Title

Rethinking scientists' ongoing participation in "feeding the world"

Authors

Haring, Steven
Schmulevich, Sasha Pesci
Manser, Gwyneth M
et al.

Publication Date

2023

DOI

10.3389/fsufs.2023.1174704

frontiers | Frontiers in Sustainable Food Systems

TYPE Perspective
PUBLISHED 12 July 2023
DOI 10.3389/fsufs.2023.1174704

OPEN ACCESS

EDITED BY
Rachel Bezner Kerr,
Cornell University, United States

REVIEWED BY
Alistair Fraser,
Maynooth University, Ireland

*CORRESPONDENCE
Mark H. Cooper
✉ mhcooper@ucdavis.edu

RECEIVED 27 February 2023
ACCEPTED 30 May 2023
PUBLISHED 12 July 2023

CITATION
Haring S, Pesci Schmulevich S, Manser GM and Cooper MH (2023) Rethinking scientists' ongoing participation in "feeding the world". *Front. Sustain. Food Syst.* 7:1174704. doi: 10.3389/fsufs.2023.1174704

Rethinking scientists' ongoing participation in "feeding the world"

Steven Haring[1,2], Sasha Pesci Schmulevich[3], Gwyneth M. Manser[3] and Mark H. Cooper[4]*

[1]Department of Plant Sciences, University of California, Davis, Davis, CA, United States, [2]Institute of Ecology and Evolution, University of Oregon, Eugene, OR, United States, [3]Geography Graduate Group, University of California, Davis, Davis, CA, United States, [4]Department of Human Ecology, Department of Animal Science, University of California, Davis, Davis, CA, United States

Agricultural science necessarily involves a commitment to some form of humanitarian and environmental ethics. For the past century, agricultural science has been based on a productivist ethic of maximizing agricultural production in pursuit or support of food security. Recognition of the ethical and political disposition of contemporary agricultural science can help scientists reorient their work to better address the urgent problems of the upcoming century: environmental degradation, climate change, and social inequality. A commitment to solving these problems is well within the scope of modern agricultural science. Supporting and furthering multidimensional food systems should replace productivism as an explicit goal of agricultural development and scientific innovation.

KEYWORDS

agroecology, political ecology, green revolution, food security, food sovereignty

Introduction

Agricultural science is built on a common goal of "feeding the world," a fundamentally humanitarian and compassionate goal that aims to reduce hunger, alleviate human suffering, and protect the environment. Although modern agricultural science has contributed to the production of a higher volume of food, 767 million people in the world remain undernourished, and 3.1 billion people remain unable to afford healthy diets (FAO, IFAD, UNICEF, WFP, and WHO, 2022). In this paper, we argue that it is time to rethink what it means to feed the world. Concerns over population growth and scarcity of food have led to scientific efforts to increase agricultural productivity, and this focus on productivity has led to technological advances that are often unsustainable, ecologically damaging, and risky for human health (Shiva, 1991; Chávez, 1993; Vitousek et al., 1997). Scientists can recommit to the benevolent ideals underpinning agricultural development by prioritizing multidimensional food system values and contending with the social and political contexts of agricultural development. Feeding the world has always been a complex political project, and agricultural scientists can effect positive change by recognizing how their work has in the past—and can in the future—engage with the social and political contexts of agricultural development.

Scientific engagement in feeding the world

A food scarcity paradigm—where the existence of hunger and food insecurity is attributed to insufficient volumes of agricultural production—underpins modern food systems and agricultural science (Stock and Carolan, 2013). Agricultural scientists have therefore sought to maximize food production in order to meet food security needs at both national and global scales. Ongoing

