

Biodiversity in Agriculture: Domestication, Evolution, and Sustainability

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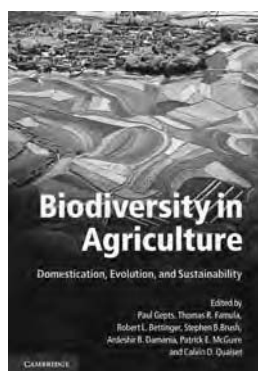
Agriculture—A Multidisciplinary Portrait

Biodiversity in Agriculture: Domestication, Evolution, and Sustainability. Paul Gepts, Thomas R. Famula, Robert L. Bettinger, Stephen B. Brush, Ardeshtir B. Damania, Patrick E. McGuire, and Calvin O. Qualset, eds. Cambridge University Press, 2012. 630 pp., illus. \$70.00 (ISBN 9780521170871 paper).

The Harlan and Harlan II Symposia (conducted in 1997 and 2008, respectively) celebrated the work and scientific philosophy of ethno-biologist and plant explorer Jack Harlan (1917–1998). In much of his work, Harlan took a multidisciplinary perspective, and his expertise spanned the disciplines of plant genetics, evolution, archeology, agronomy, and history. *Biodiversity in Agriculture: Domestication, Evolution and Sustainability* comprises the collected papers from the Harlan II Symposium (September 2008) and reflects the convergent expertise of no fewer than 17 distinct disciplines. It is a technically dense compilation of 27 contributions by 70 authors and coauthors, arranged in three sections. The first section discusses the emergence and implications of domestication, the second deals with traditional management of agricultural biodiversity, and the third is concerned with the application of modern technologies to agriculture and their implications for biodiversity.

The volume is more than simply a collection of papers organized around a common theme, however. There is a directionality to it that takes the reader on a comprehensive journey from the emergence of agriculture 10,000 or so years ago to the cutting edge of modern crop and animal sciences, fields in which scholars grapple with the complex relationships among biodiversity, domestication, and the sustainability of the food production system. The authors explore the phenomenology

of domestication from multiple perspectives (e.g., archeological, genetic, and ecological), sometimes arriving at different endpoints and divergent conclusions as a result. This is nothing to be concerned about; rather, it is the essence of science. It allows us to appreciate the extent to which our perspective in examining a phenomenon contributes to the way we perceive both the problem and its solution.



Despite subtle disagreements over details, the book's authors seem to agree, generally, about agriculture's trajectory: It came on the scene as an evolution rather than an emergence (i.e., an explosive shift). The progression toward domestication occurred in only a few suitable locations, typically as a process of increasing intervention in a natural community's structure and function. In some regions (e.g., Southwest Asia), this tinkering with nature concluded with the domestication of species and types and with the accompanying replacement of portions of (or entire) wild communities. In other places—notably, North America—the process stopped at an intermediate stage between hunting–gathering and farming—that is, in the management of the wild landscape. Agriculture spread not by the domestication of local varieties but by the transport of existing domestic strains to new locations; to wit, agriculture tends to

depress species richness (while potentially preserving or enhancing within-species genetic diversity).

Clearly, the path to modern agriculture is neither straight nor uniform. As Billie L. Turner and Deborah Lawrence point out in chapter 20, communities—even such civilizations as the Maya—rose and fell as a function of the decisions they made about the ways they used land, their choices about their relationship with the environment, and the extent to which their decisions locked them into an ultimately unsustainable trajectory. Jan Salick explains in chapter 19 that indigenous cultures, which developed biologically diverse food systems that have been sustainable over millennia, are now challenged by environmental changes brought on by external anthropogenic factors over which they have no control. In considering modern food production, the authors focus on agriculture in California and acknowledge the challenges of maintaining and even creating biological diversity through emerging fields such as sustainable agroforestry (chapter 22), pollination (chapter 25), and aquaculture (chapter 26), as well as in established industries, such as viticulture (chapter 23) and dairy (chapter 27).

