

Sustainable Agriculture

1. Concept

Sustainable agriculture refers to farming in a sustainable way to meet the society's present food, feed, fiber, and fuel needs while not compromising the ability of future generations to meet their needs. Sustainable agriculture is an integrated system of plant and animal production practices having a site-specific application that will over the long-term satisfy human food, feed, and fiber needs, protect the environment, enhance the natural resource base upon which the agriculture economy depends, make best use of nonrenewable resources and on-farm resources, sustain the economic viability of farm operations, and improve the quality of life for farmers.



2. Goals of sustainable agriculture



In addition to food, feed and fiber, modern societies also have insatiable demands for energy, water, wood products, and land area for urbanization, infra-structure, and disposal of urban and industrial wastes. Modern agricultural production has generated daunting impacts on the natural environment via deforestation, greenhouse gas emissions, soil health degradation, water and air pollution, and biodiversity declination, jeopardizing the food security and general welfare of future generations. Environmental issues which need to be addressed such as the

climate change, water eutrophication and contamination, land degradation and desertification, and loss of biodiversity. Sustainable agriculture aims to address many serious problems afflicting U.S and the world food production: high energy costs, groundwater contamination, soil erosion, loss of productivity, depletion of fossil resources, low farm incomes, and risks to human health and wildlife habitats.

Sustainable agriculture aims to achieve the following four interlocking goals:

- 1) satisfy human food, feed, fiber, and fuel needs,
- 2) enhance environmental quality and the resources base,
- 3) sustain the economic viability of agriculture, and
- 4) enhance the quality of life for farmers, farm workers, and society as a whole.

Sustainability is officially defined as “meeting the needs of the present without compromising the ability of future generations to meet their own needs.” Sustainable development centers on economic sustainability (the capacity of a system to continuously provide goods and services whose values exceed the cost of production), social sustainability (the capacity of a system to continue to meet society’s expectations for social justice and security), and environmental sustainability (the capacity to manage natural resources and ecosystems to continually support human health and wellbeing), with the three components interlocking with and interdependent on each other. Sustainable agriculture is part of the so-called **sustainable development**. It seeks to sustain resources, farmers, and communities by promoting farming practices and methods that are profitable, environmentally sound, and desirable for the community.

3. Characteristics of sustainable agriculture

Sustainable agriculture is economically viable, ecologically sound, and socially supportive, in simultaneous pursuit of balanced economic profitability, environmental health, and social equity.

Sustainable agriculture integrates cropping systems, local environments, and social contexts in planning and implementation. As there are numerous combinations of cropping systems, local environments, and social contexts, there is no single prescription of sustainable farming practices but many permutations. In a rule of thumb, sustainable farming practices are economically viable, environmentally safe, and socially acceptable. The practices are developed and adopted using an ecological systems approach with full considerations of local landscapes, resources, and culture. It is particularly important to understand and harness the complex interactions within agricultural ecologies in developing and deploying sustainable agriculture practices.

4. Sustainable agriculture systems

Basically, sustainable agricultural production systems are agroecological farming systems, operated with modern equipment, certified seed, soil and water conservation practices and the latest innovations in feeding and handling livestock. Emphasis is placed on rotating crops, cover crop planting, diversifying crops and livestock, adding organic residues, building up healthy soil, and controlling pests naturally. Sustainable agriculture systems have at least two eminent attributes: resource conservative and



relying more on internal ecosystem services than on external inputs. Sustainable agriculture embraces several variants of nonconventional agriculture that are often called organic, alternative, regenerative, ecological or low-input. Low-input sustainable agriculture (LISA), for example, has the particular objectives to reduce reliance on fertilizer, pesticide and other purchased resources to farms; to increase farm profits and agricultural productivity; to conserve energy and natural resources; to reduce soil erosion and the loss of nutrients; and to develop sustainable farming systems.

5. Sustainable agriculture practices

Numerous sustainable agriculture strategies and practices have been identified, including

- 1) crop rotation,
- 2) cover crops,
- 3) conservation tillage,
- 4) rotary grazing,
- 5) integrated pest management,
- 6) soil health management,
- 7) soil nutrient management,
- 8) soil conservation,
- 9) contour farming,
- 10) agroforestry,
- 11) alley cropping,
- 12) silvopasture,
- 13) organic farming,
- 14) precision agriculture,
- 15) farm and food waste management,
- 16) controlled environment agriculture,
- 17) urban agriculture,
- 18) agritourism,
- 19) direct marketing, and
- 20) biologically integrated farming systems.



Policies, regulations, and incentive programs are commonly used as instruments to encourage farmers to adopt sustainable agriculture practices for protecting or enhancing ecosystem services beneficial to the public (e.g., water quality and soil conservation) while simultaneously improving the productivity (e.g., yields and labor) and the competitiveness (e.g., costs and profitability) of the agricultural sector. These may include market-based and non-market incentives, regulatory measures, and cross-compliance incentives.