narratives about the Green Revolution (e.g., feeding 9 billion people by 2050 (Godfray et al., 2010), feeding 11 billion people by 2100 (Lal, 2016), the Malthusian dilemma (Trewavas, 2002), and other growth-oriented frameworks) and 'food security as national security' (Falcon and Naylor, 2005; Hopma and Woods, 2014) continue to center the importance of increased food production (Rosin, 2013; Tomlinson, 2013; Fouilleux et al., 2017). This paradigm, however, has not been universally successful in ending hunger and seldom addresses the urgent concerns of the 21st century: environmental degradation, climate change, and deepening social inequality (Holt-Gimenez and Patel, 2012). Productivist narratives have normalized using agroecosystems solely for the purpose of maximizing crop yield. Intensified cropping systems continuously demand synthetic inputs, modern crop varieties, significant capital expenditures, and acceptance of environmental and social negative externalities (Altieri, 1998; Leguizamón, 2014). Meanwhile, the standardization and homogenization of food products into commodities suitable for international trade has displaced local foodways, ignoring existing local knowledge systems about agriculture in favor of systems that are designed to maximize export value (Scott, 1998; Shiva, 2016; McMichael, 2021). Increasingly, the benefits and surpluses of agricultural development are primarily captured by a decreasing number of people and institutions that are distant from the sites of agricultural production (Heffernan, 2000; Hendrickson and Heffernan, 2007; Patel, 2012).

Agricultural research has been shaped by—and has contributed to—these extractive political economies. The design of technological solutions with the goal of increasing production volumes typically occurs in lockstep with existing agribusiness interests (Scott, 1998; Harker et al., 2017). Agricultural scientists continue to valorize increasingly intensified systems and ongoing technoscientific development. Viable scientific and technological developments require not just the potential to change food systems but also compatibility with the profit-driven agribusiness interests and national interest-driven programs that often fund this work. This hybrid public-private responsibility for agricultural development continues to affect agricultural science and food policy (Busch et al., 1991). Public scientists frequently work with, and respond to, the needs of rent-seeking agribusinesses that are motivated primarily by profits, rather than the social responsibility to feed people. While profits are accumulated among private enterprises, the consequences of agricultural intensification are again socialized, through externalities such as air and water pollution and harm to farmworker health caused by pesticide exposure (Saxton, 2015; Guthman, 2017). In continuously advancing intensified production systems, scientists reinforce extractive relationships between people and the land.

Agricultural research institutions reflect the deep and ongoing tension between dominant approaches to feeding the world/feeding our citizenry and supporting more equitable food systems. For example, the land-grant university system is central to agricultural research in the United States but has also historically supported colonial and capitalist interests. This system was created in 1862, during the American Civil War, ostensibly to democratize higher education and provide practical knowledge to the public (APLU, 2012). Following decades of agricultural development based on chattel slavery and manifest destiny, land-grant universities prepared American farmers to create specialized cropping and livestock systems and cemented the United States' position as an agricultural powerhouse. The namesake land grants that funded these prestigious agricultural colleges were appropriated directly from Indigenous Peoples in North America (Lee and Ahtone, 2020; Stein, 2020). Land-grant universities also intentionally excluded Black people from accessing an education, despite the fact that it was the labor of Black people that built much of United States agriculture (Humphries, 1991; Wennersten, 1991). The 1890 and 1994 land grants eventually provided limited institutional resources to Black and Indigenous peoples, respectively (APLU, 2012). Nonetheless, 1862 land-grant universities and, by extension, the US agricultural research enterprise, have their origins firmly rooted in settler colonialism and white supremacy. This entanglement of agricultural science and settler colonialism is by no means unique to the United States, and it was prominent in other areas of the world throughout the 19th and early 20th centuries (Ho, 1968; Gilmartin, 1994; Bonneuil, 2000; Maat, 2001; Shepherd, 2005; Davis, 2007; Hodge, 2007; Rotz, 2017; Tesdell, 2017; Ukelina, 2017; Eddens, 2019).

While agricultural research and development have indeed improved food security for some populations, the politics of feeding the world have also advanced a set of problematic and destructive ideals. We urge agricultural scientists to consider how the legacies of colonialism and white supremacy shape their work, and to consider working towards systemic change that protects agricultural sustainability and food sovereignty. Despite widespread adherence to scientific objectivity, involvement in agricultural science has always implied, in part, biases towards certain political approaches to agricultural development (Dundon, 2003). It is no longer acceptable for agricultural scientists to ignore these political realities, and the role that scientists and institutions play in this political project.

Recommitting to the humanitarian values of agricultural science

Scientists across all disciplines are increasingly expected not just to do good science, but also to understand and be responsive to the social and political implications of their research. We call on agricultural scientists to interrogate what feeding the world means for their values, the practical aims of their work, and the mission of agricultural science in the 21st century. Agricultural science is fundamentally a value-laden science; identifying the values that drive science can help the field move forward toward more socially just and sustainable food systems (Vietor and Cralle, 1992; Hicks, 2014). Ultimately, new progress demands a redefinition of values and an understanding of what agriculture can contribute beyond yield maximization. As such, scientists must create new ways to recognize and respect diverse social and ecological values.

