Role of Stakeholder Inputs for Sustainable Farming and Agricultural Ecology

Yara Amr Hossam Eldin Ibrahim, Department of Environmental Science, Minia University, Minya, Egypt

Abstract

Agricultural sustainability pivots on the collaboration of key stakeholders working together to advance scientific research and innovative competitiveness. Economic pressures from technology developers, worldwide political tensions, changing regulations, and evolving customer needs are critical to shaping the vision of agriculture. This review examines the agricultural ecosystem and infrastructure to build a thriving agricultural economy. It underscores the need to swiftly adapt strategies to local challenges and to empower underdeveloped communities. Academic researchers are crucial in generating science, providing learning outcomes to students, and developing the next-gen workforce. Additionally, socio-economic factors, global warming, and geopolitical conditions are essential in designing the system needed for future generations. The article highlights the need to understand and value different perspectives and research strategies to the sustainability goals in agriculture and ecology.

Introduction

Farmers must regularly learn to observe and adapt to situations in agriculture. Concurrently, investment in infrastructure for agricultural research is essential to achieve sustainability [1-7]. This review article discusses the existing methods and viewpoints of stakeholders in agriculture, including agribusinesses. It discusses potential benefits, costs, and government regulations to promote agriculture [3-9]. Research in this field relies on the close interactions of stakeholders and their priorities. These stakeholders constantly adapt to meet the changing goals of sustainable agriculture. Academics play a crucial role by generating relevant knowhow and skills, thereby influencing the stakeholders [1-5].

Key Stakeholder Inputs in Sustainable Agriculture

In the field of agroecology, active involvement of stakeholders is key who interact closely on priority topics and strike collaborations to reach the common goals [8-14]. It is crucial to understand the views of underdeveloped communities in the society, including rural farmers, small farm owners, and others in the food chain. Inclusion in diversity within communities in agriculture is vital to impact all sectors of the society. Such diversity is also seen in agricultural farms where there is an emphasis on planting cover crops and diverse crops using crop rotations that serve to naturally provide resistance to plant diseases and global climate warming [4-11]. Additionally, it is important to recognize, evaluate, and use natural resources such as natural pollinators, natural pesticides, and chemical-free use of fertilizers in the farms [8-16]. Agroecology researchers should develop robust models that involve and characterize the interplay between different stakeholders and the natural players of the environment. Efforts should be made to provide reasonable support for underdeveloped groups, ensuring easier access to skillsets and infrastructure for sustainable benefits in crop productivity and disease resistance [10-20].

Academic Research in Sustainable Agriculture

Regular inputs from researchers and start-up companies provide a good model to drive innovation in agriculture [3-12]. Social scientists are needed to model the interrelationships between different stakeholders, social pressures, economic pressures, and consumer expectations in a comprehensive model to provide a better understanding of the changing landscape of agriculture at local and regional levels. Urbanization and upliftment of rural communities also provide incentives for

farmers to adopt bets practices that cater to the local customer demands while receiving sufficient returns on investment from their farms. As the world population grows, there is increasing crunch of space and farmlands which further promotes backyard farming and greenhouse farming and generates substantial interest from urban households.

There are a number of regional sectors in the world that rely on sustainable agriculture as their means of livelihood and survival for many generations [11-22]. New technologies, if cost-effective, can provide the resources and support needed for these communities to upskill their farm practices and catch up with the globalization in agriculture. It is important to understand the needs of these rural communities, value their ethics and best practices, and provide technological support to better their productivity while not underscoring their real-world knowledge. Research and innovation needs to be tuned to the requirements of all scales of farming while providing added value to their existing infrastructure. It is through mutual respect and recognition of talent that we can achieve the goals of sustainable farming.

Recognizing the Role of Agricultural Innovation

Innovation is often misconstrued with academic research, and is thus typically measured by scientific or technical outputs [6-13]. However, the innovation system frameworks emphasize that innovation goes beyond research in science and technology; rather it involves applying diverse forms of knowledge to achieve desired socio-economic outcomes. This learning and knowledge may come from learning, research, or experience, but it qualifies as innovation only when put into practice. The processes of learning and knowledge acquisition are inter-dependent and often require an understanding of various knowledge sources. Academic universities play a pivotal role in shaping the processes and framework driving innovation, their interactions, learning, and knowledge dissemination.