6. Barriers to sustainable agriculture

Adoption of sustainable agriculture practices by farmers is a continuum that depends on many



geographic, demographic, social, environmental and economic factors, in particular the environmental preferences, personal perspectives, experience and education of farmers, and the conditions of incentive programs. The “reluctance to change” may originate from the technical complexity of certain sustainable practices, incompatibility with other farm management operations,

inaccurate or even conflicting information of sustainable practices received by farmers, implementation costs, inadequate access to resources including funding, inappropriate design and ineffective targeting of incentive programs, and land tenure instability.

Farmers are more likely to adopt the sustainable practices that are specific to their operations (e.g., livestock production or crop farming). Soil and water conservation practices receive generally more attention from farmers and agencies in regions with frequent intense rainfall and wind events. The effectiveness of a particular incentive, and the likelihood of adoption, varies depending on the agricultural practice that one wants to promote and the associated (predicted) outcomes. When incentive programs are necessary to encourage adoption, incentives must be high enough to motivate a change in production practices. Farmers who are more likely to adopt incentive programs are often located in regions in which deforestation risks are lower, have stronger preferences for conservation programs, the opportunity costs from adopting sustainable practices are lower, or the net benefits of adoption are high regardless of the economic incentives. Hence, the incentives might not be the real driver for adopting sustainable practices, and adopters might participate in the program regardless of the incentives. Incentive programs should therefore target vulnerable areas to ensure addition of the program and the most effective use of resources.

Regardless of the incentive type, linking programs to economic benefits (productivity or profitability) is essential for farmers to adopt sustainable agriculture practices in the short term. In the long term, one of the strongest motivations for farmers to adopt and maintain sustainable practices is perceived positive outcomes of adoption for their farm or the environment. If the economic incentives or payment levels do not offset the costs of adoption (cover opportunity costs of changing production techniques or for the most productive land uses), farmers will rarely switch to the desired practices.

7. Sustainable agriculture extension

Agricultural institutions, policies and regulations, social protection, infrastructure and markets, relative prices, off-farm employment opportunities, structural poverty and the scarcity of asset endowments all influence the capacity and willingness of farmers to invest in soil and water



conservation and to adopt sustainable agriculture practices. There is a need to better understand the interrelationships between these influencing factors, incentives, adoption and outcomes. Cooperative extension efforts are necessary to assist farmers with information sharing, capacity building, technical assistance, and training support in adopting stress-tolerant or improved crop varieties, precision agriculture technologies, reduced tillage or no-till farming, rotations with legumes, microbial

inoculants for plant growth promotion, new fertilizer technologies, and other sustainable agriculture practices. The ability of the media to alter audience's perceptions and behavior can be influenced by how it changes the salience of topics (Salience is the prominence of certain aspects of topics). Altering synonyms for "genetic modification" into "genetic engineering" or "agbiotech" can, for example, result in higher perceived benefits and support by readers.

Many factors can enable or constrain adoption of sustainable agriculture practices, but a key overarching aspect is **knowing about the product or practice**, including the benefits and risks. In general, new approaches integrating biological and ecological processes into food production, minimizing the use of non-renewable inputs that cause harm to the environment or to the health of farmers and consumers, making productive use of the knowledge and skills of farmers are needed. To prompt farmers to try sustainable agriculture practices, factsheet descriptions of new practices or technologies in the farming press may help. Most farmers may require additional verification from trusted sources such as farmers they knew and triangulate the information. Farmers, in general, place most trust in the farming advice from other farmers and are more likely to act on advice from farmers than non-farmers. Farmers are primarily influenced by peer farmers or advisors that they know, trust and have a long-term relationship with. Often, the decision to try a new practice is due to numerous factors related to economics, a willingness to try something new, coupled with knowing someone who had already tried it and seen financial success with using it.

Sustainable agriculture serves as the ultimate standard for modern intensified farming. Though education, cultural norms, and access to technology all play a part, social science research reveals that the main barrier for farmers to adopt sustainable agriculture practices is the economic cost. With innovative research, efficient incentive programs, and consistent political will, a sustainable agriculture is achievable.

P.S. Sustainable farming and farm management involves comprehensive agricultural production and business knowledge and skills, such as basic crop and livestock farming practices, climate-smart agriculture and soil health management adoption, natural resource management and planning, financial and business management, diversification and marketing strategies, resources and referrals, farm safety and awareness, food safety and recordkeeping, and entrepreneurship maintenance. The 10-week virtual, synchronous online class ***Sustainable Farming Fundamentals*** (<https://futureharvest.org/sustainable-farming-fundamentals/>) hosted by Future Harvest, Inc. (Cockeysville, MD) covered the following topics:

- Goal setting, and site selection
- Soil health
- Plant pest and disease management
- Farm systems, weed Management and soil preparation
- Crop planning, crop rotation, and transplant production
- Business planning and marketing
- Budgeting and farm financing
- Food safety, post-harvest handling and record keeping
- Livestock
- Land access and new farmer success stories