Some lines of agricultural research have addressed multidimensional food system values, such as sustainable intensification, regenerative agriculture, agricultural resilience, and climate-smart agriculture. These "sustainable agriculture" frameworks promote productivist paradigms with slight accommodations for sustainability and are fundamentally anthropocentric, failing to view nature as more than a resource that can serve humans (Loos et al., 2014; Godfray, 2015; Rupprecht et al., 2020). Agroecosystems, however, are not machines capable of unlimited growth. Agricultural scientists must consider the biophysical and ecological limits of agricultural growth, as well as the long-term social and environmental repercussions of intensified production systems (Scott, 1998; McGreevy et al., 2022). Systemic change begins by addressing the

reciprocity between humans and nature and adopting more multidimensional and holistic values for agriculture.

Many agricultural scientists working today will likely continue to support technological innovation, ecosystem services, and other components of scientific agroecology. However, agricultural scientists also need to be more actively engaged in examining how the technological and practical changes that their research promotes affect agriculture and agricultural communities in the real world. Scientists must also consider how their research contributes to the reconfiguration of ecosystems and food systems. Food systems bridge the gap between natural systems and social systems, bringing together aspects like environmental sustainability, environmental stewardship, food availability, food choice, food quality, cooking, labor, human nutrition, cultural acceptability, community building, agency, and vital materiality (Fernandez et al., 2013; Diekmann et al., 2020). Acknowledgement of these complex connections can strengthen the practice of science (Harding, 1993), and agricultural scientists must devote more attention to these multifaceted issues if they aim to work towards sustainability and equity in food systems.

Reframing agricultural science to build sustainable and equitable food systems

Agricultural scientists already have the tools to address the social and political elements of food systems. For decades, agricultural institutions have worked towards specialized and intensified agricultural systems driven by a scarcity framework, but it is time to recognize an existing capacity to work in support of revitalized and abundant agroecological systems. Just as agricultural scientists were once primarily driven by development-oriented goals, agricultural research can be reoriented, rather than reconstructed, to support multidimensional solutions to collective agroecological and social problems. In recent years, more scientists have begun to more vigorously and explicitly advocate for certain political values within food systems (Campbell et al., 2009; Ponisio and Ehrlich, 2016; Hunter et al., 2017; Jordan et al., 2021). However, commitment to these values and goals requires a reorientation not just of the work of individual scientists, but of agricultural research institutions. Agricultural scientists already develop practical technologies, practice community engagement through cooperative extension, and apply systems thinking to solve complex problems. Refocusing these existing skills towards sustainable and equitable values can help scientists and research institutions support multidimensional food system values while supporting both scientific and political agroecology.

Research and development that promotes practical technologies and supports diverse food systems are essential for transitioning away from the productivist focus of modern agricultural science. Such practices might include support for agrobiodiversity conservation, improved crop varieties for small farmers, integrated cropping systems, reduced labor and small farm machinery, pesticide reductions, development of local markets, accessible value-added production, food products that are healthy and culturally appropriate, diverse food economies, urban agriculture, and direct participation in food production (Tscharntke et al., 2012; DeLonge et al., 2016; Springmann et al., 2018). These kinds of innovations can support smallholders and farmers without secure land tenure, improving the ability of those classes to steward working lands. Modern food systems are built on specialized technologies that require significant capital investment and technical knowledge, but scientists could also develop low-cost, simple technologies that fulfill social and cultural needs in addition to economic and nutritional needs. Locally adapted management practices and incremental technological advances are frequently unrewarded within research institutions, but these advances are essential for improving sustainability, land tenure, and resilience across diverse farming systems.

