

## COMMENTARY:

# Gaps in agricultural climate adaptation research

Debra Davidson

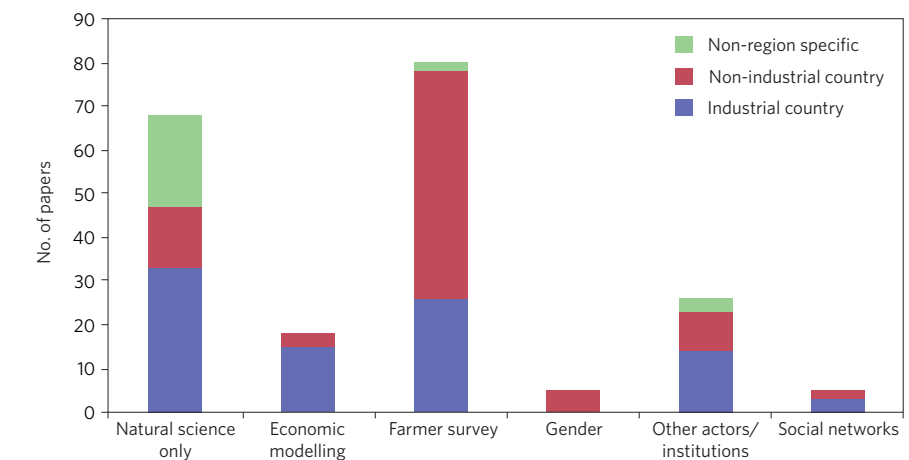
The value of the social sciences to climate change research is well recognized, but notable gaps remain in the literature on adaptation in agriculture. Contributions focus on farmer behaviour, with important research regarding gender, social networks and institutions remaining under-represented.

The need for more social science research directed towards addressing complex problems such as climate change has been widely acknowledged<sup>1,2</sup>. Yet important social scientific research remains limited in many cases, to the detriment of effective policy responses. The integration of the social sciences into research programmes on climate change adaptation in agriculture provides a case in point.

Given the obvious social dimensions of adaptation in general — and agriculture in particular — one might expect to observe a high degree of social science integration in this field. Growing calls for transformative adaptation in agri-food systems that constitute fundamental structural shifts have been bolstered by research indicating the sensitivity of agricultural production to climate change<sup>3,4</sup>, the associated potential losses in farmer income<sup>5</sup> and food security<sup>6</sup>, the incommensurability of conventional production practices with climate resilience<sup>7</sup> and the potential for mitigation co-benefits. Although instances of autonomous adaptation have been noted<sup>8</sup>, the adoption rates of adaptive measures in agriculture nonetheless have been disappointing<sup>9</sup>, and in high-income countries the perceived threat of climate change and subsequent support for adaptation among farmers is particularly low<sup>10</sup>. To maximize the potential for effective transformative adaptation, researchers must be able to identify and evaluate multiple adaptation pathways, as well as their limits and barriers, throughout our agri-food systems. This in turn requires that the social factors defining these pathways should be at the forefront of research.

## Research contributions

To assess the contributions of the social sciences to research on climate change



**Figure 1** | Categorization of journal articles on the topic of climate change adaptation in agriculture published in 2015. A total of 201 articles were analysed for the inclusion of various social dimensions across regions. See Supplementary Information for details.

adaptation in agriculture, content analysis of peer-reviewed journal articles on the topic published in 2007 and 2015 was conducted (see the Supplementary Information for the method). Three trends include a substantial increase in the research attention to climate change adaptation in agriculture, an increase in the proportion of studies that focus on farming in developing countries, and growth in the social science input. In 2007, just 18% of the 39 peer-reviewed articles on the topic of climate change adaptation in agriculture included a social dimension. In 2015, this rose to 58% of the 201 relevant articles (see Supplementary Table 1).

These advances are laudable. The increase in the proportion of studies that included a social component, however, masks notable gaps.

The social component in the vast majority of studies entails survey research on the perceptions and/or practices of farmers,

often conducted by natural scientists. This constitutes important information on observed adaptation practices. Yet the number of published studies that included deeper understanding of the social factors that explain farmer behaviour, as well as other social factors that are influential in agri-food systems, is small. Thus the social factors that facilitate or constrain systemic change in agriculture tend to be missed.

The following highlights three interrelated factors that constitute the subject matter of all of the remaining publications that included a social component — gender, social networks and institutions (including governance). As those remaining studies show, these social factors are key to adaptation, but are by no means the only ones of relevance. None of these are prominent in the literature, yet research exemplifies the important insights to be offered by such social-scientific analyses.

## Research gaps

Just five of the 201 studies published in 2015 focused on gender, and all were conducted in non-industrial countries (Fig. 1). The limited research that has focused on gender nonetheless reiterates its relevance. Research consistently shows that farming households headed by women are more vulnerable to the impacts of climate change and women in all types of households are relatively more vulnerable to food insecurity in those cultural settings in which men control food distribution<sup>11</sup>. Female farmers are also less likely to adopt any available adaptation strategies<sup>12</sup> due to financial and resource limitations, control over smaller land parcels and less tenure security. The invisibility of women's roles in farming and the associated male biases of many agricultural organizations in several regions also supports the exclusion of female farmers from many of the benefits of extension efforts<sup>13</sup>, including information, subsidized tools, seed, fertilizers and improved livestock breeds. Women are consequently often excluded from participation in adaptation decision making, and thus the unique knowledge and needs associated with their specific roles in farming tend not to be reflected in those decisions.

