degradation and sustainable land management. These include the The Economics of Ecosystems and Biodiversity (TEEB) study led by Pavan Sukhdev and the Economics of Land Degradation Initiative which seeks to establish an economic cost benefit analysis on the practice of sustainable land management and sustainable agriculture.

The way that crops are sold must be accounted for in the sustainability equation. Food sold locally does not require additional energy for transportation (including consumers). Food sold at a remote location, whether at a farmers' market or the supermarket, incurs a different set of energy cost for materials, labour, and transport.

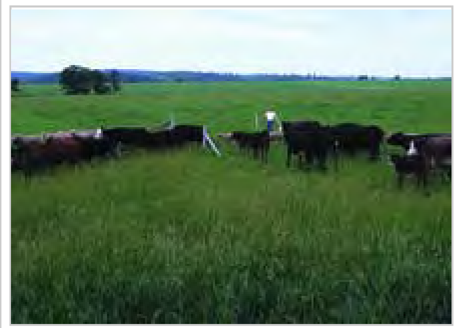
Pursuing sustainable agriculture results in many localized benefits. Having the opportunities to sell products directly to consumers, rather than at wholesale or commodity prices, allows farmers to bring in optimal profit.

Methods

What grows where and how it is grown are a matter of choice. Two of the many possible practices of sustainable agriculture are crop rotation and soil amendment, both designed to ensure that crops being cultivated can obtain the necessary nutrients for healthy growth. Soil amendments would include using locally available compost from community recycling centers. These community recycling centers help produce the compost needed by the local organic farms.


Polyculture practices in Andhra Pradesh

Using community recycling from yard and kitchen waste utilizes a local area's commonly available resources. These resources in the past were thrown away into large waste disposal sites, are now used to produce low cost organic compost for organic farming. Other practices includes growing a diverse number of perennial crops in a single field, each of which would grow in separate season so as not to compete with each other for natural resources.[17] This system would result in increased resistance to diseases and decreased effects of erosion and loss of nutrients in soil. Nitrogen fixation from legumes, for example, used in conjunction with plants that rely on nitrate from soil for growth, helps to allow the land to be reused annually. Legumes will grow for a season and replenish the soil with ammonium and nitrate, and the next season other plants can be seeded and grown in the field in preparation for harvest.


Rotational grazing practices in use with paddocks

Monoculture, a method of growing only one crop at a time in a given field, is a very widespread practice, but there are questions about its sustainability, especially if the same crop is grown every year. Today it is realized to get around this problem local cities and farms can work together to produce the needed compost for the farmers around them. This combined with growing a mixture of crops (polyculture) sometimes reduces disease or pest problems[18] but polyculture has rarely, if ever, been compared to the more widespread practice of growing different crops in successive years (crop rotation) with the same overall crop diversity. Cropping systems that include a variety of crops (polyculture and/or rotation) may also replenish nitrogen (if legumes are included) and may also use resources such as sunlight, water, or nutrients more efficiently (Field Crops Res. 34:239).

Replacing a natural ecosystem with a few specifically chosen plant varieties reduces the genetic diversity found in wildlife and makes the organisms susceptible to widespread disease. The Great Irish Famine (1845–1849) is a well-known example of the dangers of monoculture. In practice, there is no single approach to sustainable agriculture, as the precise goals and methods must be adapted to each individual case. There may be some techniques of farming that are inherently in conflict with the concept of sustainability, but there is widespread misunderstanding on effects of some practices. Today the growth of local farmers' markets offer small farms the ability to sell the products that they have grown back to the cities that they got the recycled compost from. By using local recycling this will help move people away from the slash-and-burn techniques that are the characteristic feature of shifting cultivators are often cited as inherently destructive, yet slash-and-burn cultivation has been practiced in the Amazon for at least 6000 years;[19] serious deforestation did not begin until the 1970s, largely as the result of Brazilian government programs and policies.[20] To note that it may not have been slash-and-burn so much as slash-and-char, which with the addition of organic matter produces terra preta, one of the richest soils on Earth and the only one that regenerates itself.

There are also many ways to practice sustainable animal husbandry. Some of the key tools to grazing management include fencing off the grazing area into smaller areas called paddocks, lowering stock density, and moving the stock between paddocks frequently.[21]

Sustainable intensification

In light of concerns about food security, human population growth and dwindling land suitable for agriculture, sustainable intensive farming practises are needed to maintain high crop yields, while maintaining soil health and ecosystem services. The capacity for ecosystem services to be strong enough to allow a reduction in use of synthetic, non renewable inputs whilst maintaining or even boosting yields has been the subject of much debate. Recent work in the globally important irrigated rice production system of east Asia has suggested that - in relation to pest management at least - promoting the ecosystem service of biological control using nectar plants can reduce the need for insecticides by 70% whilst delivering a 5% yield advantage compared with standard practice (http://www.nature.com/articles/nplants201614).