Community engagement is a tool for identifying appropriate stakeholders and responding to the real needs of people and ecosystems. Community engagement and reciprocal support of stakeholders, rather than top-down technology transfer to capitalist industries, can help scientists extend their advancements (Röling and van de Fliert, 1994; Jarosz, 2000; Goldstein et al., 2019). Agricultural researchers, who are also frequently extensionists, can practice community engagement by first reflecting on their role and position in food systems, understanding the different ways in which they can interact with the communities that they serve, and appreciating the limits of their expertise or knowledge (Diekmann et al., 2017; Espinal et al., 2021). For many agricultural researchers, stakeholders have included agricultural input manufacturers, investment farmers, and large-scale commodity producers, but we call for renewed engagement between researchers and a more diverse set of community members, such as farmworkers, non-profit organizations, mutual aid groups, environmental justice groups, and other grassroots community initiatives. Importantly, agricultural scientists have an imperative to engage with farmers and farmworkers who are not landowners, but are nonetheless directly involved in and hold vast knowledge about agriculture. The stakeholders that scientists engage should include all people and communities who are most directly involved with food systems. International food sovereignty movements provide particularly valuable examples as to how effective grassroots extension programs and farmer-to-farmer education can create power within food systems (Martínez-Torres and Rosset, 2010; Altieri and Toledo, 2011; Sampson, 2018).

Systems thinking is also essential for agricultural institutions to address the web of biophysical, economic, and cultural factors in which food systems are situated (Vietor and Cralle, 1992). In contrast to addressing hunger only by increasing agricultural productivity, systems thinking facilitates a more holistic and complex approach to agricultural development, in which agricultural researchers have more capacity to challenge embedded commodity market structures, build mutual aid networks, develop appropriate tools for smallholder farmers, identify and support opportunities for land reform, and identify areas of human and ecological resilience. To support this, research institutions must reward this type of work and recognize its alignment with common institutional values of producing high-quality research and contributing to long-term community well-being and sustainability. By fostering deeper, trust-based connections and collaborative links among eaters, farmers, and other food system actors, agricultural scientists can contribute to the systemic changes that are needed for a re-envisioned food system.

Our vision for sustainable, revitalized, and abundant food systems is rooted in the support and recognition of the many people who nourish the world. To address the severe problems of the 21st century, food systems must catalyze community engagement in research and a right to accessible, healthy, safe, and delicious food. These goals require cooperative efforts among diverse stakeholders with multidimensional values. Agricultural scientists' ongoing political participation in feeding the world has historically centered on supporting increasing

agricultural productivity and identifying markets for the resulting production. Instead, we envision a food system where people come together to care for the environment and for their communities. While dominant scientific, regulatory, and economic systems as they exist now may seem at odds with this vision of transformation, we believe that agricultural scientists already have the capacity for reorienting their work service toward holistic, equitable, and sustainable food systems.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Funding

This work is the result of a symposium entitled "Critical Perspectives on Feeding the World" that was supported by the Office of Global Affairs at the University of California, Davis.

Acknowledgments

This work was prepared primarily on lands that are the home of the Patwin people, which includes three federally recognized tribes: Cachil DeHe Band of Wintun Indians of the Colusa Indian Community, Kletsel Dehe Wintun Nation, and Yocha Dehe Wintun Nation. This work is the result of a symposium held on May 14, 2021, entitled "Critical Perspectives on Feeding the World," which included contributions from Liz Carlisle, Lucy Diekmann, Charlotte Glennie, Mariah Coley, and Lauren Asprooth. The workshop was organized by the Political Ecology Lab at UC Davis and sponsored by UC Davis Global Affairs.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Altieri, M. A. (1998). Ecological impacts of industrial agriculture and the possibilities for truly sustainable farming. *Mon. Rev.* 50:60. doi: 10.14452/MR-050-03-1998-07_5

Altieri, M. A., and Toledo, V. M. (2011). The agroecological revolution in Latin America: rescuing nature, ensuring food sovereignty and empowering peasants. *J. Peasant Stud.* 38, 587–612. doi: 10.1080/03066150.2011.582947

APLU, (2012). *The Land-grant Tradition: 150 Years of Learning, Discovery, and Engagement*. Association of Public and Land-Grant Universities, Washington, DC.

Bonneuil, C. (2000). Development as experiment: science and state building in late colonial and postcolonial Africa, 1930-1970. *Osiris* 15, 258–281. doi: 10.1086/649330

Busch, L., Lacy, W. B., Burkhardt, J., and Lacy, L. R. (1991). *Plants, Power and Profit: Social, Economic and Ethical Consequences of the New Biotechnologies*. Cambridge, MA: Blackwells.