The agricultural policies also significantly influence human behavior in farmers and small households [22-27]. An innovation environment conducive to fostering innovation may not result from a single policy change but rather from a set of policies that slowly shape innovative behavior in farming. Established habits and practices in farming may interact with these policies, so effective policy design must consider the farming habits and practices of the affected stakeholders. An example framework emphasizes involving stakeholders and ensuring organizational and policy responsiveness to stakeholder agendas and demands. Innovation focus and direction are shaped by stakeholder demand, which extends beyond market forces to include non-market drivers, such as collaborative relationships between knowledge users and producers. Policy interventions, such as offering incentives for adopting specific technologies or management practices, can stimulate demand for certain types of innovation, especially when key stakeholders lack social and economic influence or when addressing adverse environmental impacts of development is crucial [27-32].

The habits and practices essential for innovation are acquired behaviors that may change gradually or abruptly. These are often institutionalized through innovative practices like farmer field schools or participatory plant breeding, arising from scientists' experimentation and learning. Such novel approaches to research and development often require forging new partnerships and adopting fresh methodologies. Successful innovation systems tend to form new partnerships and alliances when confronted with external disruptions [22-31]. Governing stakeholders and academic researchers must introduce effective policies and institutions, that acknowledge the dynamic interplay of critical factors in networked analysis in the farming communities. This entails adopting a broader perspective of innovation-related policies and harmonizing various policy domains. Concentrating solely on research policy as the primary driver of innovation is no longer sufficient; instead, policy frameworks must encompass the incentives, triggers, and support structures necessary to

foster and sustain creativity. Moreover, achieving policy imperatives relies greatly on the entrenched habits, practices, and institutions geared towards long-term objectives [30-36].

The holistic, multifaceted knowledge essential for sustainable, equitable development can be generated by partnerships and collaborations [30-39]. Therefore, the logical response is to forge new alliances through linkage, networking, and consortium building. It is imperative that agricultural organizations possess the skills and incentives to embrace this collaborative strategy. Additionally, research institutions must extend their role beyond mere research to act as brokers, bridges, and catalysts within the broader innovation ecosystem. The capacity for innovation should be conceptualized not solely in terms of scientific and technological resources but also in terms of policies and practices that foster learning and innovation within stakeholders. While agricultural institutions retain significance, they need better partnerships. Furthermore, policies and practices must be instituted to enhance the adaptability and flexibility of innovation systems in farming. Adopting a partnership-oriented approach to fostering innovation requires cultivating working practices and institutions that nurture trust and cooperation among individuals and organizations in pursuit of shared objectives—essentially, social capital [39-43]. This can be achieved by designing policies and programs that enhance interaction levels among key stakeholder groups in agriculture.

Evaluation and Assessment of Activities and Sustainability Goals

It is important to regularly evaluate and improvise the sustainability goals and activities in agriculture [22-36]. Re-evaluation of current practices is a better way to keep pace with the changing pressures of climate change and consumer demands. Academic researchers must be provided incentives to conduct cutting-edge research in new technologies that target difficult problems related to real-world farms. Academics provide a number of extension activities to reach out to farmers to showcase their technologies and understand the real farm problems that need assessment and improvement. It is also important to cultivate a culture of inclusion that brings in farmers and other stakeholders on a common platform for interactive discussions [30-38].

Nevertheless, real-world farm challenges exist in providing sustainable outcomes, underscoring the need for guidance for decision-makers. There are different set of needs of small-scale farmers compared to medium- or large-scale farmers. This adds a realistic tradeoff in technology development as the needs of different farms may be different. Local and regional policy changes have proven to positively influence farmers to adopt new and existing technologies which needs to be further promoted for sustainability. There is a need to understand the local farm preferences and adapt any policy to cater to the greater good of the local producers while also promoting the local economy and global trade.

Conclusion

Reaching the goals of sustainable agriculture requires tradeoffs that need to be understood and modelled appropriately. Innovation and academic research has the potential to push next generation resources to create new companies and generate new technological impacts. Agriculture is an old profession that requires constant input from several groups of stakeholders, including governing bodies at local, regional, and country level. The governing policies need to be developed keeping in mind the minority and underdeveloped communities who have limited access to knowledge, skillsets, and support to thrive in the global economy. These policies and methods need to evolve with changing climate and changing consumer demands, while providing adequate incentives for farm owners and producers. Lastly, there should be an emphasis on diversity, inclusion, and equity of resources for marginalized communities because there is a significant gap between the developed and underdeveloped countries within the field of agriculture.

References:

[1]. Ashley, C. and Maxwell, S. 2001. Rethinking rural development. Development Policy Review 19(4): 395–425.

[2]. Biggs, S.D. 1990. A multiple sources of innovation model of agricultural research and technology promotion. World Development 18(11): 1481–1499.

