Renewable Agriculture and Food Systems: 28(1); 93–96 doi:10.1017/S1742170512000154

Sharing a vision for biodiversity conservation and agriculture

John E. Quinn*

University of Nebraska-Lincoln, School of Natural Resources, 3310 Holdrege, Lincoln, NE 68583, USA.
*Corresponding author: jquinn2@unl.edu

Accepted 24 March 2012; First published online 8 May 2012 **Commentary**

Abstract

Conservation biology and agriculture share a common landscape and a future that demands novel research and practice. Inevitably, limited resources create conflict in the absence of a shared vision forward. Therefore, given the similarities in proximate and even ultimate goals, we must envision a joint path toward renewable and resilient agroecosystems. In this commentary, I highlight the root of past conflicts and share a vision of progress forward that encompasses mutually beneficial outcomes. I include six areas of anticipatory research and inquiry at the intersection of conservation biology and agriculture to better identify shared goals and facilitate more frequent communication among disciplines.

Key words: agroecosystems, farmland, ecology, future collaboration, interdisciplinary

Climate change, population growth, biodiversity loss and broken biogeochemical cycles[1] are global challenges that necessitate a new and integrated vision for applied sciences, including agriculture and biodiversity conservation. Sharing a common landscape and resource base and inevitably a shared future, conservation biology and agriculture need to envision a joint path toward renewable and resilient agroecosystems where management, research and dialogue identify and work toward win–win situations. However, unlike other managed land-use systems such as forestry and range management, row crop agriculture has yet to embrace the conservation of biological diversity[2]. Likewise, perhaps due to the perception that row-crop farmland has little value for conservation efforts[3], conservation biology specialists have limited engagement with agronomists and farmers, choosing instead to focus on threatened and endangered species, protected landscapes and natural habitats. Yet for each to succeed, the definition of progress needs to take into account how conservation of biodiversity may increase productivity and profitability when farmers manage their systems in ways that augment regional biodiversity conservation priorities.

The poetic Wendell Berry[4] expresses a most critical barrier to this endeavor; 'My sorrow in having been for so long on two losing sides has been compounded by knowing that those two sides have been in conflict.' This inability to reconcile the conflict of competing land and resource use between biodiversity conservation and agriculture continues to impede significant progress toward addressing the above challenges. Ultimately, the failure to achieve a shared vision and one common language compounds the challenges and opportunity costs for researchers and practitioners alike.

At the root of this conflict is each discipline's dominant vision of how to singularly address each challenge. For example, global agricultural research has dramatically improved crop yields, in some cases tripling production. This undeniably benefited the near-term needs of producers and consumers[5]. However, these results are largely an outcome of biological simplification and control of regulatory ecosystem processes[6]. The subsequent unintended consequences for people and the environment, both locally and globally, are now being recognized[7]. In turn, conservation biology has begun to address the extinction crisis with respect to both deterministic drivers and the consequences of small populations[8]. Important local and federal conservation programs, including the Endangered Species Act, have successes to celebrate. Yet the field has focused its resources largely on protection and exclusion[9] or replicating historical habitat patterns as an end, largely ignoring the massive changes underway or that have already occurred in many ecosystems shaped by food production[10].

Although ecological and cultural barriers to multiple uses of arable cropland do exist, building a shared vision is necessary for progress to occur. It is perhaps the dissenting vision of conservation and agricultural specialists that provide the foundation. For instance, the organic food movement celebrates biodiversity as part of the farm system, whereas a new generation of conservation practitioners managing landscapes to increase the flow of ecosystem services gives credit to the value of those services provided by biodiversity in farmland[11]. Further progress and mediation of the perceived conflict will require more frequent interaction and discussion between disciplines focusing on how both fields can evolve beyond production and exclusion toward agroecosystem management that measures and balances multiple ecological functions.

As agronomy and conservation biology are driven and constrained by similar ecological and social forces[4], collaborative discussions with the goal of moving both disciplines forward simultaneously would prove fruitful. Building on the recent efforts of Sutherland, Pretty and colleagues to compile list of the 100 most important questions for each discipline[12,13], I describe six areas of anticipatory research and inquiry focused on the intersection between conservation biology and agroecology, where progress requires multidisciplinary teams of agronomists and conservation biologists. Examples of possible literature at the intersection of conservation biology and agroecology are included to stimulate this discussion.

