Sustainable Agriculture Research; Vol. 4, No. 3; 2015
ISSN 1927-050X E-ISSN 1927-0518
Published by Canadian Center of Science and Education

Innovations in Organic Food Systems for Sustainable Production and Ecosystem Services: An Introduction to the Special Issue of *Sustainable Agriculture Research*

Ellen B. Mallory[1], Niels Halberg[2], Lise Andreasen[2], Kathleen Delate[3] & Mathieu Ngouajio[4]

[1] School of Food and Agriculture, University of Maine, Orono, Maine, USA

[2] International Centre for Research in Organic Food Systems, Tjele, Denmark

[3] Departments of Agronomy and Horticulture, Iowa State University, Ames, Iowa, USA

[4] United Stated Department of Agriculture, National Institute of Food and Agriculture, Washington DC, USA

Received: June 16, 2015 Accepted: June 18, 2015 Online Published: June 20, 2015

doi:10.5539/sar.v4n3p1 URL: http://dx.doi.org/10.5539/sar.v4n3p1

Organic agriculture is one of the best developed multifunctional production strategies in agriculture, and yet is not widely understood in terms of its full potential for contributing to food security, economic development, and environmental health. This special edition of the journal Sustainable Agriculture Research explores the knowledge, innovations, potentials, and research needs that will strengthen the links between organic food systems, sustainable production, and enhanced ecosystem services. The following articles are from an international conference titled "Innovations in Organic Food Systems for Sustainable Production and Ecosystem Services," held on 1-2 November 2014 in Long Beach, California. The conference was co-sponsored by the Organisation for Economic Co-operation and Development (OECD) Co-operative Research Programme on Biological Resource Management for Sustainable Agricultural Systems, the International Centre for Research in Organic Food Systems (ICROFS), the United Stated Department of Agriculture, National Institute of Food and Agriculture (USDA-NIFA), and the American Society of Agronomy (ASA).

The articles presented here provide concrete evidence of the capacity of organic agriculture to meet a diverse set of societal goals. The framework of ecosystem services as it relates to agriculture and the environment has emerged in recent years in scientific literature and international discussions, such as the *Millennium Ecosystem Assessment* (2005) and the *International Assessment of Agricultural Knowledge, Science and Technology for Development* (McIntyre et al., 2009). Organic agriculture has embodied this concept from its inception. As defined by the International Federation of Organic Agriculture Movements (IFOAM), "Organic agriculture is a production system that sustains the health of soils, ecosystems, and people." The multifunctionality of organic agriculture is well illustrated in this issue with examples related to enhancing soil quality and farm profitability (Delate et al., 2015), reducing nitrate leaching and increasing nitrogen use efficiency (Cambardella et al., 2015), increasing phosphorus use efficiency (Lynch, 2015), enhancing food quality (Heckman, 2015), and improving food security for smallholder farmers (Halberg et al., 2015).

The papers in this issue are presented in the context of recent calls for 'ecological intensification' as a new pathway for sustainable agriculture to achieve global food security (FAO, 2011; UNCTAD, 2013). As outlined by Niggli et al. (2008), eco-functional intensification of organic agriculture involves improving our knowledge and application of biological principles and agro-ecological methods to optimize system processes and increase synergies among system components, with the aim of enhancing the health, productivity, and resilience of the agro-ecosystem, food system, and environment. Jensen et al. (2015) illustrate the synergistic effects of enhancing spatial crop diversity through intercropping grains and legumes. Hokkanen et al. (2015) provide an example of optimizing system processes by using crop pollinators to precision deliver biocontrol agents in small fruits. Lynch (2015) describes how organic pasture systems enhance phosphorus cycling such that forage yields are equivalent to conventionally managed pastures despite significantly lower soil test phosphorus levels. Heckman (2015) and Vaarst (2015), in separate papers, discuss the importance of integrating livestock, trees, and pasture for eco-functional intensification of organic agriculture.

The complexity of agro-ecological systems and the input restrictions imposed for organic certification have fostered a unique culture of farmer experimentation, innovation, and collaboration that has and will continue to

be a key driver of advancements in organic agriculture. Vogl et al. (2015) argue that while farmer experimentation is intrinsic to all agricultural endeavors, it is uniquely important in organic systems because adapting organic practices to specific sites is inherently knowledge intensive. The author calls for explicit efforts to create environments that encourage creativity, open communication, and reflection on both the experimental process as well as outcomes. Vaarst (2015) explores the role of farmer groups in addressing the need for context specific knowledge generation in the development of complex integrated animal farming. Padel et al. (2015) discuss how the effective combination of experiential and experimental knowledge, via farmer-researcher collaboration and participatory research, can drive innovation, and can be encouraged through farmer research funds and innovation awards.

