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Agricultural Systems

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Abstarct: Agriculture is an interdisciplinary field that deals with the behavior of complex agricultural systems. Better results can be obtained by treating the agricultural operation as a system. Research has shown that treating production operations holistically provides greater management flexibility, more environmentally and economically sound practices, and safer and healthier conditions for workers and farm animals. This paper develops a more holistic perspective of how agricultural systems provide benefits to society without increasingly use the scarce natural resources such as land and water.

Key points: agricultural systems, farming systems, food systems, scarce natural resources.

INTRODUCTION

It is difficult to exaggerate the role that agriculture plays in human society. From providing employment for millions of farmers worldwide, agriculture is a fundamental part of almost all societies and economies. In the 21st century, agriculture remains fundamental to economic growth, poverty alleviation, and environmental sustainability. Agriculture has been successful in addressing the food and fiber needs of today's world population. However, sustainability in agriculture has been a major concern. Many consumers are taking greater interest in where their food comes from and how it is grown. Public interests have further constrained farmers by an increasing demand for clean air and water, healthy soils, humane animal treatment, and minimal chemical applications. This makes it difficult for smaller producers of specialty products to succeed [1].

US farmers are under pressure to satisfy multiple, competing demands, such as to produce more crops, pollute less, fulfill consumer preferences, pay fair wages, and make a living. They face the challenge of producing enough food, feed, and fiber to meet increasing demand in conditions of changing climate and scarce natural resources. At the heart of the goal to meet those multiple demands is the idea of sustainability in agriculture. Sustainability may be regarded as progress towards four goals: (1) producing enough to satisfy human needs; (2) enhancing environmental quality and protecting the natural resource base; (3) being profitable; and (4) increasing the quality of life for farmers, farm workers, and society as a whole [2]. Research has led to the development and adoption of many agricultural practices designed to improve various aspects of sustainability. Rural community vitality and prosperity are closely tied to agricultural sustainability. Figure 1 shows various components of agricultural sustainability [3].

AGRICULTURAL SYSTEMS

The term "agricultural system" refers broadly to any system that produces livestock and crops (food, feed, fiber and/or energy). The term "system" is often used to help describe broader considerations related to transportation, water, sewage, and electricity for example. Figure 2 shows the illustration of a system [4]. An agricultural system is an assemblage of components which are united by some form of interaction and which operate to achieve a specified agricultural objective.

Agricultural systems have been described in many ways over the years. It has be described as farming system, cropping system, organic production system, ecologically based system, food system, conservation system, corn–soybean system, and vegetable or hog production system. Agricultural systems are open, meaning that energy, nutrients, organisms and information constantly cross system boundaries [5]. Farming system is a resource management strategy to achieve economic and sustained agricultural production to meet diverse requirements of farm livelihood while preserving resource base and maintaining a high level of environment quality. Figure 3 illustrates the components of a farming system [4], while Figure 4 shows the classification of farming system [6].

Like other systems, agricultural systems may be categorized as [7]:

- *Purposeful* or *non-purposeful* depending on whether or not they can select goals and the means by which to achieve them.
- *Static* or *dynamic* depending on whether or not they change over time in response to internal or external influences.
- *Open* or *closed* depending on whether or not they interact with their environment.
- *Abstract* or *concrete* depending on whether or not they are conceptual or physical in nature.
- *Deterministic* or *stochastic* depending on whether or not their behavior exhibits randomness over time, i.e., their future behavior is uncertain.

At its most basic level, a relationship exists between farmers and the land. Farmers use the earth's resources to plant and harvest crops, which are also used to feed people and livestock. At its most complex level, a web of relationships exists between farmers, natural systems such as climate, geology, soil, air, pests, and water; and human systems involving politics, land-use planning and infrastructure, law, finances, and marketing [8].