1 The emerging discussion around managed lands maintained by human inputs of energy and materials and novel ecosystems embedded within managed ecosystems that have a diversity of species not occurring previously[14], provides an area of mutual interest to improve the dialogue between conservation and production. These 'neutral' areas provide a space beyond the protected areas and crop fields that are typically the focus of research and practice. Yet, the new mix of species[15,16] currently in these ecosystems may or may not be ecologically sound or beneficial. What are potential and realized costs and benefits of new biological communities and the resulting interactions and flow of ecosystem services among native, novel, managed and agroecosystems?
2 The acres planted with genetically modified crops are expanding. How will these unique new organisms interact with the existing species in an ecosystem? For instance, what are the implications of the transfer of novel traits to wild relatives or between non-organic and organic varieties? What are the consequences of limiting the available agro-biodiversity due to introduction of narrow genetically bred high-yield varieties and disappearance of many land races of crops and animals? Lastly, what measures do we use to assess the ecological impacts, both positive and negative[17,18]?
3 Sufficient, high-quality data are necessary to make informed decisions. How and what do we monitor in an ecologically meaningful way to understand the mechanisms, trade-offs and synergies encountered in agro and novel ecosystems? For example, conservation biology practitioners focus on biological measures of progress (e.g., species richness and population abundance), while agronomists focus on measures of agricultural resources (e.g., soil quality and crop yield). How should the researchers and practitioners prioritize and integrate the metrics of sustainability?
4 Production agriculture is essential to sustain a global population. Are there productive arable crop systems that mimic the ecological conditions necessary for biodiversity maintenance? What is the value of alternative agricultural land uses (e.g., biofuels[19] or perennials[20]) for biodiversity conservation?
5 Ecosystem services derived from biodiversity provide a variety of functional and economic benefits to croplands and society at multiple spatial and temporal scales[11,21]. In one case study, it is estimated that the economic value of pollination services provided by California wildlands is between $937 million to $2.4 billion[22]. How does the flow of ecosystem services differ between natural and agroecosystems? What are the economic benefits of ecosystem services at the farm scale as well as at larger spatial scales? The patterns of change in the flow of ecosystem services do not act in isolation[23]. What are the positive synergies between management for different ecosystem services? How can these services be bundled to aid management decisions and garner policy support?
6 Funds for agri-environmental schemes are often tied to multiple goals. For instance, the USDA Conservation Reserve Program was started as a means to address crop prices, but is now expected to retain soil and protect grassland birds, while farmers compete in the market. Because of the broad objectives, policy programs are often less successful than intended[24]. In addition, many mechanisms for farmland environmental programs are often perceived as rigid[25], or lack specificity regarding the objectives. The USDA National Organic Program standards, for example, define organic production as a system with practices that 'conserve biodiversity' yet the standards lack any rules or relevant measures. Thus, an important discussion is how the support dollars for nature conservation and farming should be integrated and allocated in the future.

We are currently at crossroads and yet there are many challenges in defining a mutual path forward[12,13,26–28]. Although the ultimate goals of food production and reduced extinction rates must be maintained, the proximate objectives of researchers, practitioners and policymakers can be redefined through collaborative discussions and evaluating the funding environment. One example of this progress is the work of the University of Nebraska-Lincoln (UNL) Organic Working Group with the recent grant titled 'Improving Organic Farming Systems and Assessing their Environmental Impacts'. As a multidisciplinary team, we have successfully integrated departments, defined common objectives, and worked with farmers to address local production and conservation goals. However, room remains for progress as we seek to define the appropriate scales and outcomes for research and practice. Future discussions among practitioners, researchers and policy-makers should focus on mutual benefits and costs as well as processes and functions supported by biodiversity within and associated with renewable agroecosystems. Agriculture and biodiversity conservation need not be in conflict. Meeting shared goals through more frequent communication among disciplines can be the backbone for the success of future farming systems and nature conservation alike.

Acknowledgements. I appreciate the comments provided by C. Francis, J. Brandle, R. Johnson, J. Doran and two anonymous referees that improved this manuscript. Funding for this work was provided by USDA CSREES Integrated Organic Program Grant Number: 2005-51300-02374 and the USDA McIntire-Stennis program.

References

1 Rockström, J., Steffen, W., Noone, K., Persson, A., Chapin, S.F., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., and Foley, J.A. 2009. A safe operating space for humanity. Nature 461:472–475.