[3]. Niblack TL, Arelli PR, Noel GR, Opperman CH, Orf JH, Schmitt DP, Shannon JG, Tylka GL. A Revised Classification Scheme for Genetically Diverse Populations of Heterodera glycines. J Nematol. 34(4):279-88, 2002.

[4]. J. Saldanha, A. Parashar, J. Powell-Coffman, Multi-parameter behavioral analyses provide insights to mechanisms of cyanide resistance in Caenorhabditis elegans, Toxicological Sciences 135(1):156-68, 2013.

[5]. Guzmán, G. I., and A. M. Alonso. 2008. A comparison of energy use in conventional and organic olive oil production in Spain. Agricultural Systems 98(3): 167–176.

[6]. Byerlee, D. and Alex, G.E. 1998. Strengthening National Agricultural Research Systems: Policy Issues and Good Practice. Washington DC, USA: World Bank.

[7]. Chambers, R. 1983. Rural Development: Putting the Last First. London, UK: Longman Scientific.

[8]. A. Joseph, R. Lycke, Decision-making by nematodes in complex microfluidic mazes, Advances in Bioscience and Biotechnology. 2(6) (2011) 409-415.

[9]. Akwete Bortei-Doku, Marvin H. White, Simulation of biological ion channels with technology computer-aided design. Computer Methods and Programs in Biomedicine, 85, 1 (2007) 1-7.

[10]. Kloppenburg, J. 1991. Social theory and the reconstruction of agricultural science: local knowledge for an alternative agriculture. Rural Sociology 56: 519–548.

[11]. A. Parashar, Plant-in-chip: Microfluidic system for studying root growth and pathogenic interactions in Arabidopsis, Applied Physics Letters, 98, 263703 (2011).

[12]. Francis, C., G. Lieblein, S. Gliessman, T. A. Breland, N. Creamer, R. Harwood, L. Salomonsson, J. Helenius, et al. 2003. Agroecology: The ecology of food systems. Journal of Sustainable Agriculture 22(3): 99–118.

[13]. J. Saldanha, A. Parashar, J. Powell-Coffman, “Multi-parameter behavioral analyses provide insights to mechanisms of cyanide resistance in Caenorhabditis elegans”, Toxicological Sciences 135(1):156-68. (2013).

[14]. Beeman, Z. Njus, G. L. Tylka, “Chip Technologies for Screening Chemical and Biological Agents against Plant-Parasitic Nematodes”, Phytopathology, 106 (12), 1563-1571 (2016).

[15]. Parashar A, Lycke R, Carr JA. Amplitude-modulated sinusoidal

microchannels for observing adaptability in C. elegans locomotion. Biomicrofluidics. 5(2):24112, 2011.

[16]. T. Kong, S. Flanigan, M. Weinstein, U. Kalwa, C. Legner, "A fast, reconfigurable flow switch for paper microfluidics based on selective wetting of folded paper actuator strips", Lab on a Chip, 17 (21), 3621-3633, 2017.

[17]. J. Saldanha, J. Powell-Coffman. The effects of short-term hypergravity on Caenorhabditis elegans. Life Science Space Research, 10:38-46, 2016.

[18]. J.P. Jensen, A.Q. Beeman, Z.L. Njus et al. Movement and Motion of Soybean Cyst Nematode Heterodera glycines Populations and Individuals in Response to Abamectin. Phytopathology. 108(7):885-891, 2018.

[19]. Wezel, A., S. Bellon, T. Dore, C. Francis, D. Vallod, and C. David. 2009. Agroecology as a science, a movement and a practice. A review. Agronomy for Sustainable Development 29: 503–515.

[20]. S. Pandey, Marvin H White, Parameter-extraction of a two-compartment model for whole-cell data analysis, Journal of Neuroscience Methods, 120(2), 131-143, 2002.

[21]. Niblack TL, Lambert KN, Tylka GL. A model plant pathogen from the kingdom Animalia: Heterodera glycines, the soybean cyst nematode. Annu Rev Phytopathol. 2006;44:283-303.

[22]. R. Lycke, A. Parashar, Microfluidics-enabled method to identify modes of Caenorhabditis elegans paralysis in four anthelmintics. Biomicrofluidics. 7(6), 64103, 2013.

[23]. Carr JA, Parashar A, Gibson R, Robertson AP, Martin RJ, Pandey S. A microfluidic platform for high-sensitivity, real-time drug screening on C. elegans and parasitic nematodes. Lab Chip. 11(14):2385-96, 2011.

[24]. Cuéllar-Padilla, M., and Á. Calle-Collado. 2011. Can we find solutions with people? Participatory action research with small organic producers in Andalusia. Journal of Rural Studies 27: 372–383.