Biodiversity in Agriculture is not a book for the freshman class. It is, however, a volume that should be read by graduate students in both the natural and social sciences, because it demonstrates the value of interdisciplinary approaches to scholarship. That said, the book is sometimes a difficult read, given that one's expertise rarely spans the breadth of the subject matter and the diversity of approaches presented. Unfortunately, those who read *Biodiversity in Agriculture* are likely to focus on chapters germane to their own disciplines;

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that is, many will use it as a reference work. But doing so will shortchange both the reader and those who clearly worked hard to create a volume of this caliber. To conduct a review of the book, I had to read all of it—not a trivial task—but I profited from the experience. To state what has long been known: Working across disciplines can be painfully difficult, but sustainability science and its applications in society demand the effort. Nowhere else is the idea that the whole is greater than the sum of its parts more relevant.

Despite its breadth, *Biodiversity in Agriculture* leaves one wanting in some obvious areas, particularly those in which the science has societal implications. Although there are lively discussions about the risks of genetic erosion by domestication and about the mitigation of genetic pollution by using sterile stocks in aquaculture, little is provided on the implications of genetic modification to biodiversity or sustainability in agriculture. Transgenics is a pivot point in agriculture's development and certainly a hot-button issue, in both the public and commercial sectors, but academics may be repelled from confronting it by perceived consequences to funding and career advancement.

Similarly, discussions on the sustainability of the modern industrial model of agriculture and its potential impacts on biodiversity (among other things) are limited. Perhaps this subject is not consistent with the context or spirit of the symposium, although Jack Harlan's independence and dedication to academic freedom are legendary. For example, Juan F. Medrano (chapter 27) discusses the extent to which inbreeding is currently incorporated into California's massive dairy industry. The suggestion that such a system could become sustainable, even with the use of genomic tools for genetic selection, places a heavy burden of proof on the industry. Modern alternative agricultural models (particularly those based on direct marketing) and small-scale, local, and organic techniques are also not addressed in any meaningful way. Although they represent a

miniscule portion of today's market share, these traditional-agriculture-based approaches are emergent. They have enormous implications for biodiversity and for the future (i.e., the sustainability) of agriculture, particularly in developed countries.

These shortcomings, although they are not insignificant, can be forgiven when considering the sheer breadth and quality of the work and the possibility that the topics missed in Harlan II may form a portion of a third Harlan symposium. On balance, Jack Harlan would probably be pleased with *Biodiversity in Agriculture*.

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BEING HUMBLLED BY ANIMAL NAVIGATION

Nature's Compass: The Mystery of Animal Navigation. James L. Gould and Carol Grant Gould. Princeton University Press, 2012. 320 pp., illus. \$29.95 (ISBN 9780691140452 cloth).

As one of nature's most awe-inspiring and fascinating phenomena, the innate ability of animals to navigate accurately during their daily routines or during long-distance migrations across the globe engages us deeply on both intellectual and emotional levels. *Nature's Compass: The Mystery of Animal Navigation* provides the first serious treatment for the non-specialist in 20 years of the myriad problems faced by animals that must navigate and the various solutions that have evolved to achieve this goal. Animal navigation is complex, and this book tackles the disparate topics of the geometry and physics of navigation, as well as the aspects of animal

behavior, physiology, cognition, and evolution involved in the tapestry of techniques that allow animals to navigate successfully.

The book's scope is vast and ranges from local movements (e.g., ants returning to their hole in the sand, honeybees returning to their hive) to the immense cross-hemispheric movements of migratory birds and marine mammals. *Nature's Compass* also provides a detailed history of how researchers, using a host of cues and strategies, have overcome many of the immense challenges of deciphering the mechanisms that animals use to navigate. Yet, significant puzzles and unanswered questions remain, as the book also reveals. This is a reader-friendly and engaging contribution to the literature of navigation at a time when the field has shifted into a highly technical arena that would otherwise be inaccessible to all but the specialist.

Coauthor James L. Gould is a professor of ecology and evolutionary biology at Princeton University who has conducted seminal research on animal navigation primarily—but not exclusively—using honeybees and homing pigeons as model systems. Carol Grant Gould is a widely published popular science writer. Prior to *Nature's Compass*, the Goulds had already written an impressive collection of nine books. That writing experience shows here, and the combination of scientist and science writer successfully produces entirely accessible prose despite the book's complexity. Each chapter is a narrative that blends rigorous scientific principles and research designs with anecdotes of the people involved and the natural history of the organism in question.

I particularly enjoyed the way the book starts with accounts of the historical saga of human celestial navigation across the oceans during the seventeenth century and the challenges that we humans have faced in at-sea navigation. These early pages set up a theme about our assumption that other animals also use various