There are six elements of the agricultural system [8]:

1. *Farms:* Farms of various sizes produce a range of crops, livestock and other goods and services.
2. *Natural Environment:* Including climate, soil types, and water access, these and other natural inputs impact agricultural viability but are also impacted by farming activity.
3. *Government*: Services and programs, policy directives, and regulations from all levels of government impact production.
4. *Agribusiness:* Includes the range of wholesale or retail companies who buy, process, package, store and/or distribute goods or services to or from farms.
5. *Technical and Professional Expertise:* Farms depend upon labor and the services of various technical and professional people, including accountants, bankers, lawyers, IT service providers, crop advisors, electricians, carpenters, plumbers, etc.
6. *Non-Profit and Community Sector:* This includes research and innovation institutes, farm associations, advocacy organizations, and community groups. It also includes a broad range of organizations involved in research, innovation, and knowledge transfer.

BENEFITS

There are increasing concerns about the economic, environmental, and social costs of agriculture. Integrated agricultural systems may provide a means to address these concerns while increasing sustainability. The complexity of today's agriculture compels farmers to consider making decisions that meet multiple objectives. Farmers must also consider the social ramifications of their decisions, not only for their own economic well-being but also on society as a whole [10]. A more thoughtful and holistic discussion and understanding of the agricultural system can contribute to improved policy and practices that help to strengthen agriculture. A new global framework for the sustainable development of agriculture systems is essential to increase food availability and utilization, improve human health, create more prosperous rural communities, and rejuvenate the environment. One significant element is shifting toward healthier diets and reducing food waste and loss. While agricultural production depends on the quality of natural inputs, farms also provide numerous environmental benefits; the natural heritage system and agricultural system rely on each other in several ways [10].

CHALLENGES

One-third of Earth's land is devoted to agriculture, more than any other industry. Yet the agricultural sector struggles to keep up with a growing global population. Estimates are that we will need to increase food production by 60-70% by 2050. Agriculture must reduce the pressure placed on the environment, including land degradation, water depletion, pollution, unbalanced nutrient cycles, greenhouse gas emissions, and threats to bio-diversity. Maximizing agriculture's potential to reduce rural poverty is another challenge, particularly in South Asia and Sub-Saharan Africa. Female smallholder farmers face barriers to success, despite the fact that they comprise half of smallholder farmers in East and Southeast Asia and Sub-Saharan Africa. Empowering and encouraging women is not an opportunity we can afford to miss.

In rich and poor nations, consumption of processed foods is rising, with negative impacts on both health and resource use. Dietary behaviors need to change to be healthier and more sustainable. As much as one-third of all food grown may be lost or wasted from farm to fork. Investments in rural infrastructure, especially roads, electricity, and telecommunications are essential to increase access to markets, reduce food loss, and improve storage and handling. Good governance is key to ensuring fair access to resources, markets, and new technologies. Addressing these challenges requires Sustainable Intensification of Agriculture (SIA) around the world. SIA aims to reduce the environmental footprint of agriculture while meeting all its other social and economic goals. It requires tailored strategies and transformation changes in all nations [9]. The transformative approach seeks to design agricultural systems that balance the four goals of sustainability from the outset. The agricultural land base is a precious resource and prized possession that cannot be moved; it is finite in size and the location is fixed.

CONCLUSION

Agricultural activity has evolved over the years from being a simple production activity to a multi-functional sector. Agriculture is an information-intensive industry where there is a continual need for updated information about the agricultural inputs, market information, and logistics. Farmers need updated and accurate information to make informed decisions that can enhance their agricultural productivity.

The concept of an agriculture system is an important component of land use planning. It is in direct contrast to the treatment of natural heritage. The agricultural system is connected to numerous other systems, such as natural systems and human systems. Ensuring a strong agriculture system is important for ensuring a healthy source of local food and strong rural economies. Agricultural information systems can help in disseminating information to farmers to enable them make better decisions and leverage market opportunities. More information about agricultural systems can be found in the books in [11-30] and the following related journals:

- ✓ *Agricultural Systems*

✓ *Renewable Agriculture and Food Systems*

REFERENCES

1. "Agricultural systems,"

   https://www.nifa.usda.gov/topics/agricultural-systems

2. "Toward sustainable agricultural systems in the 21st century,"

   https://nap.nationalacademies.org/resource/12832/Systems-Ag-Report-Brief.pdf

3. https://images.search.yahoo.com/yhs/search?p=images+of+agricultural+systems&fr=yhs-fc-3211&type=fc_A519E8A3231_s69_g_e_d_n200001_c999&hspart=fc&hsimp=yhs-3211&imgurl=https%3A%2F%2Fwww.bosch.co.uk%2Fmedia%2Fnews%2Fnews_1%2Fnevonex_keyvisual_web.jpg#id=66&iurl=https%3A%2F%2Fwww.mdpi.com%2Fsustainability%2Fsustainability-11-05120%2Farticle_deploy%2Fhtml%2Fimages%2Fsustainability-11-05120-g001.png&action=click

4. M. R. Shaikh, "Farming system," 2017

   https://www.researchgate.net/publication/340429050_Farming_Systems

5. L. E. Drinkwater, D. Friedman, and L. Buck, "Understanding agricultural systems," 2016,

   https://www.sare.org/publications/systems-research-for-agriculture/chapter-one-introduction-to-agricultural-systems-and-agricultural-systems-research-a-paradigm-change/understanding-agricultural-systems/

6. https://images.search.yahoo.com/yhs/search;_ylt=AwrFEq0dJgxmmkQYQFMPxQt.;_ylu=Y29sbwNiZjEEcG9zAzEEdnRpZAMEc2VjA3Nj?p=images+of+agricultural+systems&type=fc_A519E8A3231_s69_g_e_d_n200001_c999&param1=7&param2=eJwtS9EOhCAM%2B5U9amJ0KKDip1x8QEAlohj14uW%2B%2FmZyW7K2azt5%2B%2Br6wzJE3pb4yvqNdIk0jMRjEhiCtm2J%2Bf2xJaJiNR3HB6uoi6q0o1aNMVwJ2whVoxQUn1yk%2FPsk%2BtbE1vj1IehC5AjJ7Tcb7xO2Cxjm2AE9JO%2FgI3kKet%2BDu92w%2BKsQVZ1XEpJlvtaQQfCLg8mZJaZg5iOurmBlleOzcOpRH%2F5f%2BQFTl0GR&hsimp=yhs-3211&hspart=fc&ei=UTF-8&fr=yhs-fc-3211#id=2&iurl=https%3A%2F%2Fwww.jliedu.com%2Fblog%2Fwp-content%2Fuploads%2F2019%2F02%2FTypes-of-crop-production-system-830x445.png&action=click

7. "Agricultural and farm systems - Concepts and definitions,"

   https://www.fao.org/3/w7365e/w7365e04.htm

8. [8] W. Caldwell, "The agricultural system: Components, linkages, and rationale," June 2015,

   https://www.greenbelt.ca/agricultural_system_report_2015

9. "Transformative changes of agriculture and food systems,"

   https://sustainabledevelopment.un.org/content/documents/6484106-Transformative%20changes%20of%20agriculture%20and%20food%20systems.pdf

10. J. R. Hendrickson et al., "Principles of integrated agricultural systems: Introduction to processes and definition," *Renewable Agriculture and Food Systems,* vol. 23, no. 4,June 2008, pp. 265–271.

11. D. B. Grigg, *The Agricultural Systems of the World: An Evolutionary Approach.* Cambridge University Press, 1974.

12. L. E. Drinkwater, *System Research For Agriculture: Innovative Solutions to Complex Challenges.* Sustainable Agriculture Research and Education (SARE), 2016.

13. D. J. Connor, R. S. Loomis, and K. G. Cassman, *Crop Ecology: Productivity and Management in Agricultural Systems*. Cambridge University Press, 2nd edition, 2011.

