Citizen science for the food system

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The food system is hugely complex, encompassing many different actors, geographic areas and cultural contexts. Although the citizen science literature related to food and food systems is concentrated primarily on a few key areas of this complex system (i.e. on health and food production); citizen science has the potential to help address many grand challenges related to food and agriculture.

In this chapter we make use of multiple desk-based reviews of the literature, and draw on our own experiences of citizen science projects. We provide examples of existing citizen science projects in the UK (as well as global initiatives) that can be adapted for use to help address food policy areas of research interest. We conclude that making use of citizen science approaches in food policy reseaarch can help the transition toward a more equitable and sustainable food and agriculture system.

Why citizen science is particularly relevant to food and food policy

Food is a universal connection between people. What and how we eat, farm, cook, and produce affects us on individual, community and societal levels. Supplying safe, secure, affordable, sustainable, and nutritious food is a major challenge to all the different parts of a local and global system. Food is also ubiquitous and mundane, with many day-to-day food practices carried out as an unconscious routine. It is also deeply cultural and historic,

involving a range of values, anxieties, and personal motivations. This universality and ubiquity make food – and the many aspects of the food system – an ideal range of topics with which to engage individuals and communities.

By the same token, multiple government actors are involved in making and implementing policy related to food. For example, in England, at the level of national government, policy affecting the food system is made by at least 16 departments and public bodies.[1] This number of policy actors means that citizens' voices can be absent from the public policy debate, because they do not have the mechanisms or knowledge to engage with this multiplicity of actors. Those who do engage may come from specific segments of society that have time and resources to participate (e.g. typically whiter, older and wealthier than the general population). The result of this (and other structural issues) is that specific interest groups have become the main voices engaging with government in the formation of policy, giving rise to possible policy biases towards those groups which have the capacity to engage. Research has shown that individuals who engage with citizen science projects tend to be those who are already interested in their focal topics.[2] However, by the same token, the pool of potential participants for citizen science can be much wider if they are engaged on the topics which are meaningful to them, using the right engagement methods.

Due to the universality of food, it is a topic that offers a wide appeal, with natural pathways to strong citizen engagement throughout the food system and policy process – after all, everyone eats. This wide appeal means that there are many opportunities to harness citizen science methods to assist with the development of better food policy and a better food system.

Case study: Perceptions of food– comparing citizen science to other methods

Citizen science, like many other research methods, can have data biases resulting from only a subset of the population participating; and data biases could lead to biases in policy response. Because of the aforementioned issues of representativeness and engagement, we thought it essential to compare the results of similar tasks carried out either by a citizen science 'crowd', or by more traditionally recruited online survey panels (representative of the UK population), or by those recruited through social media channels.[3] We had each group classify images of foods according to the individual's perceptions of energy content, carbon footprint, animal welfare, and food risk. Our studies showed that different recruitment tools resulted in differences in observed perceptions on the individual level – but that overall, similar trends were observed throughout.

We highlight that the citizen science method also yielded useful qualitative engagement from participants on how to improve the research, and clarification on why some of the results were occurring. This richness of information was not available through the other methods, and was a specific benefit of citizen science engagement.

This series of projects shows that citizen science can be used as part of a wider tool box of data collection options – all of which need to be used to provide representation and quality assurance. The level of engagement with the citizen community can be a particular additional benefit of citizen science.

Benefits of citizen science methods for food policy makers

Scientific drivers for using citizen science approaches often relate to collecting or processing data that would not be possible to collect or process if professional scientists were working alone. By working with volunteers, large volumes of data can be processed; data can be collected across wide geographic areas and in fine detail; and/or data can be collected at high frequencies or for long periods of time. Data can also be collected from areas that are otherwise difficult for professional scientists to access, such as within the home or on private land. The everyday nature of food means that studying certain behaviours and practices can be difficult, particularly in household settings (with self-reported practices different from observed practices or direct measurement). Citizen science methods can act as a bridge to co-collect a wider range of robust information on household behaviours, and help to understand priorities for people based on their lived experience (e.g. around allergies, cooking, etc.).[4] Other examples of robust data collected through citizen science methods include engaging with members of the public to assess food fraud[5] or food safety,[6] quantifying household food waste, or stimulating local food production and consumption.[7]

Citizen science is also useful beyond the home, as citizens interact with all the multiple stages of the food system (e.g. retail, hospitality, consumption, disposal). In addition to the general public, farmers and food industry workers are also potential participants to be engaged. In farming and food production, citizen science approaches have been used to develop new practices, and to engage communities to propagate change and manage the use of anti-microbials.[8] Likewise, retail outlets and canteens have hosted food-related citizen science projects; citizen science approaches have been used to survey the healthiness of local retail food environments, and to empower citizens.[9] The current EU project SU-EATABLE LIFE, for example, focuses on mass catering in Italy and the UK, planning to reach 50,000 people and to actively engage around 5,000 citizen scientists, with the aim of propagating behaviour change to reduce GHG emissions and water use.[10]