Campbell, H., Burton, R., Cooper, M., Henry, M., Le Heron, E., Le Heron, R., et al. (2009). From agricultural science to "biological economies?". *N. Z. J. Agric. Res.* 52, 91–97. doi: 10.1080/00288230909510492

Chávez, C. (1993). "Farm workers at risk" in *Toxic Struggles: The Theory and Practice of Environmental Justice*. ed. R. Hofrichter (Philadelphia: New Society Publishers), 163–170.

Davis, D. K. (2007). *Resurrecting the Granary of Rome: Environmental History and French Colonial Expansion in North Africa*, Ohio University Press, Athens.

DeLonge, M. S., Miles, A., and Carlisle, L. (2016). Investing in the transition to sustainable agriculture. *Environ. Sci. Pol.* 55, 266–273. doi: 10.1016/j.envsci.2015.09.013

Diekmann, L., Bennaton, R., Schweiger, J., and Smith, C. (2017). Involving extension in urban food systems: an example from California. *J. Hum. Sci. Extension* 5:7. doi: 10.54718/ZLAU1939

Diekmann, L. O., Gray, L. C., and Baker, G. A. (2020). Growing 'good food': urban gardens, culturally acceptable produce and food security. *Renew. Agric. Food Syst.* 35, 169–181. doi: 10.1017/S1742170518000388

Dundon, S. J. (2003). Agricultural ethics and multifunctionality are unavoidable. *Plant Physiol.* 133, 427–437. doi: 10.1104/pp.103.029124

Eddens, A. (2019). White science and indigenous maize: the racial logics of the green revolution. *J. Peasant Stud.* 46, 653–673. doi: 10.1080/03066150.2017.1395857

Espinal, D. L. T., Pinto, M. L. S., Morales, H., and Estrada-Lugo, E. I. J. (2021). Feminist agroecology: analyzing power relationships in food systems. *Agroecol. Sustain. Food Syst.* 45, 1029–1049. doi: 10.1080/21683565.2021.1888842

Falcon, W. P., and Naylor, R. L. (2005). Rethinking food security for the twenty-first century. *Am. J. Agric. Econ.* 87, 1113–1127. doi: 10.1111/j.1467-8276.2005.00797.x

FAO, IFAD, UNICEF, WFP, and WHO (2022). *The State of Food Security and Nutrition in the World 2022: Repurposing Food and Agricultural Policies to Make Healthy Diets More Affordable*. FAO, IFAD, UNICEF, WFP, and WHO, Rome.

Fernandez, M., Goodall, K., Olson, M., and Méndez, V. E. (2013). Agroecology and alternative agri-food movements in the United States: toward a sustainable Agri-food system. *Agroecol. Sustain. Food Syst.* 37, 121005074109009–121005074109126. doi: 10.1080/10440046.2012.735633

Fouilleux, E., Bricas, N., and Alpha, A. (2017). 'Feeding 9 billion people': global food security debates and the productionist trap. *J. Eur. Publ. Policy* 24, 1658–1677. doi: 10.1080/13501763.2017.1334084

Gilmartin, D. (1994). Scientific empire and imperial science: colonialism and irrigation technology in the Indus Basin. *J. Asian Stud.* 53, 1127–1149. doi: 10.2307/2059236

Godfray, H. C. J. (2015). The debate over sustainable intensification. *Food Sec.* 7, 199–208. doi: 10.1007/s12571-015-0424-2

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., et al. (2010). Food security: the challenge of feeding 9 billion people. *Science* 327, 812–818. doi: 10.1126/science.1185383

Goldstein, J. E., Paprocki, K., and Osborne, T. (2019). A manifesto for a progressive land-grant mission in an authoritarian populist era. *Ann. Am. Assoc. Geogr.* 109, 673–684. doi: 10.1080/24694452.2018.1539648

Guthman, J. (2017). Lives versus livelihoods? Deepening the regulatory debates on soil fumigants in california's strawberry industry. *Antipode* 49, 86–105. doi: 10.1111/anti.12246

Harding, S. (1993). "Rethinking standpoint epistemology: what is "strong objectivity"?" in *Feminist epistemologies*. ed. L. Alcoff (New York: Routledge), 49–82.

Harker, K. N., Mallory-Smith, C., Maxwell, B. D., Mortensen, D. A., and Smith, R. G. (2017). Another view. *Weed Sci.* 65, 203–205. doi: 10.1017/wsc.2016.30

Heffernan, W. D. (2000). "Concentration of ownership and control in agriculture" in *Hungry For Profit: The Agribusiness Threat to Farmers, Food, and the Environment*. eds. F. Magdoff, J. Bellamy Foster and F. H. Buttel (New York: Monthly Review Press), 61–76.