Soil treatment

Soil steaming can be used as an ecological alternative to chemicals for soil sterilization. Different methods are available to induce steam into the soil in order to kill pests and increase soil health.

Sheet steaming with a MSD/moeschle steam boiler (left side)

Solarizing is based on the same principle, used to increase the temperature of the soil to kill pathogens and pests.[22]

Certain crops act as natural biofumigants, releasing pest suppressing compounds. Mustard, radishes, and other plants in the brassica family are best known for this effect.[23] There exist varieties of mustard shown to be almost as effective as synthetic fumigants at a similar or lesser cost.

Off-farm impacts

A farm that is able to "produce perpetually", yet has negative effects on environmental quality elsewhere is not sustainable agriculture. An example of a case in which a global view may be warranted is over-application of synthetic fertilizer or animal manures, which can improve productivity of a farm but can pollute nearby rivers and coastal waters (eutrophication). The other extreme can also be undesirable, as the problem of low crop yields due to exhaustion of nutrients in the soil has been related to rainforest destruction, as in the case of slash and burn farming for livestock feed.In Asia, specific land for sustainable farming is about 12.5 acres which includes land for animal fodder, cereals productions lands for some cash crops and even recycling of related food crops.In some cases even a small unit of aquaculture is also included in this number (AARI-1996)

Sustainability affects overall production, which must increase to meet the increasing food and fiber requirements as the world's human population expands to a projected 9.3 billion people by 2050. Increased production may come from creating new farmland, which may ameliorate carbon dioxide emissions if done through reclamation of desert as in Israel and Palestine, or may worsen emissions if done through slash and burn farming, as in Brazil.

International policy

Sustainable agriculture has become a topic of interest in the international policy arena, especially with regards to its potential to reduce the risks associated with a changing climate and growing human population.

The Commission on Sustainable Agriculture and Climate Change (https://cgspace.cgiar.org/handle/10568/10701), as part of its recommendations for policy makers on achieving food security in the face of climate change, urged that sustainable agriculture must be integrated into national and international policy. The Commission stressed that increasing weather variability and climate shocks will negatively affect agricultural yields, necessitating early action to drive change in agricultural production systems towards increasing resilience. It also called for dramatically increased investments in sustainable agriculture in the next decade, including in national research and development budgets, land rehabilitation, economic incentives, and infrastructure improvement.[24]

Urban planning

There has been considerable debate about which form of human residential habitat may be a better social form for sustainable agriculture.

Many environmentalists advocate urban developments with high population density as a way of preserving agricultural land and maximizing energy efficiency. However, others have theorized that sustainable ecocities, or ecovillages which combine habitation and farming with close proximity between producers and consumers, may provide greater sustainability.

The use of available city space (e.g., rooftop gardens, community gardens, garden sharing, and other forms of urban agriculture) for cooperative food production is another way to achieve greater sustainability.

One of the latest ideas in achieving sustainable agriculture involves shifting the production of food plants from major factory farming operations to large, urban, technical facilities called vertical farms. The advantages of vertical farming include year-round production, isolation from pests and diseases, controllable resource recycling, and on-site production that reduces transportation costs. While a vertical farm has yet to become a reality, the idea is gaining momentum among those who believe that current sustainable farming methods will be insufficient to provide for a growing global population.

Criticism

Efforts toward more sustainable agriculture are supported in the sustainability community, however, these are often viewed only as incremental steps and not as an end. Some foresee a true sustainable steady state economy that may be very different from today's: greatly reduced energy usage, minimal ecological footprint, fewer consumer packaged goods, local purchasing with short food supply chains, little processed foods, more home and community gardens, etc.[25][26][27] Agriculture would be very different in this type of sustainable economy.

See also

- Afforestation
- Agrobiodiversity
- Agroecology
- Agroforestry
- Allotment gardens
- Analog forestry
- Aquaponics
- Biodynamic agriculture
- Biointensive
- Biomass (ecology)
- Effects of climate change on agriculture
- Buffer strip
- Collaborative innovation network
- Composting
- Conservation agriculture
- Conservation Corridor Demonstration Program (in Delaware, Maryland and Virginia)
- Declaration for Healthy Food and Agriculture
- Deficit irrigation
- Deforestation
- Deforestation during the Roman period
- Desertification
- Ecological engineering
- Ecological engineering methods
- Ecological sanitation
- Environmental effects of agriculture
- Economics of Land Degradation Initiative
- Ecotechnology
- Energy-efficient landscaping
- Environmental impact of meat production
- Environmental protection
- Ethical eating
- Factory farming
- Fire-stick farming
- Food-feed system
- Food systems
- Forest farming
- Forest gardening
- Great Plains Shelterbelt
- Green payments
- Green Revolution
- Hedgerow
- Home gardens
- Human ecology
- Industrial agriculture
- Integrated production
- International Organization for Biological Control
- Land Allocation Decision Support System
- Land consolidation[28]
- Land Institute
- Landcare
- List of sustainable agriculture topics
- Local food
- Local Food Plus (organization)
- Low carbon diet
- Macro-engineering
- Megaprojects
- Organic clothing
- Organic cotton
- Organic farming
- Organic food
- Organic movement
- Perennial grain
- Permaculture
- Permaforestry
- Polyculture
- Proposed sahara forest project
- Push–pull technology
- Rainforest Alliance