Citizen science approaches can also be deployed quickly in response to sudden events or emerging issues (as has been demonstrated recently with applications in tracking and understanding the COVID-19 pandemic).[11] For example, one of our surveys (by Armstrong and Reynolds) was able to be deployed rapidly in the first weeks of the 2020 UK lockdown, measuring citizen perceptions of images of food. This was then extended to include how country-of-origin and ethical information altered consumer perceptions of food in a post-COVID-19 food system. These findings were then rapidly presented to policy makers and parliament to inform ongoing policy development.[12]

Policy makers use citizen science data in all stages of the policy cycle (problem definition, policy formation, policy implementation, compliance assurance and policy evaluation) – the collection of large amounts of data over broad spatio-temporal scales means that policy makers can utilise this evidence base for multiple purposes. Citizen science projects have also been specifically designed to address policy data gaps;[13] for example, such approaches are increasingly being discussed as a way to fill data gaps in Sustainable Development Goal reporting. A recent food-policy example is the FSA's 2021 joint funding call with UK Research and Innovation, 'Citizen science for food standards challenges', funding pilot citizen science projects to investigate themes in the FSA's areas of research interest.[14]

In addition to these national- or international-scale efforts, smaller-scale citizen science projects can also engage volunteers in generating an in-depth understanding of an issue at a local scale. Such projects provide the opportunity to incorporate local, often place-based, knowledge into the scientific process.[15] Local knowledge is particularly important for ensuring science is relevant to people's lives and can lead to local action, in contrast with 'normal science' that aims to create findings with a high degree of validity and reliability in very specific contexts only, which may not be applicable in the real world. Findings from citizen science projects can be used to support decision making and action at a local level.

The benefits do not all flow to the research itself; citizen science projects should also aim to benefit volunteer participants.[16] Well designed projects have shown increases in participants' knowledge, skills and scientific understanding – examples include projects that created crowdsourced open databases of potentially unhealthy food products; a foodborne illness reporting platform linked to social media; and improved yeast strains for sourdough bread.[17]

Individuals gaining knowledge, skills and scientific literacy in this way can lead to a number of second-order outcomes, including greater employability, behavioural changes and advocacy. Benefits to individuals can include people spending time outdoors and with other people, improving their health and sense of place, and supporting new relationship development; for example, the My Harvest citizen science project found multiple wellbeing benefits from allotment gardening.[18] Community benefits can include supporting stable communities with the potential for social learning, whereby people learn from each other via observation and imitation.

A multitude of benefits also arise from bringing together scientists and members of the public within citizen science projects – including increased understanding of the relevance of science (and increased trust in it), as well as challenges to traditional expert-citizen hierarchies, not least opening scientists' eyes to novel questions and considerations. Bringing diverse voices into the scientific process and having diversity in expert knowledge is a desirable goal, especially given the complexity of many of the environmental challenges we currently face. Innovation, invention and creativity are more likely to occur where people of diverse backgrounds are brought together.

Finally, however, it should also be noted that while the benefits of citizen science described above are widely discussed, the strength of evidence for many of these is weak, and not always directly related to food.

Challenges of citizen science methods for food policy makers

As well as benefits, there are challenges with using citizen science approaches. As with any scientific endeavour, data quality assurance processes need to be carefully considered; and while aforementioned projects have demonstrated that citizen-collected data can be of the same quality as that collected by professional scientists, others have reported problems with data quality. Concerns about data quality in citizen science projects are still a major barrier to use.[19]

Another challenge is that citizen science participants are typically not representative of wider society. Consideration should be given to how projects (and recruitment strategies) may be designed so as to widen participation. How the demographics and characteristics of participants affect data collected – and the conclusions that can be drawn – also needs to be assessed.

Some additional legal and ethical considerations (for humans and the environment) are needed for citizen science compared with other research activities. According to ECSA's characteristics of citizen science, to be considered citizen science, participant involvement should be consensual and fully understood, and so project aims should be clearly and openly communicated with participants and other stakeholders. All those involved should be aware of, and adhere to, agreed ethical and research quality standards. Co-design of these standards between scientists and participants could be considered, in order to establish shared expectations and foster inclusion.

Additional ethical and legal considerations may also arise in citizen science projects in respect of data management, because of the collaborative way in which data is generated. These include issues around data ownership, data sharing, confidentiality and participant privacy (particularly when participants are also the subjects of the research), as well as copyright

and intellectual property. Other issues include appropriate recognition of participants in outputs from research, and whether compensation for participation is required.

