Citizen Science in North American Agri-Food Systems: Lessons Learned

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This report summarizes the outcomes of a workshop at the University of Hawai`i-Mānoa, April 27-29, 2018, supported by the National Science Foundation (Award #1743138).

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Introduction

This report summarizes the ideas exchanged at a workshop entitled "Citizen Science and the Food System," which took place at the University of Hawai`i-Mānoa on April 27-29, 2018, with the support of the National Science Foundation. The premise of the workshop was that citizen science (CS) can help to build knowledge about the food system that might otherwise go unstudied or be ignored. Agri-food systems are complex, and it is often difficult to see the connections between different segments, such as farming practices, marketing, public health, and environmental impacts. Laypeople are already working with scientists on various issues, from access to nutritious food in low income communities, to monitoring pesticide drift, to measuring community health impacts of concentrated animal feeding operations. In the current climate of likely reductions in government funding for scientific research, we expect scientists' use of CS to only increase in the near future. How can CS and other forms of participatory research help to generate crucial knowledge about the food system?

We examined this question by bringing together people who have diverse practical experiences with CS on a range of food and farming issues, from seed development to pollinators, pesticide drift to seafood safety. Participants were asked to seek connections between their own projects and the broader agri-food system in order to develop a CS research agenda. Making such connections is crucial. Food production has profound impacts on the environment and public health. Agriculture alone accounts for 20-35% of greenhouse gas emissions (Vermeulen, Campbell, and Ingram 2012). Food insecurity has a dynamic interaction with economic insecurity, contributing to chronic diseases such as diabetes and hypertension (Wentworth 2016). From the perspective of human and ecological wellbeing and resilience, it makes sense to discuss agri-food as a system of interconnected and co-produced dynamics and trends.

CS is often commended for promoting scientific literacy among lay citizens and for generating much-needed data for scientific discoveries. However, the social consequences of CS, including its links to public policy, social inequality, and advocacy for change are not well understood. CS projects vary in their social and environmental outcomes, including the degree to which they promote equality in health and wellbeing of different social groups. These are at the forefront of social science analyses of CS, and our workshop brought them into focus by analyzing the context of the agri-food system.

The following questions informed the design of the workshop and the structure of the discussions that took place. These themes were interspersed throughout the workshop and were often interconnected.

1. How does public participation affect research agenda setting and investigations in different areas of the food system (e.g. production, consumption, processing, waste)?
2. What is the potential for CS to advance more holistic analysis of the agri-food system; for example, by facilitating understanding of ecosystem impacts from seed to table to compost pile?

3. How is participation in CS restricted by gender/race/class status and through what mechanisms?
4. In what circumstances does CS operate as a kind of collective action, a repertoire of contention for social justice and sustainability groups?
5. What are the institutional resources necessary to bridge CS-generated data and policy change?

The goal of this report is to draw lessons from the workshop participants to provide inspiration, critical insights, and guidance to those interested in pursuing and supporting citizen science in the food system. This report shares advice to those who want to start CS projects and provides suggestions to university administrators and funding bodies on how to support research that engages a wide range of collaborators.

Agri-food Systems, Food Justice, and Citizen Science

In the last decade, we have observed the proliferation of diverse efforts to use citizen science to attend to problems associated with food and agriculture. A subset of what Rebecca Lave (2012) calls "extramural knowledge production," citizen science (CS) refers to the practice of science by people who are not affiliated with credentialed academic/research institutions. Diverse academic fields, from ecology to astronomy, have made an extensive use of CS in recent years. The concept of CS has affinity with a variety of other research practices. These include participatory action research and community-based participatory research (CBPR), two approaches to research in which professional researchers collaborate with community partners to investigate and take action on a shared matter of concern (Bidwell 2009). In geography, participatory mapping enables researchers and communities to represent places on maps with features that are important to the people who live there (Elwood 2006; Bryan 2011). CS can also include do-it-yourself (DIY) movements that develop alternative tools for scientific research or "critical making" (Ratto 2011; Wylie et al. 2014).

CS has been hailed for various virtues; increasing scientific data; increasing citizens' scientific literacy and awareness; building community capacity for environmental protection; building more equal relationships between scientists and citizens; filling knowledge gaps and challenging official accounts; driving policy change; and catching polluters (Kimura and Kinchy 2016).

Our survey of the literature on CS relating to agri-food systems suggests that the majority of the citizen involvement in food policy making relates to the mapping of food deserts and conducting market basket audits (Mabachi and Kimminau 2012; Pothukuchi 2009; Pelletier et al. 2003; Azuma et al. 2010; Sadler 2016). However, there have been other innovative uses of CS in agri-food research. CS was used to monitor pesticide exposure (McCauley et al. 2001) and as collective responses to environmental disasters such as the case of community reporting of seafood contamination after an oil spill (McCormick 2012). Epidemiologists have used CS as a method for measuring the effects of industrial food production (e.g. health effects of large-scale confined hog production) (Wing 2002; Minkler et al. 2008), while ecologists have used citizen

scientists to assist in documenting water quality decline due to agriculture (Levain et al. 2015). Many of these CS projects are intended to contribute to policy making and grassroots advocacy.

Concurrently with academic and regulatory fields, a growing number of non-profit organizations are incorporating practices of CS when they try to address their concerns with environmental and health implications of agriculture and food production. For instance, organizations concerned with pesticide drift are collecting air samples to monitor the flow of agrichemicals from farms to residential neighborhoods (Harrison 2011) and citizen groups have set up monitoring stations to check the radiation contamination levels in food and beverages after the nuclear accident in Fukushima, Japan (Kimura 2016). In some instances, CS is a tactic for social movement activists concerned with the status quo of the food system. These CS projects by non-profit organizations tend to be less visible to scientists as they are not published in academic journals.

We see great promise in CS for increasing both scientific and public understanding of the complex connections between different segments of food systems, such as retail marketing, public health, and ecosystem impacts. The increase in scientific data and the low-cost dimension of CS appeal to many scientists, funders, and policymakers. Before rushing to embrace CS, however, researchers should consider its social, cultural and political dimensions. Decisions to invest in CS should be informed by clear understanding of its social dimensions, including its links to public policy, social inequality, and community activism.

Food justice is a concept inspired by the environmental justice (EJ) movement, which has fought for recognition that environmental problems are embedded in racist, unequal and sexist societies. The idea of food justice recognizes food problems as centrally involving questions of fairness and equity. Robert Gottlieb and Anupama Joshi elaborated the concept in their 2010 book, *Food Justice*.

> We characterize food justice as ensuring that the benefits and risks of where, what, and how food is grown and produced, transported and distributed, and accessed and eaten are shared fairly. (Gottlieb and Joshi 2010)

Sociologist Patricia Allen summarized the need for "justice" framing of agri-food system as follows; "Justice involves meeting basic human needs, freedom from exploitation and oppression, and access to opportunity and participation… It is clear that our food system does not meet the[se] fundamental criteria." (Allen 2008)

We see food injustice in the mistreatment of migrant workers and slaughterhouse employees, in high rates of food insecurity, and in widespread exposures to agricultural chemicals and other environmental harms resulting from food production. We also see food injustice when indigenous peoples are cut off from traditional wild foods and when farmers lose their rights to save and exchange seeds.

Pursuing food justice involves many strategies and tactics – including participatory research, like the examples represented in this workshop.

Workshop Participants

Janelle Marie Baker (Athabasca University), Assistant Professor in Anthropology, collaborates with sakâwiyiniwak (Northern Bush Cree) regarding their experiences with wild food contamination and boreal forest food identities in the oil sands region of Alberta, Canada.

Jay Bost is an agriculture and ethnobotany scholar and advocate for sustainable agriculture practices who works with GoFarm Hawaii, a program that offers knowledge, experience and support to those who are interested in becoming farmers.

'Qátuẃas (Jessica Brown) is the Indigenous Community Liaison for Ocean Networks Canada who works to bridge Western science and Indigenous knowledge through active engagement with coastal indigenous communities in regards to ocean observing systems, climate change, and changes in the ocean.

Catherine Chan is Professor and Chair of the Department of Natural Resources and Environmental Management at the University of Hawai`i at Mānoa.

David Crowder (Washington State University, Northwest Pollinator Initiative) is an Assistant Professor of Entomology whose lab uses citizen science to evaluate the effect that urbanization and agricultural intensification has on pollinator communities in the Pacific Northwestern United States.

Robert Gottlieb (Occidental College) is Emeritus Professor of Urban and Environmental Policy, Founder and Former Director of Occidental College's Urban & Environmental Policy Institute, and his work has paved the way for groundbreaking developments toward environmental and social justice within the food system.

Devon Hall, Sr. is the co-founder and program manager of the Rural Empowerment Association for Community Help (REACH) in North Carolina and has collaborated with UNC-Chapel Hill and John Hopkins University over the past decade to conduct research projects about the effect of hog and poultry operations on water, air, pediatric health and occupational health.

Alice Hall is a community organizer with the Rural Empowerment Association for Community Help (REACH) in North Carolina, whose mission is to highlight and right the injustices perpetrated by industrial hog and poultry operations in the community.

Jill Harrison (University of Colorado) is an Associate Professor of Sociology who focuses on

environmental sociology, including with regard to justice and inequality within agriculture and food systems.

Marcia Ishii-Eiteman is Senior Scientist and Director of the Grassroots Science Program at Pesticide Action Network North America (PANNA). The program facilitates community and public engagement in the use of scientific tools and processes, in order to strengthen community-based advocacy for social change and build public authority over policy and public resources.

Albie Miles (University of Hawai`i-West Oahu) is an Assistant Professor of Sustainable Community Food Systems whose research focuses on farming system biodiversity as well as the structural obstacles to sustainable food and farming systems.

James Myers (Oregon State University) is a Professor of Vegetable Breeding and Genetics and director of the Northern Organic Vegetable Improvement Collaborative, a federally funded grant for breeding and trialing vegetable varieties adapted to organic systems.

Daniel Nguyen is a project director for MQVN Community Development Corporation in New Orleans as well as the co-founder and director of VEGGI Farmers' Cooperative, a predominantly Vietnamese cooperative that aims to create jobs and enhance local food security.

Mónica Ramírez-Andreotta (University of Arizona) is an Assistant Professor of Soil, Water and Environmental Science with a joint appointment to the College of Public Health and is also the Director of two co-created citizen science programs, Gardenroots and Project Harvest.

Sarah Rhodes (University of North Carolina) is an environmental microbiologist, spatial analyst, and advocate for community-driven research at UNC Chapel Hill where she partners with REACH, a community-based organization working to remediate the disproportionate burden of pollution from livestock production industries on communities of color and the environment in eastern North Carolina.