- Reconciliation Ecology
- *Renewable Agriculture and Food Systems* (journal)
- Renewable resource
- Sand fence
- Seawater Greenhouse
- Slash-and-burn technique, a component of Shifting cultivation
- Slash-and-char, environmentally responsible alternative to slash-and-burn
- Sustainable Agriculture Innovation Network (between the UK and China)
- Sustainable Commodity Initiative
- Sustainable development
- Sustainable food system
- Sustainable landscaping
- Sustainable Table
- Terra preta
- The Natural Step
- Urban agriculture
- Victory garden
- Wild Farm Alliance
- Wildcrafting
- Windbreak

References

1. Gold, M. (July 2009). What is Sustainable Agriculture? (http://www.nal.usda.gov/afsic/pubs/agnic/susag.shtml). United States Department of Agriculture, Alternative Farming Systems Information Center.
2. Rural Science Graduates Association (2002). "In Memorium - Former Staff and Students of Rural Science at UNE". University of New England. Retrieved 21 October 2012.
3. Wes Jackson, *New Roots for Agriculture*. Foreword by Wendell Berry. University of Nebraska Press. ISBN 0803275625
4. A Brief History of Sustainable Agriculture (http://www.sehn.org/Volume_9-2.html), Frederick Kirschenmann, editor's note by Carolyn Raffensperger and Nancy Myers. The Networker, vol. 9, no. 2, March 2004.
5. Altieri, Miguel A. (1995) *Agroecology: The science of sustainable agriculture*. Westview Press, Boulder, CO.
6. "Scientists discover genetics of nitrogen fixation in plants - potential implications for future agriculture". News.mongabay.com. 2008-03-08. Retrieved 2013-09-10.
7. Proceedings of the National Academy of Sciences of the United States of America, March 25, 2008 vol. 105 no. 12 4928–4932 [1] (http://www.pnas.org/content/105/12/4928.full.pdf+html)
8. "What is Sustainable Agriculture? — ASI". Sarep.ucdavis.edu. Retrieved 2013-09-10.
9. "Indicators for sustainable water resources development". Fao.org. Retrieved 2013-09-10.
10. "CEP Factsheet". Musokotwane Environment Resource Centre for Southern Africa.
11. "Cordell et al, 2009". *Global Environmental Change*. **19**: 292–305. doi:10.1016/j.gloenvcha.2008.10.009. Retrieved 2013-09-10.
12. "FAO World Agriculture towards 2015/2030". Fao.org. Retrieved 2013-09-10.
13. "FAO World Agriculture towards 2015/2030". Fao.org. Retrieved 2013-09-10.
14. "FAO 2011 Energy Smart Food" (PDF). Retrieved 2013-09-10.
15. "Advances in Sustainable Agriculture: Solar-powered Irrigation Systems in Pakistan". McGill University. 2014-02-12. Retrieved 2014-02-12.
16. Netting, Robert McC. (1993) Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture. Stanford Univ. Press, Palo Alto.
17. "Glover et al. 2007. "Scientific American"" (PDF). Retrieved 2013-09-10.
18. Nature 406, 718–722 Genetic diversity and disease control in rice (http://www.nature.com/nature/journal/v406/n6797/abs/406718a0.html), Environ. Entomol. 12:625)
19. Sponsel, Leslie E. (1986) Amazon ecology and adaptation. Annual Review of Anthropology 15: 67–97.
20. Hecht, Susanna and Alexander Cockburn (1989) The Fate of the Forest: developers, destroyers and defenders of the Amazon. New York: Verso.
21. "Pastures: Sustainable Management". Attra.ncat.org. 2013-08-05. Retrieved 2013-09-10.
22. "Soil Solarization". *Rodale's Organic Life*. Retrieved 14 February 2016.