[25]. X. Ding, Z. Njus, T. Kong, et al. Effective drug combination for Caenorhabditis elegans nematodes discovered by output-driven feedback system control technique. Science Advances. 2017, eaao1254.

[26]. S. Pandey, Marvin H White, Parameter-extraction of a two-compartment model for whole-cell data analysis, Journal of Neuroscience Methods, 120(2), 131-143, 2002.

[27]. R. Lycke, A. Parashar, Microfluidics-enabled method to identify modes of Caenorhabditis elegans paralysis in four anthelmintics. Biomicrofluidics. 2013, 7(6), 64103.

[28]. Tomich, T. P., S. Brodt, H. Ferris, R. Galt, W. R. Horwath, E. Kebreab, J. H. J. Leveau, D. Liptzin, et al. 2011. Agroecology: A Review from a global change perspective. Annual Review of Environment and Resources 36: 193–222.

[29]. J.P. Jensen, U. Kalwa, G.L. Tylka, Avicta and Clariva Affect the Biology of the Soybean Cyst Nematode, Heterodera glycines. Plant Dis. 2018 Dec;102(12):2480-2486.

[30]. Hall, A.J., Sivamohan, M.V.K., Clark, N.G., Taylor, S. and Bockett, G. 2001. Why research partnerships really matter: innovation theory, institutional arrangements and implications for developing new technology for the poor. World Development 29(5): 783–797.

[31]. Santosh Pandey, Upender Kalwa, Taejoon Kong, Baoqing Guo, Phillip C. Gauger, David Peters, Kyoung-Jin Yoon, "Behavioral Monitoring Tool for Pig Farmers: Ear Tag Sensors, Machine Intelligence, and Technology Adoption Roadmap", Animals, Vol. 11, Issue 9, pages 2665, 2021.

[32]. S. Pandey, Analytical modeling of the ion number fluctuations in biological ion channels, Journal of nanoscience and nanotechnology, 12(3) (2012), 2489-2495.

[33]. Wezel, A., and V. Soldat. 2009. A quantitative and qualitative historical analysis of the scientific discipline of agroecology. International Journal of Agricultural Sustainability 7: 3–18.

[34]. Z. Njus, D. Feldmann, R. Brien, T. Kong, U. Kalwa, "Characterizing the Effect of Static Magnetic Fields on C. elegans Using Microfluidics", Advances in Bioscience and Biotechnology, Vol. 6, No. 9, pp. 583-591, 2015.

[35]. J. Carr, R. Lycke, A. Parashar, Unidirectional, electrotactic-response valve for Caenorhabditis elegans in microfluidic devices. Applied Physics Letters, 98, 143701, 2011.

[36]. J. Saldanha, A. Parashar, J. Powell-Coffman, Multi-parameter behavioral analyses provide insights to mechanisms of cyanide resistance in Caenorhabditis elegans, Toxicological Sciences 135(1):156-68, 2013.

[37]. J. Saldanha, J. Powell-Coffman. The effects of short-term hypergravity on Caenorhabditis elegans. Life Science Space Research. (2016) 10:38-46.

[38]. Hall, A.J., Sulaiman, R.V., Clark, N.G. and Yoganand, B. 2003. From measuring impact to learning institutional lessons: An innovation systems perspective on improving the management of international agricultural research. Agricultural Systems 78: 213–241.

[39]. Njus Z, Kong T, Kalwa U, et al. Flexible and disposable paper- and plastic-based gel micropads for nematode handling, imaging, and chemical testing. APL Bioengineering. 2017 Dec;1(1):016102.

[40]. Hall, A.J., Sulaiman, R.V., Clark, N.G., Sivamohan, M.V.K. and Yoganand, B. 2000. New agendas for agricultural research in developing countries: policy analysis and institutional implications. Knowledge, Technology and Policy 13(1): 73–91.

[41]. Mytelka, L.K. 2000. Local systems of innovation in a globalized world economy. Industry and Innovation 77(1): 15–32.

[42]. J.P. Jensen, A.Q. Beeman, Z.L. Njus et al. Movement and Motion of Soybean Cyst Nematode Heterodera glycines Populations and Individuals in Response to Abamectin. Phytopathology. 2018 Jul;108(7):885-891.

[43]. Whitmer, A., L. Ogden, J. Lawton, P. Sturner, P. M. Groffman, L. Schneider, D. Hart, B. Halpern, et al. 2010. The engaged university: providing a platform for research that transforms society. Frontiers in Ecology and the Environment 8: 314–321.