Jeffrey Wickliffe is an environmental toxicologist, health risk assessor, and Associate Professor of Environmental Health Sciences at Tulane University in New Orleans, Louisiana. His work and research centers on collaboratively addressing environmental health and food safety issues that communities view as priority problems in their areas.

CS Projects Featured in the Workshop

The central questions that each citizen science project covered varied greatly. They considered a range of issues including diet-related health problems such as diabetes, mental health problems, the lack of livable income, lack of diversity in seeds available to farmers, and lack of accessible

capital for small farmers and fisher folks. When describing the situations they faced, participants did not stop at the contemporary and visible phenomena. For instance, the health and mental health issues in indigenous communities are tied to colonization and the displacement of indigenous people from land.

Our workshop sought to establish a broadly inter- and trans-disciplinary field of research on CS and the agri-food system in North America. Some participants worked on projects outside of North America and we do not include these in this section; however, their input has been integrated in other sections of the report.

Hog Operations and Public Health

The Rural Empowerment Association for Community Help (REACH) is a community-based organization in Duplin County, North Carolina. Duplin County is home to one of the highest concentrations of hog operations in the United States. Founded in 2002, REACH created a space for residents to communicate their concerns and connect with external advocacy groups, legal services, and academic researchers. REACH collaborates with universities like the University of North Carolina at Chapel Hill and Johns Hopkins University to document the dangers that hog operations pose to community and environmental health in eastern North Carolina. The group's aim is not only to meet basic human needs for community members, but to also provide them with equal opportunity and improve their access to quality education, youth programs, employment, housing, and recreation.

REACH and university researchers have conducted research to document community and worker exposure to antibiotic resistant bacteria from industrial animal production facilities. For instance, workshop participants Devon Hall (REACH) and Sarah Rhodes (UNC-Chapel Hill), in collaboration with other authors, studied the prevalence of antibiotic-resistant bacteria among industrial hog operation workers and community residents, as well as young children living in their households. The result was published in *Environmental Health Perspectives* (Hatcher et al. 2017).

Oil Development and Wild Berry Contamination

Fort McKay First Nation in Canada lies in the middle of oil sands development. Community members are concerned with contamination from oil sands mining, extraction, and other development activities on one of their traditional and important foods: berries. A group of about fifteen Elders and land users started to monitor changes and health of four blueberry (*Vaccinium myrtilliodes*) and cranberry (*Vaccinium vitis-idaea*) patches. Community members participate in and design this project.

Since its inception in 2012, the project has been managed by a non-profit air quality monitoring organization, the Wood Buffalo Environmental Association (WBEA), which has members from industry, government, local community organizations, and Aboriginal communities. The WBEA provides passive air monitors and weather stations in each of the berry patches and sends the berries to a laboratory for contaminant testing (heavy metals and volatile organic compounds)

and another laboratory for nutritional testing. The project is funded by a joint oil sands environmental monitoring initiative between the federal and provincial governments and now falls under a new provincial government branch called "Indigenous Knowledge, Community Monitoring and Citizen Science." Workshop participant Janelle Marie Baker is an anthropologist working with the project.

Monitoring Environmental Quality in Residential and Community Gardens

Gardenroots is a citizen science garden project that partners with community members to measure potential contaminants in residential and community gardens neighboring active or legacy resource extraction sites. Gardenroots also aims to communicate the results of their studies to all participating families and individuals, and aims more broadly to influence environmental decision making. Gardenroots was developed in 2010 by environmental health scientist, Monica Ramírez-Andreotta, with the Dewey-Humboldt, AZ community. Since then, Gardenroots has expanded in to three Arizona counties: Apache, Cochise, and Greenlee counties as well as locations in Pennsylvania and California. In 2015, over 90 community members were trained in sample collection protocols and by December 2015, 63 kits were returned for analysis totaling 267 plant, 174 water, and 125 soil samples. Individualized result booklets were prepared and community gatherings and data sharing events were later held with participants.

Project Harvest is another community-based project in Arizona spearheaded by Ramírez-Andreotta with University of Arizona colleagues in partnership with the Sonora Environmental Research Institute, Inc. The project aims to monitor and evaluate the use of harvested rainwater at homes and community gardens in selected urban and rural Arizona communities. Project Harvest citizen scientists were trained by and work alongside a team of *promotoras* (community health workers) and University of Arizona scientists to determine potential microbial, organic and inorganic contaminants in harvested rainwater as well as soil and fresh produce grown in home, school, and/or community gardens irrigated by harvested rainwater. The data collected will then move on to inform the broader community and guidelines and recommendations for safe harvested rainwater use in gardens, which will in turn support communities in their efforts to grow safe and sustainable produce.

Exposures to Pesticide Drift

The Pesticide Action Network North America (PANNA) is a non-profit organization that partners with frontline communities and other social justice groups to end pesticide reliance and build healthy, just and resilient food and farming systems, locally and globally. Workshop participant Marcia Ishii-Eiteman is a Senior Scientist at PANNA and Director of the organization's Grassroots Science (GRS) Program. This program facilitates community engagement with science in order to build public authority over policy and public resources, effectively turning science into a tool for frontline communities and social justice movement leaders. One GRS project entails community use of PAN's Drift Catcher, an air monitoring device that enables residents to determine whether

harmful pesticides are drifting from agricultural areas into their homes, schools and neighborhoods. Communities in Hawai`i and California, for example, have incorporated PAN's Drift Catcher into their existing campaigns, successfully proving that pesticides of concern are drifting into residential and school areas and winning health-protective policies as a result.

Fishing and Gardening after Environmental Disasters

Mary Queen of Vietnam Community Development Corporation (MQVN CDC) is a non-profit organization based in New Orleans East, which is a community with high instances of poverty, unemployment, inadequate access to nutritious food, as well as low access to public transportation. The group was created by Reverend Vien The Nguyen and Daniel Nguyen (a workshop participant) in 2006, following the devastation of Hurricane Katrina. They sought to rebuild the community through focusing on urban agriculture, business development, and healthcare among other issues. The organization's citizen science project investigates the concerns of Louisiana fisherfolk and urban farmers in New Orleans East, often collaborating with workshop participant Jeffrey Wickliffe, an environmental health specialist at Tulane University. In one study, they analyzed seafood for contamination, a significant concern for the community after the 2010 Deepwater Horizon Oil Spill. They worked with boat captains, deckhands, seafood processors, and fisherfolk in identifying the priority areas and selecting sampling locations.

Emerging out of MQVN CDC is another community organization called VEGGI Farmers' Cooperative (VFC). This group also works closely with Tulane University to examine samples from local urban farming soils to determine whether they are safe for producing food. Community members are concerned about the potential impact from industrial dumping in the surrounding area. In addition to community-based research projects, farmers under VEGGI are trained in aquaponics and greenhouse technology in partnership with JOB 1 and Delgado Community College.

Pollinator Health

The Northwestern Pollinator Initiative (NWPI) was created in 2013 by entomologists Dave Crowder and Eli Bloom to investigate pollinator conservation on small-scale production systems in western Washington. NWPI's research focuses on developing methods for observing bee communities, and establishing bee-friendly habitat, that are practical and beneficial for growers. The program also actively educates the local community to increase knowledge of pollinators in the Puget Sound. Other partners include local organizations like The Common Acre, Tilth Producers of Washington, and a number of participating farms. The program has received support from larger organizations like the US Department of Agriculture, Sustainable Agriculture Research and Education (SARE), and the National Science Foundation. Overall, the work of NWPI aims to guide efforts toward restoring and conserving ecosystems as well as promoting sustainable agriculture through understanding processes that affect insect communities.

NWPI's citizen science program has been motivated by the decline in pollinators over the recent years. In 2015, the Citizen Science Initiative for Bees (CSI: Bees), was initiated with the purpose of

encouraging conservation on wild bees through collaborative bee monitoring and short courses. CSI Bees is comprised of two separate projects: WildBeeSense Biodiversity Project and Pollinator Post Project. WildBeeSense Biodiversity Project monitors wild bees to investigate in the decline of wild bees in over 70 of Seattle's urban gardens. Community participants are given free guides on identifying and observing wild bees, a hands-on instruction in pollinator identification and monitoring. The Pollinator Post Project studies the needs of cavity nesting bees in urban locations through citizen science because urbanization threatens wild bee habitats. Citizen scientists attend a class by NWPI's Eli Bloom to learn about the life history of cavity nesting bees, how to observe them, and they are then provided with a "bee mailbox" to take home for monitoring. Citizen scientists collect their data through the summer season, then send the results to WSU for further analysis. Both projects seek to promote science-based community action and pollinator conservation in an empowering and collaborative way.

Participatory Vegetable Breeding

Northern Organic Vegetable Improvement Collaborative (NOVIC) is an effort to join researchers and farmers to address the needs of seed and plant breeding. Jim Myers at Oregon State University helped establish NOVIC as there was a dearth of breeding programs with a specific focus on organic agriculture. The program utilizes participatory plant breeding which includes farmer-breeder's development of open-pollinated crops. NOVIC collaborators work regionally with farmers on endeavors such as breeding, trials, and education all while sharing findings with farmers, seed companies, and research and education organizations. NOVIC variety trials are published in a national dataset of organic variety trial results called Organic Variety Trial Database (https://varietytrials.eorganic.info/), which is maintained by collaborators and partners at eOrganic (https://eorganic.info/). The database is open to the public and is a great tool for sharing information between researchers and organic growers. Ultimately, the goal of NOVIC is to develop open-pollinated crop varieties adapted to the needs of organic growers. The program benefits farmers through increasing local and seasonal vegetable production, assist farmers in complying with organic regulations, and improving farmer's success through outreach and education resources.

Sea Life that is Vital to Indigenous Communities

Ocean Networks Canada (ONC) is a not-for-profit society that was created by the University of Victoria in 2007 that oversees the east and west coasts of the Arctic and Canada using two major observatories. These observatories deliver continuous data about ocean changes and other vital waterways in real-time. Data collected by this project informs communities, the government, and industry to make crucial decisions. Representing this organization at the Citizen Science Workshop was Indigenous Community Liaison, 'Qátuẃas (Jessica Brown). 'Qátuẃas works to bridge the gap between Indigenous knowledge and Western science through active engagement with Indigenous communities regarding ocean observing systems, the changing ocean, and climate change.

There are three citizen science projects under ONC: Digital Fisher, Coastbuster, and Live Video feeds. All projects are open to anyone who wants to participate and no experience is required. Digital Fisher is a crowdsourced ocean science observation game that asks volunteers to watch a 60-second video of ocean observation footage, then describe what was seen, like sea life, water clarity, etc. Coastbuster is an app that reports potentially hazardous marine debris to OCN staff members. Watching streams of live video from ONC observatories and reporting unusual creatures and events is another opportunity for volunteers to participate. The three projects contribute to the understanding of the deep ocean as well as protecting Canada's coasts from marine debris.