Hendrickson, M., and Heffernan, W. (2007). *Concentration of Agricultural Markets*. Columbia, MI: Department of Rural Sociology, University of Missouri.

Hicks, D. J. (2014). A new direction for science and values. *Synthese* 191, 3271–3295. doi: 10.1007/s11229-014-0447-9

Ho, S. P.-S. (1968). Agricultural transformation under colonialism: the case of Taiwan. *J. Econ. Hist.* 28, 313–340. doi: 10.1017/S0022050700073095

Hodge, J. M. (2007). *Triumph of the Expert: Agrarian Doctrines of Development and the Legacies of British Colonialism*. Ohio University Press, Athens.

Holt-Gimenez, E., and Patel, R. (2012). *Food Rebellions: Crisis and the hunger for justice*. Oakland CA: Food First Books.

Hopma, J., and Woods, M. (2014). Political geographies of 'food security' and food sovereignty. *Geogr. Compass* 8, 773–784. doi: 10.1111/gec3.12163

Humphries, F. S. (1991). 1890 land-grant institutions: their struggle for survival and equality. *Agric. Hist.* 65, 3–11.

Hunter, M. C., Smith, R. G., Schipanski, M. E., Atwood, L. W., and Mortensen, D. A. (2017). Agriculture in 2050: recalibrating targets for sustainable intensification. *Bio Sci.* 67, 386–391. doi: 10.1093/biosci/bix010

Jarosz, L. (2000). Understanding Agri-food networks as social relations. *Agric. Hum. Values* 17, 279–283. doi: 10.1023/A:1007692303118

Jordan, N., Gutknecht, J., Bybee-Finley, K. A., Hunter, M., Krupnik, T. J., Pittelkow, C. M., et al. (2021). To meet grand challenges, agricultural scientists must engage in the politics of constructive collective action. *Crop Sci.* 61, 24–31. doi: 10.1002/csc2.20318

Lal, R. (2016). Feeding 11 billion on 0.5 billion hectare of area under cereal crops. *Food Energy Secur.* 5, 239–251. doi: 10.1002/fes3.99

Lee, R., and Ahtone, L. (2020). Land-grab universities. *High Country News*. 52. https://www.hcn.org/issues/52.4/indigenous-affairs-education-land-grab-universities

Leguizamón, A. (2014). Modifying Argentina: GM soy and socio-environmental change. *Geoforum* 53, 149–160. doi: 10.1016/j.geoforum.2013.04.001

Loos, J., Abson, D. J., Chappell, M. J., Hanspach, J., Mikulcak, F., Tichit, M., et al. (2014). Putting meaning back into sustainable intensification. *Front. Ecol. Environ.* 12, 356–361. doi: 10.1890/130157

Maat, H. (2001). *Science Cultivating Practice: A History of Agricultural Science in the Netherlands and Its Colonies, 1863–1986, Library of Environmental, Agricultural, and Food Ethics*. Kluwer Academic Publishers; Dordrecht; Boston, MA.

Martínez-Torres, M. E., and Rosset, P. M. (2010). La Vía Campesina: the birth and evolution of a transnational social movement. *J. Peasant Stud.* 37, 149–175. doi: 10.1080/03066150903498804

McGreevy, S. R., Rupprecht, C. D. D., Niles, D., Wiek, A., Carolan, M., Kallis, G., et al. (2022). Sustainable agrifood systems for a post-growth world. *Nat. Sustain.* 5, 1011–1017. doi: 10.1038/s41893-022-00933-5

McMichael, P. (2021). "Food regimes" in *Handbook of Critical Agrarian Studies*. eds. A. H. Akram-Lodhi, K. Dietz, B. Engels and B. M. McKay (Cheltenham: Edward Elgar Press), 218–231.