14. The World Bank, *Agricultural Innovation Systems: An Investment Sourcebook.* Washington, DC: The World Bank, 2012.
15. C. Spedding, *An introduction to Agricultural Systems*. Springer Science & Business Media, 2012.
16. C. A. Edwards, *Sustainable Agricultural Systems*. CRC Press, 2020.
17. National Research Council et al., *Toward Sustainable Agricultural Systems in the 21st Century*. National Academies Press, 2010.
18. S. Fillinger and Y. Elad (eds.), *Botrytis-the Fungus, the Pathogen and Its Management in Agricultural Systems*. Cham, Switzerland: Springer International Publishing, 2016.
19. E. Westphal and J. M. C. Stevels, *Agricultural Systems in Ethiopia*. Wageningen: Centre for Agricultural Publishing and Documentation, 1975.
20. T. P. Bayliss-Smith, *The Ecology of Agricultural Systems*. 1982.
21. C. R. W. Spedding, *The Biology of Agricultural Systems*. 1975.
22. J. L. Hatfield and D. L. Karlen, *Sustainable Agriculture Systems*. Boca Raton, FL: CRC Press, 1993.
23. D. J. Molden et al., *Indicators for Comparing Performance of Irrigated Agricultural Systems*. Iwmi, 1998.
24. B. D. Booth, S. D. Murphy, and C. J. Swanton. *Weed Ecology in Natural And Agricultural Systems*. 2003.
25. L. E. Buck, J. P. Lassoie, and E. C. M. Fernandes (eds.), *Agroforestry in Sustainable Agricultural Systems*. Boca Raton, FL: CRC Press, 1998.
26. J. L. Hatfield, J. M. Baker, and M. K. Viney, *Micrometeorology in Agricultural Systems*. 2005.
27. M. Farooq and K. H. M. Siddique, *Conservation Agriculture: Concepts, Brief History, and Impacts On Agricultural Systems*. Springer International Publishing, 2015.
28. J. N. Pretty, S. Williams, and C. Toulmin, *Sustainable Intensification: Increasing Productivity in African Food and Agricultural Systems*. Routledge, 2012.
29. M. J. Swift and P. Woomer, *Organic Matter and the Sustainability of Agricultural Systems: Definition and Measurement*. 1993.
30. G. C. Rausser and E. Hochman, *Dynamic Agricultural Systems: Economic Prediction and Control*. 1981.

Figure 1. Various components of agricultural sustainability [3].

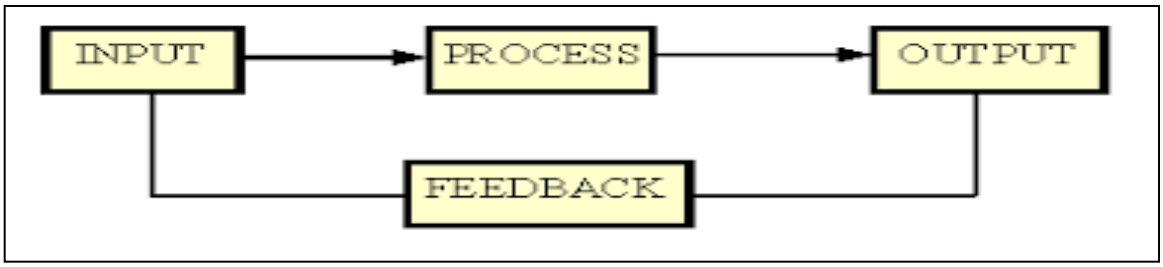

Figure 2. General illustration of a system [4].