2 Perrings, C., Jackson, L., Bawa, K., Brussaard, L., Brush, S., Gavin, T., Papa, R., Pascual, U., and de Ruiter, P. 2006. Biodiversity in agricultural landscapes: Saving natural capital without losing interest. Conservation Biology 20:263–264.

3 Jackson, D.L. and Jackson, L.L. 2002. The Farm as Natural Habitat: Reconnecting Food Systems with Ecosystems. Island Press, Washington; Covelo, London.

4 Berry, W. 2006. Conservationist and Agrarian. In D. Imhoff and J.B. Baumgartner (eds). Farming and the Fate of Wild Nature: Essays on Conservation-based Agriculture. Watershed Media, Healdsburg, CA. p. 3–13.

5 Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: A Framework for Assessment. General Synthesis. Island Press, Washington, DC.

6 Altieri, M.A. 1999. The ecological role of biodiversity in agroecosystems. Agriculture, Ecosystems and Environment 74:19–31.

7 Tilman, D., Cassman, K.G., Matson, P.A., Naylor, R., and Polasky, S. 2002. Agricultural sustainability and intensive production practices. Nature 418:671–677.

8 Brooks, T.M., Wright, S.J., and Sheil, S. 2009. Evaluating the success of conservation actions in safeguarding tropical forest biodiversity. Conservation Biology 23:1448–1457.

9 Terborgh, J. 1999. Requiem for Nature. Island Press, Washington, DC.

10 Ellis, E.C. and Ramankutty, N. 2008. Putting people in the map: anthropogenic biomes of the world. Frontiers in Ecology and the Environment 6:439–447.

11 Zhang, W., Ricketts, T.H., Kremen, C., Carney, K., and Swinton, S.M. 2007. Ecosystem services and disservices to agriculture. Ecological Economics 64:253–260.

12 Sutherland, W.J., Adams, W.M., Aronson, R.B., Aveling, R., Blackburn, T.M., Broad, S., Ceballos, G., Cote, I.M., Cowling, R.M., Da Fonseca, G.A.B., Dinerstein, E., Ferraro, P.J., Fleishman, E., Gascon, C., Hunter, M., Hutton, J., Kareiva, P., Kuria, A., MacDonald, D.W., MacKinnon, K., Madgwick, F.J., Mascia, M.B., McNeely, J., Milner-Gulland, E.J., Moon, S., Morley, C.G., Nelson, S., Osborn, D., Pai, M., Parsons, E.C.M., Peck, L.S., Possingham, H., Prior, S.V., Pullin, A.S., Rands, M.R.W., Ranganathan, J., Redford, K. H., Rodriguez, J.P., Seymour, F., Sobel, J., Sodhi, N.S., Stott, A., Vance-Borland, K., and Watkinson, A.R. 2009. One hundred questions of importance to the conservation of global biological diversity. Conservation Biology 23:557–567.

13 Pretty, J., Sutherland, W., Ashby, J., Auburn, J., Baulcombe, D., Bell, M., Bentley, J., Bickersteth, S., Brown, K., Burke, J., Campbell, H., Chen, K., Crowley, E., Crute, I., Dobbelaere, D., Edwards-Jones, G., Funes-Monzote, F., Godfray, H.C.J., Griffon, M., Gypmantisiri, P., Haddad, L., Halavatau, S., Herren, H., Holderness, M., Izac, A., Jones, M., Koohafkan, P., Lal, R., Lang, T., McNeely, J., Mueller, A., Nisbett, N., Noble, A., Pingali, P., Pinto, Y., Rabbinge, R., Ravindranath, N.H., Rola, A., Roling, N., Sage, C., Settle, W., Sha, J.M., Shiming, L., Simons, T., Smith, P., Strzepeck, K., Swaine, H., Terry, E., Tomich, T.P., Toulmin, C., Trigo, E., Twomlow, S., Vis Jan, K., Wilson, J., and Pilgrim, S. 2010. The top 100 questions of importance to the future of global agriculture. International Journal of Agricultural Sustainability 8:219–236.

14 Hobbs, R.J., Arico, S., Aronson, J., Baron, J.S., Bridgewater, P., Cramer, V.A., Epstein, P.R., Ewel, J.J., Klink, C.A., Lugo, A.E., Norton, D., Ojima, D., Richardson, D.M., Sanderson, E.W., Valladares, F., Vilà, M., Zamora, R., and Zobel, M. 2006. Novel ecosystems: theoretical and management aspects of the new ecological world order. Global Ecology and Biogeography 15:1–7.