Collaborative Experiments on the Farm

GoFarm Hawai`i is a beginning farmer development program started in 2012 at the University of Hawai`i in collaboration with different groups such as community colleges, Kamehameha Schools, Pioneer, and several non-profit organizations. It offers agricultural training called AgSchool across the state as well as courses and lectures on business development and management in agriculture. The workshop participant, Jay Bost, is the farm coach and site manager at GoFarm Hawai`i's Windward Oahu program.

While the agricultural training for beginning farmers is the core mission of the program, GoFarm Hawai`i has also collaborated with university-based researchers to carry out experiments.

Outcomes of Citizen Science

Many different outcomes of citizen science were shared at the workshop, reflecting the diversity of projects represented by the participants.

Contributing to scientific knowledge

Participatory research projects can lead to scientific discoveries and innovations. Citizen science projects resulted, for instance, in new plant varieties for organic farming (NOVIC), greater understanding of pollinator health (Northwestern Pollinator Initiative), evidence of linkage between antibiotic resistant bacteria and livestock worker health (REACH), and documentation of pesticide drift into homes and schools (PANNA). Many studies resulted in peer-reviewed articles, which are listed in Appendix B.

Improving community health

CS can directly help community members to avoid environmental and health harms. For instance, the Gardenroots project provided concrete lifestyle modification suggestions so that residents could reduce their exposure to hazards (for example, washing food and hands, refraining from tracking soil indoors).

Fostering relationships between universities and communities

CS can nurture better relationships between researchers from universities and community members. For instance, in the GoFarm program for sustainable gardening and farming, on-site research is a part of the process from the beginning. In another example, REACH has partnered with Johns Hopkins and UNC, overcoming a legacy of distrust of academic researchers among a predominantly African American community that has been subject of unethical treatment in the name of science.

Showing public concerns to policy makers

Citizen science can function as a space to showcase public interest in a particular health and environmental problem. The pollinator project is a good example of how CS can demonstrate to policy makers that an issue has strong public interest. The project involved various actors (4H, master gardeners, college and elementary students, etc.), which demonstrated widespread public interest in solving the problem of declining pollinator communities. As a result, members of government organizations based in western Washington contacted the project team about methods that address the issues of declining pollinator populations. The project team also met with members of the governor's office to address this problem. This is one way that citizen science provides a forum for people to indicate that a societal problem is important enough for law makers to consider implementing new law and policy.

Increasing civic capacity of community partners

CS also builds confidence and willingness to participate in the regulatory and policy processes that are needed to protect the environment and health. For instance, PANNA's Drift Catcher project builds knowledge in farming and farmworker communities about pesticides' effects on human health. Drift Catcher studies often validate residents' own lived experiences and concerns so that they can more effectively advocate for stronger rules on the use of pesticides (e.g. creating buffer zones and limiting use of chemicals linked to illnesses). In one example, a PANNA driftcatching project with communities in the Central Valley of California enabled local organizers to prove the extent of pesticide drift and win a county-level ordinance designating no-spray buffer zones between fields and homes. In another example, a driftcatching project in the Midwest helped expand conversation among community members about the extent and harms of pesticide exposure in the region.

Supporting litigation with evidence

In some instances, CS results may be used as evidence in lawsuits. For instance, REACH and other environmental justice advocacy groups filed a Title VI Civil Rights Act complaint against the North Carolina Department of Environmental Quality (NCDEQ) after the agency re-permitted industrial livestock operations using waste management procedures that disproportionately burden communities of color in eastern North Carolina. In May 2018, a settlement agreement was reached that will require NCDEQ to improve the waste management permitting process and conduct added environmental monitoring, among other changes.

Challenges to Address

While workshop participants were happy to share their successes, much of the discussion focused on the challenges that can undermine participatory agri-food research, such as:

- Misalignment of expectations and priorities
- Credibility challenges
- Colonial relations
- Gender inequality
- Corporate food regime

Misalignment of expectations and priorities

Researchers and community members may not realize that they bring different expectations to a CS project. Workshop participants emphasized the importance of good communication before the initiation of a project. There should be agreement on the following questions: What are the desired outcomes, who is to be involved, what resources are expected from each party, and how and when are results shared?

Partnering with scientists in citizen science projects can help grassroots organizations document their grievances, but sometimes such partnerships can serve some partners' needs better than others.

Some participants also indicated the importance of maintaining focus on the broader social and ethical priorities that interest the public in the research project, which can sometimes be in tension with professional researchers' needs for producing publishable scientific knowledge.

While in some cases, volunteers may prioritize social change goals (e.g. making agriculture more sustainable, improving health), others may be mainly motivated by desires to learn about a topic. In those cases, volunteers may be unwilling

TRANSPARENCY NEEDED

The goals of agricultural scientists and citizen farmers are often not completely aligned. For citizen science in agriculture to be successful, the benefits of collaboration need to outweigh the transaction costs of the collaboration. Transparency on the expected returns for all parties is required. Entrepreneurial efforts on how to meet various expectations for the scientists and citizens need to be mapped. Shared publications, shared royalties, shared responsibility for data quality, as well as the legal liabilities and ethical issues must be laid out at the onset of the research.

- Catherine Chan, Brent Sipes, and Patricia Laporte, University of Hawai`i

EXTENSIVE TRAINING

In my CS projects, I provide extensive training sessions with the residents, have community members collect field blanks, complete a chain of custody form, and randomly select households where I collect my own samples to comp are against the participants' samples. I'm exceedingly careful because I knew if we observed a contaminant of concern at an elevated concentration, one of the first things others might want to challenge is the methodology; they'd say, 'Oh, they did not know how to collect the samples'….These notions of who can generate knowledge, who has authority, and that science should be fully divorced from advocacy really gets me riled up because I'm frustrated by the disparities in access to knowledge. …. In my experience, participants follow protocols, demand accuracy and precision in me and themselves, and want answers that will inform whether they need to modify their behavior to reduce exposure.

- Monica Ramírez-Andreotta

to commit to a project for the long term. One scientist estimated, "Usually, we lose 70-80% of the people because they've learned what they wanted and they never gather the data for us."

Workshop participants debated how to address this situation. One idea was to simplify projects so that volunteers can make a contribution while gaining the knowledge they seek. Yet others suggested that simplifying the research task might lower the stakes for volunteers and diminish their commitment to the issue. When volunteers do not have uniform reasons for joining the project, it is important to be aware of the range of motivations. This can be accomplished by forming a stakeholder advisory group, representing the different interest groups engaged in the project. This group can have meetings to determine what the priorities and shared interests are.

If the volunteers are intrinsically interested in making socio-environmental change, the project leaders need to design the program accordingly – building the volunteers' sense of efficacy and confidence. This may mean establishing projects with clear normative goals (e.g. transformation of the food system), bringing people together around those goals, and allowing research to emerge out of that collaboration.

Misalignment of expectations also can emerge when study results do not confirm a community's perceptions. Often times, community groups contact university researchers when they suspect environmental pollutants and contamination in the environment. They may hope to get hard data on pollution and contamination that can help them to press for policy change and corporate behavioral changes. However, test results may come back negative or not above the regulatory thresholds.

Several workshop participants described how partnerships with community groups were challenged when there was a finding of no significant impact (e.g. air pollution is measured at

"safe" levels, or suspicions of food contamination are not confirmed). Often, a researcher's findings of no significant hazards are interpreted as suggesting that there is no problem and that the community's concerns are unwarranted. For community partners, this may come as a relief but also can be experienced as demoralizing, because their direct experiences of a problem are not validated.

Workshop participants emphasized that a negative finding can result from a narrow framing of the problem; a marginalized community might experience a wide range of injustices that are not adequately represented in measures of environmental quality. Addressing the patterns of exposure that concern residents might require a wider variety of collaborators and additional research questions (social, mental health, economic, and so on). Through multidisciplinary research, collaborators can expand the conversation about which questions should be asked and who should be involved in addressing community concerns.

In one example, the researchers emphasized that even though their study did not confirm the community's suspicions that their fisheries were polluted, there were limitations on the study, and they lacked the funding to pursue subsequent questions.

> *When we found out there was nothing in the shrimp, [the lead scientist] was specific that it is only about the shrimp that we trawled in these areas at a specific time. This doesn't speak to consumption levels. FDA set the consumption levels. Assuming that you eat a quarter pound, they were curious about if you eat 5 pounds. They wanted to look at genotoxicity, if it changes over time. There was a whole list of other types of fish that consumers were concerned about. …We had a discussion and agreed it's not just the oil spill it's about mental health and social economic. …I don't know what the solution is. You start to answer but then you can't get the funding to answer the rest of the question.*

Many workshop participants agreed that it was essential to have funding to pursue new lines of investigation, even when the first part of a study did not have expected results (see section on institutional support near the conclusion of this report).

Credibility challenges

In CS, data collected by non-professionals may attract scrutiny. Because science has been professionalized and is now seen as a domain of credentialed experts, lay people's involvement raises suspicion about data quality. In the scientific research community, there is increasing attention to ways to enhance data quality, such as training by professional scientists, pre and posttests, competency tests of citizen data collectors, identification and exclusion of data from unreliable contributors, and aggregation of citizen data (Dickinson, Zuckerberg, and Bonter 2010; Swanson et al. 2016).

Scientists' perceptions of citizen science may be changing as well. For instance, influential and high-impact journals such as *Conservation Biology* have had special sections featuring citizen science in recent years. Nonetheless, the workshop participants reported persisting prejudice against data produced by volunteers, even with the help of credentialed scientists.

Workshop participants shared stories of struggling to establish the legitimacy of their data. Particularly when scientific validity needs to be defended by community members, that becomes a big challenge. For instance, in the case of pesticide drift monitoring, PANNA uses a reference exposure level (REL) that is based on the California Office of Environmental Health Hazard Assessment's (OEHHA) framework rather than the federal EPA's REL. Because pesticides are applied in areas where children reside, PANNA prefers to use the OEHHA calculation of REL which is designed for sensitive populations, such as children or pregnant women, and is based on children's breathing rates and body weight. However, PANNA's partner organizations' findings have been dismissed when results do not exceed the federal EPA REL, which is higher. While PANNA feels that it can justify its use of OEHHA's REL, "it can be extremely challenging for community members and project partners to defend this highly technical component of the analysis, even with PANNA scientists testifying in support", writes Ishii-Eiteman.