Patel, R. C. (2012). Food sovereignty: power, gender, and the right to food. *PLoS Med.* 9:e1001223. doi: 10.1371/journal.pmed.1001223

Ponisio, L. C., and Ehrlich, P. R. (2016). Diversification, yield and a new agricultural revolution: problems and prospects. *Sustainability* 8:1118. doi: 10.3390/su8111118

Röling, N., and van de Fliert, E. (1994). Transforming extension for sustainable agriculture: the case of integrated pest management in rice in Indonesia. *Agric. Hum. Values* 11, 96–108. doi: 10.1007/BF01530451

Rosin, C. (2013). Food security and the justification of productivism in New Zealand. *J. Rural. Stud.* 29, 50–58. doi: 10.1016/j.jrurstud.2012.01.015

Rotz, S. (2017). 'They took our beads, it was a fair trade, get over it': settler colonial logics, racial hierarchies and material dominance in Canadian agriculture. *Geoforum* 82, 158–169. doi: 10.1016/j.geoforum.2017.04.010

Rupprecht, C. D. D., Vervoort, J., Berthelsen, C., Mangnus, A., Osborne, N., Thompson, K., et al. (2020). Multispecies sustainability. *Glob. Sustain* 3:e34. doi: 10.1017/sus.2020.28

Sampson, D. (2018). Productivism, agroecology, and the challenge of feeding the world. *Gastronomica* 18, 41–53. doi: 10.1525/gfc.2018.18.4.41

Saxton, D. I. (2015). Strawberry fields as extreme environments: the ecobiopolitics of farmworker health. *Med. Anthropol.* 34, 166–183. doi: 10.1080/01459740.2014.959167

Scott, J. C. (1998). "Taming nature: an agriculture of legibility and simplicity" in *Seeing Like A State* (New Haven: Yale University Press), 262–306.

Shepherd, C. J. (2005). Imperial science: the Rockefeller Foundation and agricultural science in Peru, 1940–1960. *Sci. Cult.* 14, 113–137. doi: 10.1080/09505430500110879

Shiva, V. (1991). *The Violence of the Green Revolution: Third World Agriculture, Ecology and Politics*. London: Zed Books.

Shiva, V. (2016). *Biopiracy: The Plunder of Nature and Knowledge*. Berkeley CA: North Atlantic Books.

Springmann, M., Clark, M., Mason-D'Croz, D., Wiebe, K., Bodirsky, B. L., Lassaletta, L., et al. (2018). Options for keeping the food system within environmental limits. *Nature* 562, 519–525. doi: 10.1038/s41586-018-0594-0

Stein, S. (2020). A colonial history of the higher education present: rethinking land-grant institutions through processes of accumulation and relations of conquest. *Crit. Stud. Educ.* 61, 212–228. doi: 10.1080/17508487.2017.1409646

Stock, P., and Carolan, M. (2013). "A utopian perspective on global food security" in *Food Systems Failure: The Global Food Crisis and the Future of Agriculture*. eds. C. Rosin, P. Stock and H. Campbell (London: Earthscan), 114–128.

Tesdell, O. (2017). Wild wheat to productive drylands: global scientific practice and the agroecological remaking of Palestine. *Geoforum* 78, 43–51. doi: 10.1016/j.geoforum.2016.11.009

Tomlinson, I. (2013). Doubling food production to feed the 9 billion: a critical perspective on a key discourse of food security in the UK. *J. Rural. Stud.* 29, 81–90. doi: 10.1016/j.jrurstud.2011.09.001

Trewavas, A. (2002). Malthus foiled again and again. *Nature* 418, 668–670. doi: 10.1038/nature01013

Tscharntke, T., Clough, Y., Wanger, T. C., Jackson, L., Motzke, I., Perfecto, I., et al. (2012). Global food security, biodiversity conservation and the future of agricultural intensification. *Biol. Conserv.* 151, 53–59. doi: 10.1016/j.biocon.2012.01.068

Ukelina, B. U. (2017). *The Second Colonial Occupation: Development Planning and the Legacies of British Colonial Rule in Nigeria*. Lexington Books, Lanham.

Vietor, D. M., and Cralle, H. T. (1992). Value-laden knowledge and holistic thinking in agricultural research. *Agric. Hum. Values* 9, 44–57. doi: 10.1007/BF02217920

Vitousek, P. M., Mooney, H. A., Lubchenco, J., and Melillo, J. M. (1997). Human domination of Earth's ecosystems. *Science* 277, 494–499. doi: 10.1126/science.277.5325.494

Wennersten, J. R. (1991). The travail of black land-grant schools in the south, 1890-1917. *Agric. Hist.* 65, 54–62.