Despite significant advances, key challenges remain if organic agriculture is to develop its full potential as a sustainable food production strategy. Niggli (2015) outlines the main factors limiting yields and yield stability in organic agriculture, and argues for a research approach based in agro-ecological theory to address these factors. Such an approach, explain Abbott and Manning (2015), requires a better understanding of the complex soil system and the interactions between biological and mineral fractions and bio-physical and bio-chemical processes. From a management standpoint, cover crops and green manures offer multiple essential functions including fixing nitrogen, adding organic matter, and providing habitat for beneficials, and are thus critical to the success of organic systems. However, the development of best management practices and suitable germplasm are needed to assure that cover crops can reliably provide these functions. For instance, the method by which green manure are terminated can significantly impact nitrogen use efficiency, as discussed by Lynch (2015).

Reducing reliance on tillage in organic systems is being explored for the potential to enhance energy efficiency, soil quality, and water availability. Canali (2015) presents results from research on a no-till cover crop system for Mediterranean vegetable production. Köpke et al. (2015) provide evidence that periodic tillage in organic systems may be beneficial in terms of enhancing nutrient cycling between the subsoil and surface soil, and offers a glimpse into the unique role that subsoil processes play in nutrient dynamics.

Ensuring that organic agriculture will meet society's evolving expectations for sustainable production and ecosystem services is another challenge. Merfield et al. (2015) note that while research supports the assertion that organic can deliver better economic, social, and environmental outcomes than other production systems, organic standards still do not cover many of the broader dimensions of sustainability. The authors describe an ecosystem services benchmarking tool for farmers to compare their production system anonymously with others in their community as a means of fostering innovation and learning. Jensen et al. (2015) call for more widespread adoption of evaluation metrics that measure yields in relation to environmental and social impacts; and Vaarst (2015) advocates for including factors that are more difficult to measure, like fairness and humaneness, in organic evaluations. Bàrberi (2015) argues that developing solutions based on functional biodiversity, rather than input substitution, will result in systems that are more resilient to biotic and abiotic stresses, and products that are more easily differentiated by consumers.

Organic agriculture has yet to become a dominant production method in any region of the world yet it serves a much broader role than is suggested by figures for the land area under organic certification or proportion of market share. Organic agriculture offers a "protective space" that fosters agro-ecologically based solutions to difficult questions (Niggli, 2015). The constraints imposed on the system encourage innovations that address simultaneous goals of food security, economic development, and environmental health; and that advance our collective understanding of the complex ecological processes underlying all agricultural systems. We hope the articles in this issue serve as a unique resource of information and inspiration for further research, innovation, policy recommendations, and development of organic and sustainable agriculture.

Acknowledgements

The authors and organizers of the Innovations in Food Systems for Sustainable Production and Ecosystem Services conference would like to thank the following organizations for funding support: Organisation for Economic Co-operation and Development (OECD) Co-operative Research Programme on Biological Resource Management for Sustainable Agricultural Systems, the International Centre for Research in Organic Food Systems (ICROFS), the United Stated Department of Agriculture, National Institute of Food and Agriculture (USDA-NIFA), and the American Society of Agronomy (ASA). We also thank Hans-Joachim Weigel (OECD) and Jill Auburn (USDA-NIFA) for their leadership, Janet Schofield (OECD) and Megan O'Reilly (USDA-NIFA) for technical assistance, and Stacey Phelps of ASA for assistance with organizing the conference.

References

Abbott, L. K., & Manning, D. A. C. (2015). Soil health and related ecosystem services in organic agriculture. *Sustainable Agriculture Research, 4*(3), 116-125. http://dx.doi.org/10.5539/sar.v4n3p116

Bàrberi, P. (2015). Functional biodiversity in organic systems: The way forward? *Sustainable Agriculture Research, 4*(3), 26-31. http://dx.doi.org/10.5539/sar.v4n3p26

Cambardella, C. A., Delate, K., & Jaynes, D. B. (2015). Water quality in organic systems. *Sustainable Agriculture Research, 4*(3), 60-69. http://dx.doi.org/10.5539/sar.v4n3p60