HAVING A STAKE IN CREDIBLE SCIENCE

Citizen science questions that are often trying to address concerns that are tied to political issues can definitely be credible especially when it is about enhancing transparency and access to information. In 2013, both MQVN CDC and Tulane University worked with VEGGI Farmers' Cooperative to test local urban farming soils based on concerns around a history of local industrial dumping. This was done to increase transparency even though it posed an economic risk to farmers because if the results showed tainted soils, their ability to farm may well be negatively impacted. This commitment to enhancing community access to science and knowledge was especially highlighted when farmers attended mass to pray for favorable outcomes. This shows that even though farmers had a particular interest, they were still committed to engaging in the scientific process to gain a better understanding of their communities. In fact, it is arguable that this approach makes application of science more relevant to communities rather than tainting data.

- Daniel Nguyen and Jeffrey Wickliffe

The credibility problem of CS is particularly salient when CS involves community members with explicit advocacy and policy change goals. In fact, recent writings on CS tend to frame the issue as "conflict of interest" (COI). Several articles on the topic have raised concerns of COI when citizen scientists have a goal "to advance their political objectives" ("Rise of the Citizen Scientist" 2015) or with "alliances with private, nonprofit, and political organizations, as well as their involvement in lawsuits" (Guerrini et al. 2018). Examples of such COI that are given by these

authors include anti-fracking activists monitoring pollution and volunteers involved in lawsuits regarding corporate polluters. Observers of CS are particularly worried about COI in these cases, as academia has some level of safeguards such as COI policies at universities, funding organizations, and academic journals. However, volunteers in CS are not subject to such institutional rules, sanctions and norms, so there is a particular concern about their COI (Resnik, Elliott, and Miller 2015).

Nonetheless, the workshop participants pointed out that politically-minded community members do not necessarily "corrupt" science and typically produce valid scientific data. In two sidebars in the previous pages, Nguyen and Wickliffe and Ramírez-Andreotta write about the meticulous ways that CS volunteers and organizers try to increase the validity of their CS data.

Colonial relations in agri-food systems

Lack of access to culturally appropriate and nutritious food is a major problem that is particularly salient in indigenous communities. Colonization, forced migration, privatization of land and water, and encroachment by White settlers have critically harmed the connection between indigenous communities and their traditional food. Industrial activities, pollution and extraction of natural resources reduced availability and desirability of land to cultivate, waterways to fish, and forests and swamps to forage.

Indigenous knowledge is often attacked and devalued. Indigenous scholar Linda Tuhiwai Smith writes about the imperial history of rendering indigenous people as "Other." "Scientific" accounts and histories of indigenous people have been written as a part colonial endeavors. She writes, "research is an important part of the colonization process because it is concerned with defining legitimate knowledge" (Smith 2005a, 285). She argues that "the methodologies and methods of research, the theories that inform them, the questions which they generate and writing styles they employ, all become significant acts which need to be considered carefully and critically before being applied. In other words, they need to be 'decolonized'" (Smith 2005b). Asking the following questions can aid in decolonizing research (Smith 2005b):

- Who defined the research problem?
- For whom is this study worthy and relevant? Who says so?
- What knowledge will the community gain from this study?
- What knowledge will the researcher gain from this study?
- What are some likely positive outcomes from this study?
- What are some possible negative outcomes?
- How can the negative outcomes be eliminated?
- To whom is the researcher accountable?
- What processes are in place to support the research, the researched, and the researcher?

MARGINALIZATION OF INDIGENOUS KNOWLEDGE

It often seems climate change science is only the study of colonial destruction to the environment rather than an investment to societal restructuring regarding the general public's relationship to nature and personal responsibility to the environment. We know the ocean is changing and we know greed is at the center of why. It seems that science holds the ability to be coopted by funding sources and pulls us further away from the social and ethical concerns that ignited the science in the first place. It is often not the participants who lose sight of project's goal, but rather they are guided by a flawed system that exists to privilege the colonial worldview and the settler understanding of scientific questions.

What I have continually witnessed is the omission of the intergenerational knowledge of Indigenous people, and the screams and cries of our environment, to instead prove something scientifically that has been observed first hand by those living on the frontlines of climate change.

- 'Qátuẃas (Jessica Brown)

Workshop participants also called attention to the OCAP principles for conducting research with First Nations, excerpted below (https://fnigc.ca/ocapr.html).

- **Ownership** refers to the relationship of First Nations to their cultural knowledge, data, and information. This principle states that a community or group owns information collectively in the same way that an individual owns his or her personal information.
- **Control** affirms that First Nations, their communities, and representative bodies are within their rights in seeking to control over all aspects of research and information management processes that impact them. First Nations control of research can include all stages of a particular research project-from start to finish. The principle extends to the control of resources and review processes, the planning process, management of the information and so on.
- **Access** refers to the fact that First Nations must have access to information and data about themselves and their communities regardless of where it is held. The principle of access also refers to the right of First Nations communities and organizations to manage and make decisions regarding access to their collective information. This may be achieved, in practice, through standardized, formal protocols.
- **Possession** While ownership identifies the relationship between a people and their information in principle, possession or stewardship is more concrete: it refers to the physical control of data. Possession is the mechanism by which ownership can be asserted and protected.

Citizen science, when done by indigenous communities or in deep collaboration with them may start to address power asymmetries. But, as Janelle Marie Baker describes below, the power asymmetry between Western science and indigenous knowledge, credentialed scientists in Western academia and indigenous communities is a real problem.

OWNERSHIP AND AUTHORITY

A major struggle I have experienced and observed in helping to co-ordinate the research is that in spite of the claim that this project is "community-based," I find myself constantly fighting for Fort McKay [First Nation] to have control, ownership, design, and authority over their own project. … I witness regular small acts of aggression from non-Aboriginal project partners, such as interpreting silence as consent in project design, people trying to control the berry field trip monitoring scheduling (which has always been determined by the berry group based on environmental observations), people getting angry in meetings when I describe the need to prioritize First Nations' ways of knowing in the project, and partners wanting to take over the fieldwork in the project and completely remove Fort McKay's participation in the project, in spite of the project being created by Fort McKay as a community-based monitoring endeavour. Most of all, the concern I have had from the beginning of this project is the use of science to prove or disprove Fort McKay participants' observations and how the scientific results from this project could be (mis)used by government and industry to publicly demonstrate that the oil sands industrial activities are having "no significant impacts" on First Nations' traditional lands or health. … Underlying the above-described and often subtle tensions is systemic racism in Canada toward Aboriginal peoples. … This means that even well-meaning scientists…often assume that the First Nations project members are not able to manage their own research funds or projects, and that First Nations no longer possess or practice their traditional knowledge, even though it is easily observable in the region. Ultimately, settlers on these projects are sometimes blind to the rich spiritually based environmental knowledge that community members share and enact for survival and systems of respect and reciprocity on the land.

-Janelle Marie Baker

Additionally, some studies have suggested challenges that are specific to research in agri-food systems. Writing on the academic research on crops that are important to native Hawaiians such as Kalo (taro; *Colocasia esculenta*) and ʻawa (kava, *Piper methysticum*), researchers at University of Hawai`i and their community partners have pointed out that several issues such as:

- The lack of consultation and transparency in research by credentialed scientists
- The scientists' tendency for a reductionist framing of the "crop problem" to a disease or a pest, rather than situating it in historical and holistic contexts
- Normalization of industrial farming

- The incongruence between university research's drive to patent new varieties and spiritual view of crops by indigenous communities

They have called for more "*pono*" (balanced, ethical) ways of doing agricultural research.

- Acknowledge different world views, objectives, and time frames
- Exercise individual accountability
- Improve institutional ethics and support
- Cultivate spaces for healthy exchange
- Shape research agendas around indigenous crops and farmer realities
- Invest time in scoping questions of interest to communities
- Invest time in engaging communities in the research
- Allocate institutional support for culturally important facilities, projects and research (Kagawa-Viviani et al. 2018).

Research output requires similar careful considerations and dialogue. Wildlife, food, and crops have spiritual, social, and cultural values in addition to industrial, economic, and scientific ones. There is an increasing pressure to claim intellectual property over germplasm, and this may go counter to indigenous beliefs. For instance, declarations such as the *Treaty for a Lifeforms Patent-Free Pacific* and the *Paoakalani Declaration* in Hawai`i embody the rejection of privatization of lifeforms from indigenous perspectives.

Gender inequality

Many localized environmental struggles have gained strength through the activism of female community members. From residents fighting chemical contamination of home properties to those opposing mountain top removal of coal, women often are the first to speak up about changes in their environment and community health (Blum 2008; Bell 2013). Food, cooking, and gardening are often culturally marked as female domain. This might also motivate women to participate in food-related CS.

Gender inequality should be considered in CS projects that involve unpaid volunteers. Women often shoulder a "second shift" of unpaid care work beyond their paid jobs. Thus, their leisure and discretionary time may be smaller than their male counterparts. A report issued in Europe on CS notes that "Not surprisingly, because of imbalances in care responsibilities, biases in science education, and in income, men are overrepresented in citizen science. For example, a study found that 87% of the participants in a volunteer computing project were men, while a similar bias was identified in ecological observations of birds. Moreover, white men aged 20-65 from well-to-do socioeconomic backgrounds are overrepresented in citizen science" (Haklay 2015). Researchers and organizers of CS need to be reflexive about gendered barriers and pressures on CS participation.

GENDER IN AGRICULTURE

In order to properly address gender issues in innovations of agriculture practices, feasibility assessments must strive to include gender implications. To properly assess gender issues, citizen science project design needs to consider impacts in term of gender-based constraints that hamper productivity, rebalancing gender equity in income or income-earning opportunities, reducing the time or energy women spend on labor intensive tasks such as house related tasks due to inadequate rural infrastructure, promoting more gender balanced access to project activities or factors of production, encouraging men's and women's participation and decision-making at the community level, strengthening institutions' gender awareness and the application of gender analysis into design and monitoring. … Incorporating gender analysis into project design shapes and creates improved technologies in agriculture and has the ability to trace the welfare gains from their adoption.

- Catherine Chan, Jacqueline Chan-Dentoni, and Brent Sipes

In addition to the issue of participation, the goals and output of CS need to consider gender dynamics. In the context of agriculture, workshop participant Catherine Chan and her colleagues (sidebar above) commented on the need to design CS in a manner that is sensitive to gender differences. "Community" is not a monolithic entity. Even when a CS project features collaboration and co-creation with the "community," consideration of whose voices dominate as the voice of community is needed.