15 Wortman, S.E., Lindquist, J.L., Harr, M.J., and Francis, C. A. 2010. Increased weed diversity, density, and above-ground biomass in long-term organic crop rotations. Renewable Agriculture and Food Systems 25:281–295.

16 Johnson, R.J., Jedlicka, J.A., Quinn, J.E., and Brandle, J.R. 2011. Global perspectives on birds in agricultural landscapes. In W.B. Campbell and S.L. Ortiz (eds). Integrating Agriculture, Conservation and Ecotourism: Examples from the Field, Issues in Agroecology—Present Status and Future Prospectus 1. Springer, New York. p. 55–140.

17 Firbank, L.G., Heard, M.S., Woiwod, I.P., Hawes, C., Haughton, A.J., Champion, G.T., Scott, R.J., Hill, M.O., Dewar, A.M., Squire, G.R., May, M.J., Brooks, D.R., Bohan, D.A., Daniels, R.E., Osborne, J.L., Roy, D.B., Black, H.I.J., Rothery, P., and Perry, J.N. 2003. An introduction to the farm-scale evaluations of genetically modified herbicide-tolerant crops. Journal of Applied Ecology 40:2–16.

18 Brummer, E.C., Barber, W.T., Collier, S.M., Cox, T.S., Johnson, R., Murray, S.C., Olsen, R.T., Pratt, R.C. and

Thro, A.M. 2011. Plant breeding for harmony between agriculture and the environment. Frontiers in Ecology and the Environment 9:561–568.
19 Robertson, B.A., Doran, P.J., Loomis, L.R., Robertson, J. R., and Schemske, D.W. 2011. Perennial biomass feedstocks enhance avian diversity. GCB Bioenergy 3:235–246.
20 Glover, J., Reganold, J.P., Bell, L.W., Borevitz, J., Brummer, E.C., Buckler, E.S., Cox, T.S., Cox, C.M., Crews, T.E., Culman, S.W., DeHaan, L.R., Eriksson, D., Gill, B.S., Holland, J., Hu, F., Hulke, B.S., Ibrahim, A.M. H., Jackson, W., Jones, S.S., Murray, S.C., Paterson, A.H., Ploschuk, E., Sacks, E.J., Snapp, S., Tao, D., Van Tassel, D. L., Wade, L.J., Wyse, D.L., and Xu, Y. 2010. Increased food and ecosystem security via perennial grains. Science 328:1638–1639.
21 Swinton, S.M., Lupi, F., Robertson, G.P., and Hamilton, S. K. 2007. Ecosystem services and agriculture: cultivating agricultural ecosystems for diverse benefits. Ecological Economics 64:245–252.
22 Chaplin-Kramer, R., Tuxen-Bettman, T., and Kremen, C. 2011. Value of wildland habitat for supplying pollination services to Californian agriculture. Rangelands 33:33–41.
23 Bennett, E.M., Peterson, G.D., and Gordon, L.J. 2009. Understanding relationships among multiple ecosystem services. Ecology Letters. 12:1394–1404.
24 Kleijn, D., Berendse, F., Smit, R., Gilissen, N., Smit, J., Brak, B., and Groeneveld, R. 2004. Ecological effectiveness of agri-environment schemes in different agricultural landscapes in the Netherlands. Conservation Biology 18:775–786.
25 Ahnström, A., Höckert, J., Bergeå, H.L., Francis, C.A., Skelton, P. and Hallgren, L. 2009. Farmers and nature conservation: What is known about attitudes, context factors and actions affecting conservation? Renewable Agriculture and Food Systems 24:38–47.
26 Ikerd, J. 2008. Farming in the future: the triple bottom line. In J. Ikerd (ed.). Crisis and Opportunity: Sustainability in American Agriculture. Bison Books, University of Nebraska Press, Lincoln, NE.
27 Committee on a New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution; National Research Council. 2009. A New Biology for the 21st Century. Available at Web site: http://www.nap.edu/catalog/12764.html (accessed April 20, 2012).
28 IAASTD. 2009. Agriculture at a Crossroads: Global Report. Island Press, Washington, DC.