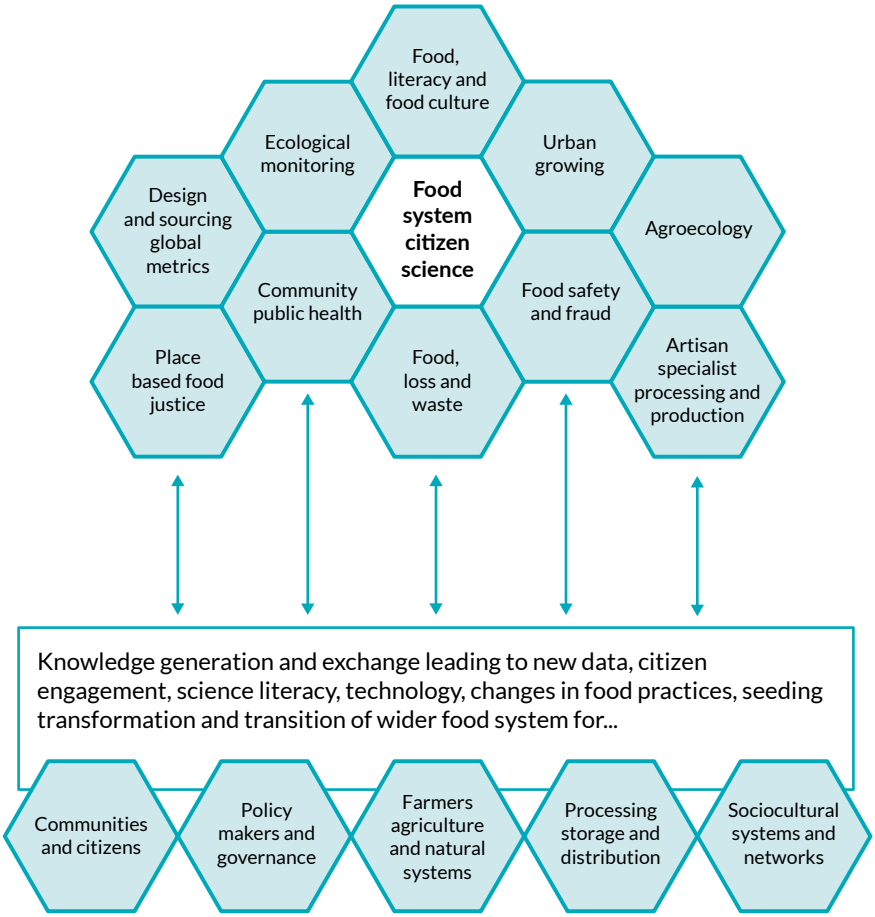
Indeed, citizen science is not always the 'cheap option' it is sometimes seen to be. Recruiting and retaining participants in projects is essential for their success, but can be costly and time consuming.[20] In order to keep participants engaged and contributing to projects, they need to be given feedback and encouragement, and this can be resource intensive. There may also be costs associated with processing or analysing data or buying equipment. Securing funding for projects, particularly in the long term, can be very challenging, but often the value of citizen science for monitoring particular issues, or creating change in participants and communities, only comes from long-term engagement. In studies focused on healthy corner stores in New Jersey, participants were given nominal payments of US$25 (for a guided walk around of their food environment) plus US$25 (for attending a community meeting).[21] We highlight that the issue of remuneration is contentious, with remuneration in some instances influencing participation and the quality of data collected.[22]

Finally, citizen science is not suited to all research questions, and consideration should always be given to whether other approaches are more appropriate.

Mapping citizen science to food system challenges

It has long been claimed that citizen science has the potential to help address many grand challenges related to food and agriculture.[23] We have recently categorised current and past citizen science projects as they relate to ten food domains (Figure 1):

Figure 1: Summary of citizen science engagement with the food system and impact pathways[24]



We have also undertaken a parallel mapping of the FSA Research Themes to potential citizen science research projects. We found examples of existing citizen science projects in the UK (as well as global initiatives) in a range of priority policy areas (Figure 2), with many ready to be deployed now. However, our review also found some gaps (food hypersensitivity, and implementing food regulation) where there were no food specific-studies found.

Figure 2: number of existing citizen science projects that relate to the Food Standards Agency's Areas of Research interest[25]

Finally, we have scoped opportunities for using citizen science to answer 26 priority research questions related to food loss and waste,[26] providing practical examples of how each question could be approached using citizen science methods, and the policy and commercial relevance of the information that may be produced.

These studies illustrate that citizen science methods are highly applicable to food systems issues, and adapted to a wide range of policy maker needs; and that there is a growing community of practice, with many projects ready to be deployed if funding is available. As such, it is clear that policy makers do not have to reinvent the citizen science wheel to successfully adopt citizen science methods into their methodological toolkits.

Conclusions

In conclusion, citizen science can help with food policy development and delivery, including:

- Monitoring and quantifying issues
- Building understanding of issues
- Educating and communicating
- Leading to action – by the individual (encouraging deep learning, agency), and by decision makers (drawing on evidence collected through citizen science).

Many different citizens, actors and communities can be involved: producers, processors, distributors, retailers and households/consumers.

Many policy actors are indeed already involved in citizen science projects around food, with food policy issues already being explored using citizen science methods. However, there is much room for expansion of methods, project scope, and number and type of citizens engaged. Adopting citizen-

science-generated evidence as part of a policy maker's methodological toolkit could be transformative to the policy making process, to the policy makers themselves and to the communities they serve. The literature reviewed in this paper highlights that the use of citizen science benefits the research community, citizens of diverse socioeconomic and cultural backgrounds, policy makers and wider society.

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FUTURE DIRECTIONS FOR CITIZEN SCIENCE AND PUBLIC POLICY

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