Corporate food regime

Sociologist Phil McMichael has described the present-day agri-food system as a "corporate food regime," in which the power of large corporations has accelerated (McMichael 2005). The expansion of the corporate food regime is rooted in the deregulation of financial systems, privatization of natural resources, corporatization of agriculture and agro-exports, and casualization of labor since the 1970s. While it may have reduced the nominal price of food to some consumers in developed countries, it has resulted in dispossession of peasants and reduction of traditional farming and concomitant expansion of chemical-seed markets. In many sectors from dairy to meat processing, oligopolistic trends have intensified, with fewer and larger companies dominating the increasingly global market.

Even with the rise of food justice movements in North America, large corporations play a pivotal role. Workshop keynote speaker, Robert Gottlieb has written the following:

> The food justice groups today are at a pivotal moment. They have begun to influence the direction of food advocacy to make it more inclusive, pointing out the need for deeper changes in the food system. They have brought about some impressive changes at the institutional level, in some policy arenas, and perhaps most extensively in the public discourse around food—where and how it is grown, the importance of access, the need for a new kind of eater's ethic, and the need for a connection to where one's food comes

> from…..An even greater hurdle looms as the dominant food industry interests begin to respond to the changes that have taken place and the challenges presented to their power and control over food system choices. As food retailers such as Wal-Mart, the pesticide and agribusiness players such as Monsanto, the fast food and junk food purveyors such as McDonald's and PepsiCo, and the vertically integrated operators such as Tyson become aware of these new challenges, they are expected to introduce a new set of arguments, to undertake preemptive and manipulative actions to obscure the notion of change, and to work to ensure that the more entrenched aspects of the food system, such as the trends toward corporate concentration and global reach, remain out of play (Gottlieb and Joshi 2010, 231)

Food-related CS does not exist in a vacuum and practitioners have to recognize the political economic structure in which their research is embedded. One of the issues that citizen scientists may have to grapple with is the power of multinational corporate players. There are multiple ways that CS interacts directly with corporate actors. CS data may threaten their economic bottom line if it strengthens the case for more stringent regulations. CS may also be perceived as a threat to a corporation's public image. In some instances, agribusinesses actors may be interested in promoting a particular kind of CS that serves as outreach and public relations (Kimura and Kinchy, 2019).

INDUSTRY SEEKS TO UNDERMINE RESEARCH

It is likely that our research will be placed under intense scrutiny, whether in the context of litigation or in the peer-review process. In particular, I have seen REACH put under a lot of pressure to perform, as industry attorneys and other critics are quick to question the quality of samples collected by what they deem to be "untrained community members," despite REACH's extensive training with UNC/JHU researchers, their participation in multiple research studies, and their extensive knowledge base. It is without a doubt that any research that is associated with social movements invokes a much greater level of external questioning of credibility compared to the other work that I am involved in.

- Sarah Rhodes

There are more subtle ways that the corporate food regime influences CS. Workshop participants observed that certain ways of producing food are normalized, escaping scrutiny about their social and environmental impacts. As a result, research that questions the sustainability of the dominant way gets marked as "political" (hence potentially biased). One example in this vein is the normalization of farming that is dependent on agrochemicals and genetically modified seeds. This kind of farming is the norm in North America in terms of acreage and gross sales, hence its peculiarity becomes hidden. Research into its social, environmental and health effects tends to be seen as driven by a political agenda.

Simultaneously, the alternative approach to farming such as agroecology and organic farming is seen as radical and new, when generations of farmers have practiced it.

If CS seems to uncover potential damages to the environment and health from corporate practices, industry players have tried to undermine its credibility by portraying it as untrained or "politicized" science. CS organizers have to anticipate these potential credibility attacks.

WHICH PRACTICES ARE "POLITICAL"?

In the new farmer program I work with, GoFarm Hawai'i, we carry out training of interested members of the public in the basics of agricultural production. The vast majority of the diverse group of people who come to our program are interested in "organic", "low-input" farming practices.

Our farming sites including a location on an international seed company's land, a University of Hawaii research station, and community colleges. To differing extents the practices that we teach and utilize are often times at loggerheads with the practices around us, and we are often criticized and/or jokingly mocked for our practices. We are pushed into the corner of being the ones who are deemed on a mission with political and social tones (which in truth we often are) or are just plain naive, but those farming around us are regarded (or at least regard themselves) as practicing the norm - an agriculture without political and/or social missions when, in fact, their practices are very much the tools of very specific political agendas.

While many of us in our program do, in fact, have food systems change as a conscious goal, for many other participants, the decision not to utilize certain substances is as simple as wanting their children to be safely able to be in their fields and to eat the food they produce. If this is political but spraying known toxins to produce seed of unadapted plant materials for seed increase to supply global agribusinesses with their patented seeds to utilize with their patented agrochemicals is not political, we find ourselves in strange times.

- Jay Bost

Building Partnerships

A key theme of the workshop was building partnerships among community organizations and scientific institutions such as universities. One academic researcher said:

> *The only thing that works is to spend time out there talking with people about the problems. Talking about what you can do and you can't do. If I didn't take the time to go*

do that, I'm not sure [my community partner] and I, some of the work we've done together, we wouldn't have done it.

Participants agreed that it was essential to make time to discuss the needs and deepen relationships. They compiled their advice to people who are seeking to develop a collaborative citizen science project.

Preliminary research on the situation is essential

Project organizers need to have a clear understanding of the historical context in which the community-based research might take place. Begin with a survey of the issues, learning from someone currently grounded in the community. Map out the relations of power among the participants and collaborators, as well as the larger situations you are in.

Have clear normative goals

What type of research do you want to do and *why*? Always discuss project goals and intended outcomes with all partners before the project begins (e.g. climate change resilience, food security, healthy children). Evaluate whether the research you are proposing is the right way to proceed for the goals that you have.

Build a relationship of trust and respect before seeking funding

Relationship-building can take a year or more. First collaborate with people you are close with and can trust, then branch out to include other partners. Be mindful that not all collaborative relationships are going to work.

If you are from outside the community, show up in service. It is worthwhile to get training in how to listen and learn to change roles. Volunteering is a good way to build authentic personal relationships. Follow the leadership of people from the affected communities.

Meeting dynamics are important to building equitable and trusting partnerships. Ask community organizers for their opinions; defer to them without assuming you know best. Treat all people at a meeting equally regardless of status and title. One helpful strategy is to ask everyone at a meeting to speak for a set amount of time, making sure everyone knows they will have a chance to speak

Make an agreement on information sharing

Before beginning a project, it is essential to create fair agreements about ownership of data, intellectual property, co-authorship, and any other products that come out of the project. University researchers should discuss with their employers about the kind of data and research that they plan to pursue and how it will be perceived. Community organizers should be prepared for scrutiny of the data, and therefore must be transparent with community partners that there may be pushback.

Value participants' time and efforts

Participants in a citizen science project may be volunteers, but their efforts should be compensated whenever possible. For example, hire a local NGO to serve as liaison and coordinate aspects of outreach, and write community workers into budgets. Even when funding is not available, other forms of collaboration can help to maintain the relationship. For example, university professors can provide informal education and environmental organizations can support communities with needed public policy information.

Go where the community is

Schedule meetings at times when people with caring responsibilities can come, and provide child care. Provide culturally appropriate food to people who are making time to come to meetings. Host gatherings where participants feel comfortable, and speak in their languages. It can be beneficial to work with elders who are retired and have more time for work on community projects, but be mindful of their needs as older adults.

Addressing Power Asymmetries in CS

Efforts to build partnerships can be undermined by significant power asymmetries between researchers and community partners. Race, class, gender, and other forms of social inequality need to be addressed in the design of citizen science projects.

Workshop participants had many suggestions on how to acknowledge and address power asymmetries in collaborative research. They called attention to the need for "political education" for the professional scientists involved in participatory projects, the importance of data sharing agreements, the value of already-established guidelines for participatory research, and the potential benefit of collaborating with social researchers.

INCLUSION

I strive to implement methods that promote integrity, engagement and inclusion, for example a co-created citizen science project design, which resembles participatory action research (PAR) and community-based participatory research (CBPR). These approaches to research introduce democratic values (justice, equity and truth), and emphasize that the individuals and groups that will be impacted by an action must be part of the problem-solving process… In my experiences working at hazardous waste sites, adapting a participatory framework that works alongside communities to identify critical concerns can increase the diversity of participants and those in leadership positions and provide a foundation for the generation of sustainable, long-term solutions.

- Mónica Ramírez-Andreotta

CREDIBILITY CHALLENGES AND BACKLASH

PAN's Drift Catcher project challenges regulatory agencies' and corporation's monopoly over science. As a result, communities have won more health-protective policies. These advances can be undermined when "professional" scientists — who may want to maintain their privileged role as "the expert" — challenge the credibility of community science. Far more damaging, however, is the corporate backlash that can devastate a community's wins, as subsequently occurred in Washington, unravelling all of that community's hard-won policy gains and even leading to the removal of sympathetic agency staff from their jobs. As our local partner there concluded, "grassroots science" projects like the Drift Catcher are immensely powerful as an organizing tool and a way to assert public authority over science and decision-making. But going forward, this partner emphasized, we must be prepared to devote as much time to fighting corporate power and influence over our democratic institutions, as to investigating and documenting grievances on the ground.

- PANNA

Scientists need political education

Community- and NGO-based participants emphasized the need for basic political education for researchers and their reflexivity about own positionality. University researchers are highly educated and are immersed in a specific institutional culture of higher education and academic science. One scientist said:

[You need] to understand power, your own power as a researcher. We all have power that moves in different ways. Understanding about race, class and the power and privilege of the role of the university that works through you. And to understand the institutional biases that are built in. To be able to get outside of your comfort zone. If you don't have the training to talk to people, [you won't] have the skills to then be able to have the capacity to have real conversations. [You should be] learning how to listen to community members, really listen for a looooooooong time.

Another scientist added: "This is not the space where you should be the dominant voice. In academia, we are told that we are the experts… and you are dictating science 'down' to lay people. …You need to understand that universities are historically actors that are not trusted in the community."

This statement reflects awareness that scientific research institutions have a fraught history of treating ethnic minority, indigenous people and others in unethical manner.

Data sharing should be equitable and responsible

The process of sharing data and findings was an important topic for discussion at the workshop. If an academic researcher is expected to publish results before publicizing them, this may limit sharing of key information with affected communities. One researcher shared: "I operate under the philosophy that if it's

something that's not good, you act on it immediately. I contact people immediately… [In contrast,] I have colleagues that are like no way am I reporting anything before I publish it."

Some researchers advocated creating a "team charter" or "memorandum of understanding" between the lead scientist(s) and the other participants in the project. This may include commitments to get people the help they need if the study shows that they have been exposed to a health risk. For example, in one study that involved biomarker work, the researchers developed a plan to report any findings of high blood levels to the affected research participant.