23. http://www.soil.ncsu.edu/publications/Bulletins/Biomass%20Prod%20of%20Cover%20Crops_Mustard%20Radish%20Fact%20Sht_AG-782_Online_Final.pdf
24. "Achieving food security in the face of climate change: Summary for policy makers from the Commission on Sustainable Agriculture and Climate Change" (PDF). CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). November 2011.
25. Kunstler, James Howard (2012). *Too Much Magic; Wishful Thinking, Technology, and the Fate of the Nation*. Atlantic Monthly Press. ISBN 978-0-8021-9438-1.
26. McKibben, D, ed. (2010). *The Post Carbon Reader: Managing the 21st Centery Sustainability Crisis*. Watershed Media. ISBN 978-0-9709500-6-2.
27. Brown, L. R. (2012). *World on the Edge*. Earth Policy Institute. Norton. ISBN 9781136540752.
28. Pasakarnis G, Maliene V (2010). "Towards sustainable rural development in Central and Eastern Europe: applying land consolidation". *Land Use Policy*. **27** (2): 545–9. doi:10.1016/j.landusepol.2009.07.008.

Sources

- Dore, J. 1997. *Sustainability Indicators for Agriculture: Introductory Guide to Regional/National and On-farm Indicators (http://www.rirdc.gov.au/pub/shortreps/sr20.html)*, Rural Industries Research and Development Corporation (http://www.rirdc.gov.au/home.html), Australia.
- Gold, Mary. 1999. *Sustainable Agriculture: Definitions and Terms* (http://www.nal.usda.gov/afsic/AFSIC_pubs/srb9902.htm). Special Reference Briefs Series no. SRB 99-02 Updates SRB 94-5 September 1999. National Agricultural Library, Agricultural Research Service, U.S. Department of Agriculture.
- Hayes, B. 2008. Trial Proposal: Soil Amelioration in the South Australian Riverland.
- Jahn, GC, B. Khiev, C. Pol, N. Chhorn, S. Pheng, and V. Preap. 2001. Developing sustainable pest management for rice in Cambodia. pp. 243–258, In S. Suthipradit, C. Kuntha, S. Lorlowhakarn, and J. Rakngan [eds.] "**Sustainable Agriculture**: Possibility and Direction" Proceedings of the 2nd Asia-Pacific Conference on Sustainable Agriculture 18–20 October 1999, Phitsanulok, Thailand. Bangkok (Thailand): National Science and Technology Development Agency. 386 p.
- Lindsay Falvey (2004) Sustainability – Elusive or Illusion: Wise Environmental Management. Institute for International Development, Adelaide pp259.
- Hecht, Susanna and Alexander Cockburn (1989) The Fate of the Forest: developers, destroyers and defenders of the Amazon. New York: Verso.
- Netting, Robert McC. (1993) Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture. Stanford Univ. Press, Palo Alto.
- Dedicated double issue of *Philosophical Transactions B* on Sustainable Agriculture. Some articles are freely available. (http://publishing.royalsociety.org/sustainable-agriculture)
- Beddington J, Asaduzzaman M, Fernandez A, Clark M, Guillou M, Jahn M, Erda L, Mamo T, Van Bo N, Nobre CA, Scholes R, Sharma R, Wakhungu J. 2011.

Further reading

- Laki, G. (2002): Added value as the basis of sustainable agriculture's subsidy system. In: (Eds. Trebicky, V. – Novak, J.) "Rio+10 Transition from Centrally Planned Economy to Sustainable Society? (Visegrad Agenda 21)", Institute for Environmental Policy, Prague, 2002, 49. p.
- Laki, G., Szakál, F. (2002): Added Value as a key indicator for sustainable agriculture. (http://businessmanagement.hu) In: A mezőgazdasági termelés és erőforrás-hasznosítás ökonómiája – VIII. Nemzetközi Agrárökonómiai Tudományos Napok, SZIE Gazdálkodási és Mezőgazdasági Főiskolai Kar, Gyöngyös, 6 p.

- Szakál, F. (2002): The need for redefining the concept of agriculture and rural areas for sustainable development. (http://blog.tandera.hu/redefining-concept-of-agriculture-and-rural-areas) In: (Eds. Trebicky, V. – Novak, J.) "Rio+10 Transition from Centrally Planned Economy to Sustainable Society? (Visegrad Agenda 21)", Institute for Environmental Policy, Prague, 2002, 51. p.
- Madden, Patrick (March–April 1986). "Debt-Free Farming is Possible". *Farm Economics*. Pennsylvania: Cooperative Extension Service, U.S. Dept. of Agriculture [and] The Pennsylvania State University. ISSN 0555-9456.
- Pender J., Place F., Ehui S. (2006) Strategies for Sustainable Land Management in the East African Highlands (http://www.ifpri.org/pubs/books/oc53.asp)
- Pollan M. (2007) The Omnivore's Dilemma: A Natural History of Four Meals (http://www.michaelpollan.com/omnivore.php) by
- Roberts W. (2008) *The No-Nonsense Guide to World Food* by Roberts W. (2008)

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