Canali, S., Diacono, M., Campanelli, G., & Montemurro, F. (2015). Organic no-till with roller crimpers: Agro-ecosystem services and applications in organic mediterranean vegetable productions. *Sustainable Agriculture Research, 4*(3), 70-79. http://dx.doi.org/10.5539/sar.v4n3p70

Delate, K., Cambardella, C., Chase, C., & Turnbull, R. (2015). A review of long-term organic comparison trials in the U.S. *Sustainable Agriculture Research, 4*(3), 5-14. http://dx.doi.org/10.5539/sar.v4n3p5

FAO. (2011). Summary Report. FAO/OECD Expert Meeting on Greening the Economy with Agriculture, Paris, France, 5 - 7 September 2011.

Halberg, N., Panneerselvam, P., & Treyer, S. (2015). Eco-functional intensification and food security: Synergy or compromise? *Sustainable Agriculture Research, 4*(3), 126-139. http://dx.doi.org/10.5539/sar.v4n3p126

Heckman, J. R. (2015). The role of trees and pastures in organic agriculture. *Sustainable Agriculture Research, 4*(3), 103-115. http://dx.doi.org/10.5539/sar.v4n3p51

Hokkanen, H. M. T., Menzler-Hokkanen, I., & Lahdenperä, M.-L. (2015). Managing bees for delivering biological control agents and improved pollination in berry and fruit cultivation. *Sustainable Agriculture Research, 4*(3), 89-102. http://dx.doi.org/10.5539/sar.v4n3p89

Jensen, E. S., Bedoussac, L., Carlsson, G., Journet, E.-P., Justes, E., & Hauggaard-Nielsen, H. (2015). Enhancing yields in organic crop production by eco-functional intensification. *Sustainable Agriculture Research, 4*(3), 42-50. http://dx.doi.org/10.5539/sar.v4n3p42

Köpke, U., Athmann, M., Han, E., & Kautz, T. (2015). Optimising cropping techniques for nutrient and environmental management in organic agriculture. *Sustainable Agriculture Research, 4*(3), 15-25. http://dx.doi.org/10.5539/sar.v4n3p15

Lynch, D. H. (2015). Nutrient cycling and soil health in organic cropping systems - Importance of management strategies and soil resilience. *Sustainable Agriculture Research, 4*(3), 80-88. http://dx.doi.org/10.5539/sar.v4n3p80

McIntyre, B. D., Herren, H. R., Wakhungu, J., & Watson, R. T. (2009). Agriculture at a Crossroads. International assessment of agricultural knowledge, science and technology for development (IAASTD): global report Synthesis Report. Island Press, Washington DC.

Merfield, C., Moller, H., Manhire, J., Norton, S., Carey, P., Hunt, L., … McCarthy, A. (2015). Are organic standards sufficient to ensure sustainable agriculture? Lessons from New Zealand's ARGOS and Sustainability Dashboard projects. *Sustainable Agriculture Research, 4*(3), 158-172. http://dx.doi.org/10.5539/sar.v4n3p158

Millennium Ecosystem Assessment. (2005). Ecosystems and human well-being: Synthesis. Island Press, Washington, DC.

Niggli, U. (2015). Incorporating Agroecology Into Organic Research –An Ongoing Challenge. *Sustainable Agriculture Research, 4*(3), 149-157. http://dx.doi.org/10.5539/sar.v4n3p149

Niggli, U., Slabe, A., Schmid, O., Halberg, N., & Schlüter, M. (2008). Vision for an organic food and farming research agenda to 2025. IFOAM-EU and FiBL.

Padel, S., Vaarst, M., & Zaralis, K. (2015). Supporting innovation in organic agriculture: A European perspective using experience from the SOLID project. *Sustainable Agriculture Research, 4*(3), 32-41. http://dx.doi.org/10.5539/sar.v4n3p32

UNCTAD. (2013). Wake up before it is too late: Make agriculture truly sustainable now for food security in a changing climate. United Nations, Geneva.

Vaarst, M. (2015). The role of animals in eco-functional intensification of organic agriculture. *Sustainable Agriculture Research, 4*(3), 103-115. http://dx.doi.org/10.5539/sar.v4n3p103

Vogl, C. R., Kummer, S., Leitgeb, F., Schunko, C., & Aigner, M. (2015). Keeping the actors in the organic system learning: The role of organic farmers' experiments. *Sustainable Agriculture Research, 4*(3), 140-148. http://dx.doi.org/10.5539/sar.v4n3p140