The struggle over individual reporting of collected data is also reported in existing research as well. In public health, the issue is about personal exposure data. Cordner et al. writes that reporting back the individual data is controversial when some IRB worry that uncertainty of contaminants and the lack of remediation can be psychologically harmful to the individuals (Cordner et al. 2012a).

The National Institutes of Health funded the Personal Exposure Report-Back Ethics Study, which examined how researchers report back data to individuals. Some of the suggestions include:

- Personal exposure reports should answer these basic questions: What did you find? How much? Where did it come from? Is it safe? What should I do?
- Include contextual information about health implications and exposure reduction strategies.
- Both narrative and graphs are helpful.
- Graphs comparing an individual's results with other participants in the study and benchmarks, such as the National Exposure Report, are helpful, but must be used carefully to avoid incorrect inferences that higher results are necessarily harmful or lower results are safe.
- Communicate what scientists do know and what potential health concerns led them to select a chemical to measure.
- Methods can be tailored for specific settings by involving participants and community members in planning (Brody et al. 2014).

What if community partners do not want results to be published or publicized? This may occur if the findings stand to threaten the value of their property or their livelihoods. There are also considerations of what to publicize if there are no significant results (e.g. no finding of food contamination). While people may be relieved that they have not been exposed to a contaminant, there may be situations where a community may want this result to remain confidential. This may happen, for instance, if a community is involved in a legal dispute and the data weakens their claims. These are issues that should be discussed and agreed upon before the start of the investigation.

Participants summarized these best practices to follow with respect to sharing information.

- Discuss with community partners different possible findings and develop "team charter" about what to do for each possible circumstance.
- For very alarming preliminary findings, share them with the research participants (i.e., don't wait) while investigating further.
- Share findings with health workers, the project's advisory committee, and other internal reviewers for feedback.
- De-identify findings in publications.
- Make sure that community partners have the resources and/or support needed to utilize the findings as they see fit.

The discussions summarized above indicate that ethics guidelines for participatory research need to be dynamic and ongoing, rather than a one-time approval by the Institutional Review Board. Cordner et al. argue that power differentials, the potential for gaps in expectations about research results, uncertainty about appropriate timing and manner of delivering research result requires "reflexive research ethics" (Cordner et al. 2012b). They point out that the participatory research "presents new moments of ethical uncertainty which cannot always be resolved through adherence to existing research practice" (p. 163). They call for reflexive ethics that is "the self-conscious, interactive, and iterative reflection upon researchers'' relationships with research participants, relevant communities, and principles of professional and scientific conduct" (164). Already-existing guidelines and principles (such as the OCAP principles summarized earlier in this report) can be a starting place for these reflections.

Seek out existing guidelines and principles

Workshop participants directed attention to existing guidelines for constructing equitable relationships between professional scientists and community groups (see Appendix). One example, from the public health field, is widely used among researchers working with communities to reduce health disparities. The Nine Principles of Community-Based Participatory Research (CBPR) lay out some foundations (Israel et al. 1998).

1. Recognize the community as a unit of identity
2. Build on the strengths and resources within the community;
3. Facilitate a collaborative, equitable partnership in all research phases through an empowering and power-sharing process that attends to social inequalities
4. Foster co-learning and capacity building among all partners
5. Integrate and achieve a balance between data generation and intervention for the mutual benefit of all partners
6. Focus on the local relevance of public health problems and on ecological perspectives that attend to multiple determinants of health
7. Involve systems development in a cyclical and iterative process
8. Disseminate results to all partners and involve them in the wider dissemination of results
9. Involve a long-term process and commitment to sustainability

The degree to which CBPR projects adhere to these principles is not clear. One study found that among CBPR-based cancer research project, most do well on the principles of 1, 2, 4, 5, 7 but varied on 3, 6, 8, 9 (Braun et al. 2012).

Another suggestion from the participants was the Jemez Principles for Democratic and Inclusive Organizing ("Jemez Principles for Democratic Organizing," n.d.). This document was adopted by environmental justice activists who participated in the Working Group Meeting on Globalization and Trade (1996) after the First National People of Color Environmental Leadership Summit (1991).

1. Be inclusive
2. Emphasize bottom-up organizing
3. Let people speak for themselves
4. Work together in solidarity and mutuality
5. Build just relationships among ourselves
6. Commit to self-transformation

Social science researchers can be helpful partners

Agri-food issues intersect with social marginality, colonialism, and concentration of economic power. Citizen science is never simply about collecting data. It is about knowledge production and knowledge is about changing or reifying power, compelling researchers to learn about political and social dimensions of the issue. Any individual researcher or community organizer is not going to have all the skills to examine every dimension of the issue fully. It is beneficial to have collaborators with different skills and perspectives (e.g. social/historical research, multiple scientific disciplines, political advocacy, community mental health support, etc.).

One of the suggestions of the workshop participants is to expand interdisciplinary collaboration to include social scientists. Many CS projects already have natural scientists on board, but not necessarily anthropologists, sociologists, or political scientists. However, social scientists who have expertise in agri-food politics and environmental justice help CS organizers to be aware of complex social dynamics that are discussed above.

The Need for Institutional Support

Workshop participants drew attention to the need for various forms of support for citizen science projects relating to food and agriculture. Funding is of course a key challenge, but academic/university expectations also hinder participatory research.

University-level support

Research universities do not always accept participatory practices toward research expectations. Workshop participants in academic positions indicated the critical need for institutional change that is conducive for fostering long-term community partnerships. Universities need to

recognize citizen science as a valid research methodology, as well as its societal benefits. For instance, universities could support citizen science projects in order to improve their relationships with their surrounding communities.

Recognition of the value of CS needs to be incorporated into the tenure and promotion criteria. One participant commented, "There needs to be something done among the institutions to make this more acceptable in terms of advancement. Otherwise, people will always go for the grant projects and the research projects that help them towards tenure."

Shifting the culture and expectations of universities needs changes in the mindset of faculty members as well as administrators. Faculty can take an active role in reviewing grants and directing funding toward citizen science projects, as well as being advocates for collaborative and community-based research on campuses, to "normalize" this type of research. Crucially, the work of Agricultural Extension at land grant institutions could be steered toward greater emphasis on citizen science and participatory action research.

Perception that citizen science is "free labor"

Some critics of citizen science have argued that it is a means of reducing public research expenditures and exploiting the free labor of volunteers. Our participants generally disagreed with this statement, for diverse reasons (see text boxes, below).

VOLUNTEERS SHOW THE IMPORTANCE OF RESEARCH

In agricultural work, it seems to me that some of the most meaningful work is carried out when there is a researcher who may or may not be trained in biological or agronomic science, who serves as an organizer and framer of the work, but who acknowledges that the farmers in their fields are the ones with the most relevant experience and in whose contexts the experiments make the most sense and need to be carried out. …Unfortunately, the research deemed important by funders and institutionally based researchers is not always the research deemed important and most meaningful to farmers. …

The fact that farmers and volunteers are willing to do the work without compensation shows that for them it is, in fact, very important and must be carried out with or without adequate funding, facilities, and/or institutional support – even though it might benefit from all of these and be ultimately more effective if provided these resources.

- Jay Bost

CITIZEN SCIENCE INCREASES THE IMPACT OF FUNDED RESEARCH

We believe that citizen science can be effectively used as a component of grants to increase the scope and impact of specific projects. In particular, citizen science can be used as a "broader impact" in grants for agencies like the National Science Foundation and US Department of Agriculture. … Citizen scientist should not be considered "free", but rather a component of a larger research project for which funding is requested…. Our survey data suggest the ability to contribute to a larger research project is important to many citizen scientists, but it is not their primary motivation. Citizen volunteers are only volunteering, in most cases, because they want to learn more about a system and learn tools and techniques that they can apply to their own lives; providing data for a larger project and connecting with other researchers are simply value-added benefits. Thus, we often view citizen science as a novel form of outreach rather than a rigorous research goal.

- Dave Crowder and Elias Bloom

Both of these commentaries suggest alternatives to the citizen science model of gathering "low-cost data" by recruiting volunteers to do simple data gathering tasks. Instead, whether funded or unfunded, citizen science can create meaningful, active roles for volunteers. To succeed, such projects require other forms of institutional support, such as funding for developing partnerships.

Scarcity of resources for developing partnerships

Participants described the obstacles to spending sufficient time building relationships in their community. Participants emphasized that everyone has other jobs, either at universities or in nonprofits, care work, etc. Academic researchers described how their teaching, research, and committee work interfered with having sufficient time to collaborate with community partners.

Some workshop participants had found solutions to these obstacles. For example, one participant had written educational grants that enabled him to pay a local non-government organization to serve as a liaison. The liaison helps to coordinate outreach, taking some responsibilities off of the faculty member's plate. Likewise, another researcher wrote funded community health worker positions into grants or created a subcontract with a local NGO.

However, the structure of the grant cycle, and the inflexibility of grants and other funding sources can hinder the work of building relationships. For example, one scholar indicated that National Science Foundation grants do not set aside the time for people to plan out how they are going to spend the money, in partnership with collaborators. Because an NSF application has to already have money allocated in a budget, community-based planning of a project must

occur before a proposal is written. Without prior grant support, it is extremely difficult to allocate time to building those relationships.

Additionally, participants who rely on grants commented that they require stable funding to maintain projects over the long term. Grants often are awarded for new and innovative practices, but ongoing partnerships are more difficult to fund.

Workshop participants identified several ways in which funding bodies could better support citizen science projects.

- Seed grants. Professional researchers should have meetings with community partners about research ideas before going forward with a proposal; this requires a longer timeframe for developing a proposal for community-driven research. Thus, seed grants are needed to build relationships and explore the many dimensions of the situation prior to pursuing funding for collaborative research. These grants should allow for the possibility that the seed project will not lead to further collaboration if it does not work as a relationship.
- Flexible spending. Grants should allow flexibility in allocating funds to what the participants prioritize. Often, this changes throughout the research process and cannot be pre-determined before the funding period begins.
- Multi-stage funding. Funders should create ways for grantees to apply for further funding to investigate new problems discovered through first stage of research process.

Misalignment of grants with seasonal practices

Seasonality is a challenge for working with farmers or doing outdoor work; this doesn't align with timeframes for grants. Some participants described the seasonality of their research and the availability of participants. Planning and funding participatory projects must take this seasonality into account. For example, one researcher described a government funded project that was logistically challenging.