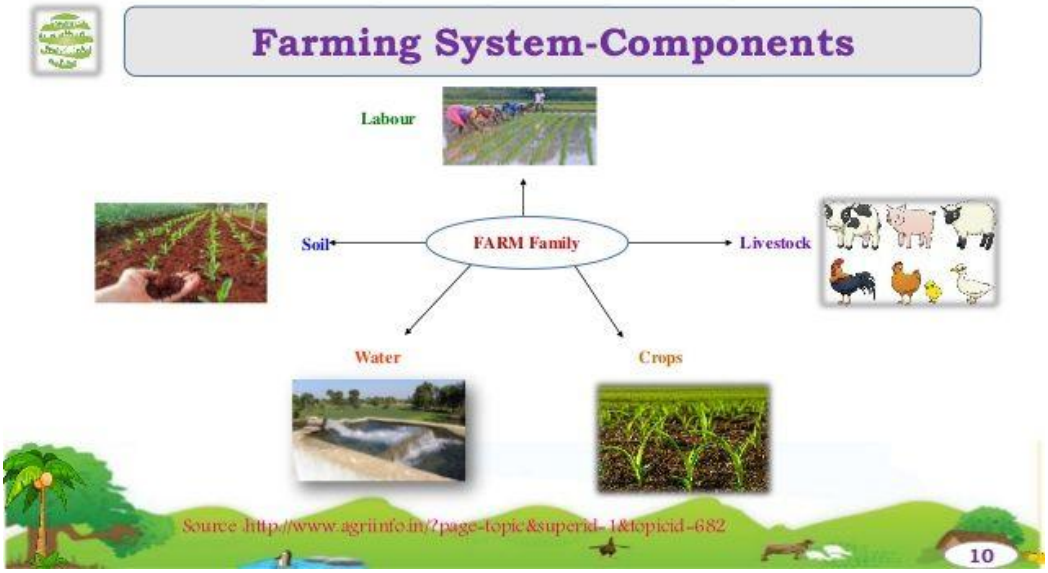

Figure 3. The components of a farming system [4].

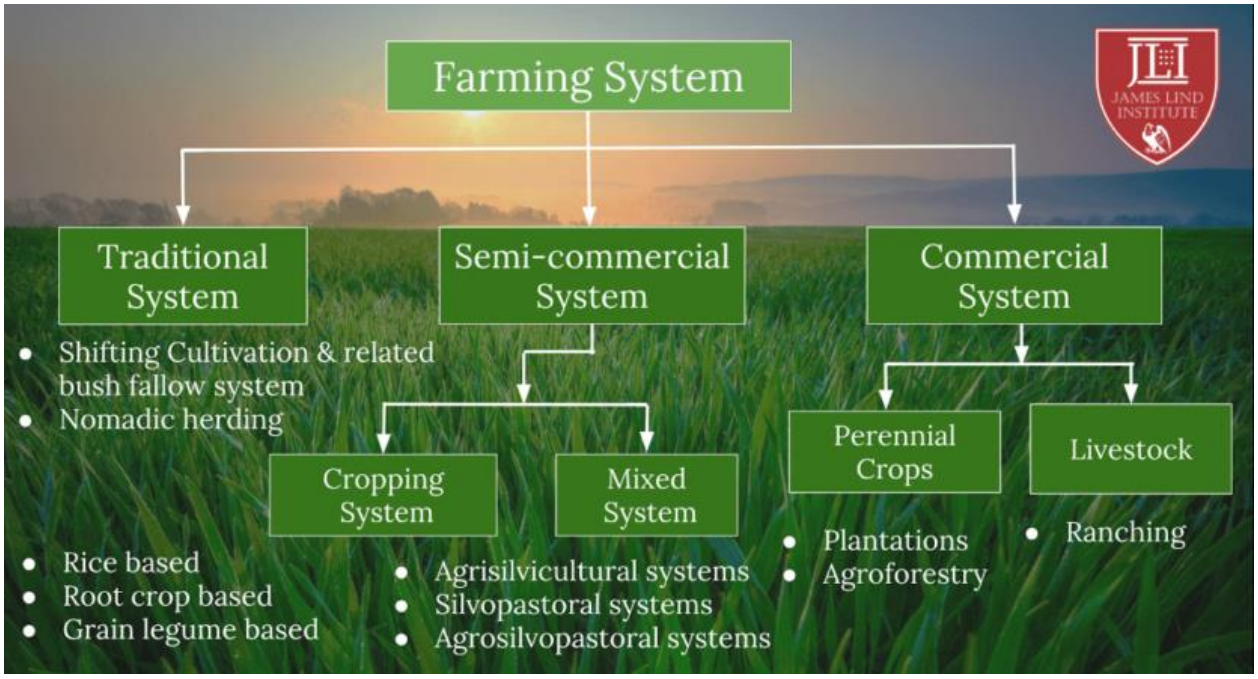

Figure 4. Classification of farming system [6].

Figures p. 38*(agric cycle)