> *We'll wait around for the government funding to come through. One year there was a fire in the community, where we had to evacuate a lot of people, so we were only able to do one research trip when we usually do three. In Canada, if you don't use all of your funds then they'll cut them the following year. The logistics are intense, especially with the snow.*

Another researcher noted, "It's like a joke for farmers. 'There's a three week window [when I'm available to participate]. It's right after elk hunting season.'" In other words, collaboration with farmers can be challenging because they are committed to activities that are fundamentally tied to the seasonal cycles.

With these situations in mind, participants made the following recommendations:

- Flexible spending and reporting deadlines. Funding programs should be more flexible and allow extensions when more time is needed or have an opportunity to pursue something interesting
- Application deadlines that reflect seasonal cycles. Funders should carefully consider timing of grant application deadlines and reporting deadlines to anticipate potential timing conflicts for participants. This is particularly relevant to agricultural and land-based projects, which are seasonal.

Conclusions

Public participation affects research agenda setting and investigations in different areas of the food system. Citizen science has already produced scientific data (e.g. data on pesticide drift, soil contamination) and new resources (e.g. new vegetable varieties). CS can also foster better relationships between academic researchers and community groups and increase interest in health and environmental issues among volunteers.

CS has potential to advance more holistic analysis of the agri-food system, and many investigators recognize the need for multidisciplinary research efforts. This includes attending to social and historical contexts. Many aspects of the agri-food system have been built on the dispossession of indigenous peoples, and food production, distribution, and consumption is highly stratified by race, ethnicity, gender, class, and citizenship. Increasingly large corporations have significant power over the norms and practices of food production, distribution, and consumption. The pursuit of "food justice" through CS requires diligent attention to these power asymmetries and concerted efforts to redistribute power.

CS can sometimes operate as a kind of collective action for social justice and sustainability groups, helping to bring about structural change in the food system. However, commitment to normative goals can sometimes come in conflict with scientists' perceived professional obligations to remain neutral. The implicit judgment that activist-oriented CS is inherently biased and unscientific works against efforts to address existing inequity and injustice.

In some instances, CS has been valuable in bringing about policy changes affecting agri-food systems. However, much greater institutional resources are needed if CS is to live up to its potential to inform policy changes. The ideas and recommendations summarized in this report can guide efforts to grow the transformative impacts of participatory research on the ecological and social systems that feed us.

Appendix A: Examples of tools to facilitate collaborative relationships

Curriculum on developing partnerships

Developing and Sustaining CBPR Partnerships: A Skill Building Curriculum
(http://depts.washington.edu/ccph/cbpr/index.php)
A set of curricula for community-institutional partnerships that are using or planning to use a CBPR approach to improving health. This was developed by the Community-Institutional Partnerships for Prevention Research Group that emerged from the Examining Community-Institutional Partnerships for Prevention Research Project funded by CDC

Individual reporting back to participants

When Pollution is Personal: Handbook for Reporting Results to Participants in Biomonitoring and Personal Exposure Studies (Silent Spring Institute)
(https://silentspring.org/personal_exposure_report_handbook.pdf)

Team charter

Public Health Foundation's Team Charter and related toolkits
(http://www.phf.org/resourcestools/Pages/Team_Charter.aspx)
"The team charter provides the initial direction a team needs to be successful in tackling the task it has been assigned. Too often a team spends valuable resources figuring out what it is supposed to do. A well-developed team charter can save time and reduce confusion by defining clear goals, expressed duties, and desired outcomes. This article by John W. Moran and Grace L. Duffy was originally published as a chapter in the Public Health Foundation (PHF) 2011 online book *Applications and Tools for Creating and Sustaining Healthy Teams.* It explains the guidelines for producing an effective team charter and provides a Team Charter Template for teams to use."

Code of ethics

International Society of Ethnobiology Code of Ethics
(http://www.ethnobiology.net/wp-content/uploads/ISE-COE_Eng_rev_24Nov08.pdf)
"The fundamental value underlying the Code of Ethics is the concept of mindfulness – a continual willingness to evaluate one's own understandings, actions, and responsibilities to others…. It acknowledges that biological and cultural harms have resulted from research undertaken without the consent of Indigenous peoples."

Memorandum of agreement

University of California San Francisco
(http://accelerate.ucsf.edu/research/community-tools#templates)
The Community Engagement Program is collecting and making available model Memoranda of Understanding (MOUs) and agreements between academic researchers and clinical partner sites to serve as models for new projects.

Appendix B: Published outcomes of projects featured in this report

Baker, Janelle M. & Fort McKay Berry Group. 2019 (in press). "Cranberries are Medicine: Monitoring, Sharing, and Consuming Cranberries in Fort McKay." In *Wisdom Engaged: Traditional Knowledge for Northern Community Well-Being*, edited by L.M. Johnson. Edmonton: University of Alberta Press.

Baker, Janelle M. 2016. "Research as Reciprocity: Northern Cree Community-Based and Community-Engaged Research on Wild Food Contamination in Alberta's Oil Sands Region." *Engaged Scholar Journal: Community-Engaged Research, Teaching, and Learning*, 2(1):109-123.

Bloom E, Crowder DW. 2019. "Educational courses and passive methods attract citizen scientists and increase data collection." *Citizen Science: Theory and Application, in press*.

Davis, LF, Ramírez-Andreotta MD, McLain JET, Kilungo A, Abrell L, Buxner S. 2018. "Increasing Environmental Health Literacy through Contextual Learning in Communities at Risk." *Journal of Environmental Research and Public Health*, Oct 9;15(10). DOI: 10.3390/ijerph15102203.

Guidry, G.T., Rhodes, S., Woods, C., Hall, D.J., Rinsky, J.L. 2018. "Connecting environmental justice and community health: Hog production in North Carolina." *North Carolina Medical Journal 79*(5), 324-328.

Hatcher, Sarah M., Sarah M. Rhodes, Jill R. Stewart, Ellen Silbergeld, Nora Pisanic, Jesper Larsen, Sharon Jiang, et al. 2017. "The Prevalence of Antibiotic-Resistant *Staphylococcus Aureus* Nasal Carriage among Industrial Hog Operation Workers, Community Residents, and Children Living in Their Households: North Carolina, USA." *Environmental Health Perspectives* 125 (4): 560–69. doi:10.1289/EHP35.

Lyon, A.H., W. Tracy, M. Colley, P. Culbert, M. Mazourek, J. Myers, J. Zystro, E.M. Silva. 2019 (in press). Using adaptability analysis in a participatory variety trial of organic vegetable crops. *Renewable Agriculture and Food Systems*.

Nadimpalli, M., Stewart, J.R., Pierce, E., Pisanic, N., Love, D.C., Hall, D., Larsen, J., Carroll, K.C., Tekle, T., Perl, T.M. and Heaney, C.D., 2016. "Livestock-associated, antibiotic-resistant Staphylococcus aureus nasal carriage and recent skin and soft tissue infection among industrial hog operation workers." *PloS One*, 11(11), p.e0165713.

Nadimpalli, M., Rinsky, J.L., Wing, S., Hall, D., Stewart, J., Larsen, J., Nachman, K.E., Love, D.C., Pierce, E., Pisanic, N. and Strelitz, J., 2015. "Persistence of livestock-associated antibiotic-resistant Staphylococcus aureus among industrial hog operation workers in North

Carolina over 14 days." *Occupational and Environmental Medicine*, 72(2), pp.90-99.

Ramírez-Andreotta MD, Brusseau ML, Artiola JF, Maier RM, Gandolfi AJ. 2015. "Building a Co-Created Citizen Science Program with Gardeners Neighboring a Superfund site: The Gardenroots Case Study." *International Public Health Journal*, 7(1):139-153, PMID: 25954473.

Ramírez-Andreotta, MD, Brusseau, ML, Artiola, JF, Maier, RM, Gandolfi, AJ. 2014. "Environmental Research Translation: Enhancing Interactions with Communities at Contaminated Sites," *Science of the Total Environment*, 497-498:651–664, PMID: 25173762.

Ramírez-Andreotta, MD, Brusseau, ML, Beamer, P, Maier, RM. 2013. "Home Gardening Near a Mining Site in an Arsenic-Endemic Region of Arizona: Assessing Arsenic Exposure Dose and Risk via Ingestion of Home Garden Vegetables, Soils, and Water." *Science of the Total Environment,* 454-455:373-82, PMID: 23562690.

Ramírez-Andreotta, MD, Brusseau, ML, Artiola, JF, Maier, RM. 2013. "A Greenhouse and Field-Based Study to Determine the Accumulation of Arsenic in Common Homegrown Vegetables." *Science of the Total Environment*, 443, 299-306, PMID: 23201696.

Rhodes, S. and Brown, K., Cooper, L., Muhammad, N., Hall, D. 2019 (in preparation). "Environmental Racism in North Carolina's Hog Industry: Lessons-learned from Community-Driven Participatory Research and the People's Professor." In *Environmental Justice and Citizen Science in a Post-truth Age.* Edited by Mah, A. and Davies, T. Manchester United Press.

Rinsky, J.L., Nadimpalli, M., Wing, S., Hall, D., Baron, D., Price, L.B., Larsen, J., Stegger, M., Stewart, J. and Heaney, C.D., 2013. "Livestock-associated methicillin and multidrug resistant Staphylococcus aureus is present among industrial, not antibiotic-free livestock operation workers in North Carolina." *PLoS One*, 8(7), p.e67641.

Sandhaus S, Kaufmann D. Ramírez-Andreotta MD. 2018. "Public participation, trust and data sharing: gardens as hubs for citizen science and environmental health literacy efforts." *International Journal of Science Education, Part B.* DOI: 10.1080/21548455.2018.1542752.

Sandhaus S, Ramírez-Andreotta MD, Kilungo A, Wolf AM, Sandoval F, Henriquez P. 2018. "Combating Climate Injustices: An Informal Science and Popular Education Approach to Addressing Environmental Health Disparities." *Pedagogy in Health Promotion: The Scholarship of Teaching and Learning*, 4(4), 260-269 https://doi.org/10.1177/2373379917751476.

Simon-Friedt BR, Howard JL, Wilson MJ, Gauthe D, Bogen D, Nguyen D, Frahm E, Wickliffe JK. 2016. "Louisiana residents' self-reported lack of information following the Deepwater Horizon oil spill: Effects on seafood consumption and risk perception." *Journal of Environmental Management* 180:526-537 http://www.ncbi.nlm.nih.gov/pubmed/27289418" PMID:272894418

Wickliffe, J.K., Simon-Friedt, B., Howard, J.L., Frahm, E., Meyer, B., Wilson, M.J., Pangeni, D. and Overton, E.B., 2018. "Consumption of Fish and Shrimp from Southeast Louisiana Poses No Unacceptable Lifetime Cancer Risks Attributable to High-Priority Polycyclic Aromatic Hydrocarbons." *Risk Analysis*, 38(9), pp.1944-1961. https://doi.org/10.1111/risa.12985

Wilson MJ, Frickel S, Nguyen D, Bui T, Echsner S, Simon BR, Howard JL, Miller K, Wickliffe JK. 2015. "A targeted health risk assessment following the Deep Water Horizon oil spill: polycyclic aromatic hydrocarbon exposure in Vietnamese-American shrimp consumers." *Environmental Health Perspectives* 123(2):152-159 http://www.ncbi.nlm.nih.gov/pubmed/25333566" PMID:25333566

Works cited

Allen, Patricia. 2008. "Mining for Justice in the Food System: Perceptions, Practices, and Possibilities." *Agriculture and Human Values* 25 (2): 157–161. http://link.springer.com/article/10.1007/s10460-008-9120-6.

Azuma, Andrea Misako, Susan Gilliland, Mark Vallianatos, and Robert Gottlieb. 2010. "Food Access, Availability, and Affordability in 3 Los Angeles Communities, Project CAFE, 2004-2006." *Preventing Chronic Disease* 7 (2): A27.

Bell, Shannon. 2013. *Our Roots Run Deep as Ironweed*. Champaign: University of Illinois Press.

Bidwell, David. 2009. "Is Community-Based Participatory Research Postnormal Science?" *Science, Technology & Human Values* 34 (6): 741–61. doi:10.1177/0162243909340262.

Blum, Elizabeth D. 2008. *Love Canal Revisited: Race, Class, and Gender in Environmental Activism*. Lawrence: University Press of Kansas.

Braun, Kathryn L, Tung T Nguyen, Sora Park Tanjasiri, Janis Campbell, Sue P Heiney, Heather M Brandt, Selina A Smith, et al. 2012. "Operationalization of Community-Based Participatory Research Principles: Assessment of the National Cancer Institute's Community Network Programs." *American Journal of Public Health* 102 (6): 1195–1203. doi:10.2105/AJPH.2011.300304.

Brody, Julia Green, Sarah C Dunagan, Rachel Morello-Frosch, Phil Brown, Sharyle Patton, and Ruthann A Rudel. 2014. "Reporting Individual Results for Biomonitoring and Environmental Exposures: Lessons Learned from Environmental Communication Case Studies." *Environmental Health* 13 (1). BioMed Central: 40. doi:10.1186/1476-069X-13-40.

Bryan, Joe. 2011. "Walking the Line: Participatory Mapping, Indigenous Rights, and Neoliberalism." *Geoforum* 42 (1): 40–50. doi:10.1016/j.geoforum.2010.09.001.

Cordner, Alissa, David Ciplet, Phil Brown, and Rachel Morello-Frosch. 2012a. "Reflexive Research Ethics for Environmental Health and Justice: Academics and Movement Building." *Social Movement Studies* 11 (2): 161–76. doi:10.1080/14742837.2012.664898.

———. 2012b. "Reflexive Research Ethics for Environmental Health and Justice: Academics and Movement Building." *Social Movement Studies* 11 (2): 161–76. doi:10.1080/14742837.2012.664898.

Dickinson, Janis L., Benjamin Zuckerberg, and David N. Bonter. 2010. "Citizen Science as an Ecological Research Tool: Challenges and Benefits." *Annual Review of Ecology, Evolution, and Systematics* 41 (1): 149–72. doi:10.1146/annurev-ecolsys-102209-144636.

Elwood, Sarah. 2006. "Negotiating Knowledge Production: The Everyday Inclusions, Exclusions, and Contradictions of Participatory GIS Research." *The Professional Geographer* 58 (2): 197–208.

Gottlieb, Robert, and Anupama Joshi. 2010. *Food Justice*. Cambridge, MA: MIT Press.

Guerrini, Christi J, Mary A Majumder, Meaganne J Lewellyn, and Amy L McGuire. 2018. "Citizen Science, Public Policy." *Science* 361 (6398): 134–36. doi:10.1126/science.aar8379.

Haklay, Muki. 2015. *Citizen Science and Policy: A European Perspective*. Washington D.C.: The Woodrow Wilson Center.

Harrison, Jill Lindsey. 2011. "Parsing 'Participation' in Action Research: Navigating the Challenges

of Lay Involvement in Technically Complex Participatory Science Projects." *Society & Natural Resources* 24 (7): 702–16. doi:10.1080/08941920903403115.

Hatcher, Sarah M., Sarah M. Rhodes, Jill R. Stewart, Ellen Silbergeld, Nora Pisanic, Jesper Larsen, Sharon Jiang, et al. 2017. "The Prevalence of Antibiotic-Resistant *Staphylococcus Aureus* Nasal Carriage among Industrial Hog Operation Workers, Community Residents, and Children Living in Their Households: North Carolina, USA." *Environmental Health Perspectives* 125 (4): 560–69. doi:10.1289/EHP35.

Israel, B., A. Schulz, E. Parker, and A. Becker. 1998. "Review of Community Based Research: Assessing Partnership Approaches to Improve Public Health." *Annual Review of Public Health* 19: 173–202.

"Jemez Principles for Democratic Organizing." n.d. http://www.ejnet.org/ej/jemez.pdf.

Kagawa-Viviani, Aurora, Penny Levin, Ed Johnston, Michael Kantar, Jeri Ooka, Jonathan Baker, and Noa Kekuewa Lincoln. 2018. "I Ke Ēwe **ʻāina o K** e Kupuna: Hawaiian Ancestral Crops in Perspective." *Sustainability* 10 (12): 4607.

Kimura, Aya H. 2016. *Radiation Brain Moms and Citizen Scientists: The Gender Politics of Food Contamination after Fukushima*. Durham, NC: Duke University Press.

Kimura, Aya H., and Abby Kinchy. 2016. "Citizen Science: Probing the Virtues and Contexts of Participatory Research." *Engaging Science, Technology, and Society* 2 (December): 331–61. doi:10.17351/ests2016.99.

Kimura, Aya H., and Abby J. Kinchy. 2019. *Science by the People: Participation, Power, and the Politics of Environmental Knowledge*. New Brunswick: Rutgers University Press.

Lave, Rebecca. 2012. "Neoliberalism and the Production of Environmental Knowledge." *Environment and Society: Advances in Research* 3 (1): 19–38. doi:10.3167/ares.2012.030103.

Levain, Alix, Françoise Vertès, Laurent Ruiz, Luc Delaby, Chantal Gascuel-odoux, and Marc Barbier. 2015. "'I Am an Intensive Guy': The Possibility and Conditions of Reconciliation Through the Ecological Intensification Framework." *Environmental Management; New York* 56 (5): 1184–98. doi:http://dx.doi.org.libproxy.rpi.edu/10.1007/s00267-015-0548-3.

Mabachi, Natabhona M., and Kim S. Kimminau. 2012. "Leveraging Community-Academic Partnerships to Improve Healthy Food Access in an Urban, Kansas City, Kansas, Community." *Progress in Community Health Partnerships-Research Education and Action* 6 (3): 279–88.

McCauley, Linda A., Marco Beltran, Jacki Phillips, Michael Lasarev, and Diana Sticker. 2001. "The Oregon Migrant Farmworker Community: An Evolving Model for Participatory Research." *Environmental Health Perspectives* 109 (Suppl 3): 449–55.

McCormick, Sabrina. 2012. "After the Cap: Risk Assessment, Citizen Science and Disaster Recovery." *Ecology and Society* 17 (4): 31. http://dx.doi.org/10.5751/ES-05263-170431.

McMichael, Philip. 2005. "Global Development and The Corporate Food Regime." *Research in Rural Sociology and Development* 11: 265–99.

Minkler, Meredith, Victoria Breckwich Vásquez, Mansoureh Tajik, and Dana Petersen. 2008. "Promoting Environmental Justice Through Community-Based Participatory Research: The Role of Community and Partnership Capacity." *Health Education & Behavior* 35 (1): 119–37. doi:10.1177/1090198106287692.

Pelletier, D., C. McCullum, V. Kraak, and K. Asher. 2003. "Participation, Power and Beliefs Shape Local Food and Nutrition Policy." *Journal of Nutrition* 133 (1): 301S–304S.

Pothukuchi, Kameshwari. 2009. "Community and Regional Food Planning: Building Institutional Support in the United States." *International Planning Studies* 14 (4): 349–67. doi:10.1080/13563471003642902.

Ratto, Matt. 2011. "Critical Making: Conceptual and Material Studies in Technology and Social Life." *The Information Society* 27 (4): 252–60.

Resnik, David B., Kevin C. Elliott, and Aubrey K. Miller. 2015. "A Framework for Addressing Ethical Issues in Citizen Science." *Environmental Science and Policy* 54. Elsevier Ltd: 475–81. doi:10.1016/j.envsci.2015.05.008.

"Rise of the Citizen Scientist." 2015. *Nature* 524 (7565): 265. doi:10.1038/524265a.

Sadler, Richard Casey. 2016. "Integrating Expert Knowledge in a GIS to Optimize Siting Decisions for Small-Scale Healthy Food Retail Interventions." *International Journal of Health Geographics* 15: 19. doi:10.1186/s12942-016-0048-6.

Smith, Linda Tuhiwai. 2005a. *Decolonizing Methodologies: Research and Indigenous Peoples*. Zed Books.

———. 2005b. *Decolonizing Methodologies: Research and Indigenous Peoples*. London: Zed Books.

Swanson, Alexandra, Margaret Kosmala, Chris Lintott, and Craig Packer. 2016. "A Generalized Approach for Producing, Quantifying, and Validating Citizen Science Data from Wildlife Images." *Conservation Biology* 30 (3): 520–31. doi:10.1111/cobi.12695.

Vermeulen, Sonja J., Bruce M. Campbell, and John SI Ingram. 2012. "Climate Change and Food Systems." *Annual Review of Environment and Resources* 37: 195–222.

Wentworth, Chelsea. 2016. "Public Eating, Private Pain: Children, Feasting, and Food Security in Vanuatu." *Food and Foodways* 24 (3–4): 136–52. doi:10.1080/07409710.2016.1210888.

Wing, Steve. 2002. "Social Responsibility and Research Ethics in Community-Driven Studies of Industrialized Hog Production." *Environmental Health Perspectives* 110 (5): 437–44.

Wylie, Sara Ann, Kirk Jalbert, Shannon Dosemagen, and Matt Ratto. 2014. "Institutions for Civic Technoscience: How Critical Making Is Transforming Environmental Research." *The Information Society* 30 (2): 116–26. doi:10.1080/01972243.2014.875783.