Given that women make up 43% of the agricultural labour force in developing countries (<http://www.fao.org/sofa/gender/did-you-know/en>), the adaptation barriers they face are relevant not only to their own household food security, but to adaptation of the agricultural sector as a whole. Women often express less skepticism<sup>14</sup> and higher concern for climate change<sup>15</sup>, suggesting that women are a key resource for adaptation of the sector that is not yet being capitalized on.

A second gap pertains to social networks. Five of the 201 published articles in 2015 consisted of social network analysis, two of which were conducted in non-industrial countries (Fig. 1). All individual behaviour is socially embedded, and addressing the question of why farmers behave in certain ways requires research that reveals this social embeddedness. Many studies, however, resort to simplified rational-actor approaches to human behaviour. But farmers are not mere 'utility maximizers'<sup>16</sup>, even when they have complete autonomy over their operations. Practices are inevitably shaped by institutional norms and discourses, which privilege some rationalities while excluding others, narrowing the range of adaptation pathways<sup>17</sup>.

The architecture of social networks is thus a critical function of adaptation. Adaptive innovation, as with all types of innovation, requires social learning, which is most likely to occur when actors have access to a plurality of new ideas and knowledge that support alternative practices — resources that

emerge and diffuse through social networks. Contrarily, social networks can serve to constrain adaptive change, particularly when power is vested in interests that favour the status quo, or otherwise marginalize important sources of knowledge and capacity.

One recent study provides clear evidence of the import of network architecture<sup>18</sup>. Australian farmers who exhibited transformational adaptation practices were engaged in strong connections with external knowledge providers, combined with relatively weak connections with family and community networks; probably because local networks can reinforce traditional cultural norms and practices at the expense of innovation.

Interestingly — and in contrast — local informal support networks have become an important resource for farmers in the developing world, particularly women, who are excluded from relationships with external knowledge and support providers<sup>19</sup>. The role of 'bringer' organizations has also been shown to be essential in closing network gaps<sup>20</sup>.

A third important area of research entails the multiple influential institutions and other actors that are engaged in agri-food systems. This describes a combined 25 studies published in 2015 (Fig. 1): 13 focused on policy or governance institutions, eight on the role of scientific organizations such as extension agents and four on the role of marketing and business institutions, such as private finance. Among these, 11 focused on non-industrial countries. Because our regional and global agri-food systems are defined by a complex web of multiple institutions and actors, research on the influence of those institutions and actors on farmer behaviour, and on the system as a whole in ways that have implications for adaptation, is critical. In many cases, actors other than farmers themselves have an enormous influence over farm-level decision-making and the transformative potential of agri-food systems. The disruptive potential of the expansion of urban producers and consumer-based food movements, for example, has been largely unremarked on. Yet the emergence of new producers, shifts in consumer behaviour and the political attention drawn to food issues by citizens all have clear repercussions for adaptation pathways.

## Stimulating cross-disciplinary research

Fostering more and better social science will require more than an 'add-on' approach whereby a social scientist or two is invited to a table dominated by natural scientists. Attention to the following three interrelated challenges in particular would go a long way towards the development of an integrated research programme that is better suited

to address complex problems such as climate change.

First, despite the inclusion of many social scientists in large scientific bodies such as the IPCC, the prevailing norms and practices that govern IPCC activities nonetheless have been adopted largely from the natural sciences and are simply not compatible with research practices in many social science disciplines. For example, the standards adopted for validation and certainty are premised on deductive, quantitative methods and are not readily transposable to research that employs other methodological approaches (placing a confidence interval around comparative case studies of community-level vulnerability makes no sense). Furthermore, the fact that human behaviour is so incredibly variable limits the generalizability of many empirical studies, another criteria for validation in the natural sciences. This is, in effect, one of the most important lessons of the social sciences: any strategies intended to incite behavioural shifts must necessarily be appropriate to specific social, cultural, political and economic contexts to be effective. Methodological privileging has marginalized and undervalued a large proportion of social scientific research<sup>21</sup>. Critical scrutiny and revisiting of the norms and practices that govern scientific bodies like the IPCC, with the inclusion of input from social scientists, is an essential step towards integration.

Social scientists themselves are also on the hook. We need to put more effort into cross-disciplinary engagement, which in turn requires an emphasis on communicating the relevance of our findings for both natural scientists and knowledge users, and greater investments into moving beyond problematizing, to the development of concrete solution pathways. More methodological work needs to be done to integrate social scientific understandings of social processes into complex frameworks of coupled social-ecological systems that accord attention to cross-scale interactions, as well as forecasting of future pathways — approaches that are critical to addressing climate change. Many such models, however, suffer from a limited input from social theory. This limitation is at least in part attributable to the norms embraced by some social science disciplines, including the tendency to overlook non-social phenomena and a general aversion to 'future-gazing'.

Finally, funding providers have not heeded the call for more social science. Funding for social sciences is lower than for the natural sciences in many countries around the world, yet there is a direct correlation between funding levels and the citation rates of articles<sup>22</sup>. Teaching loads in social science and humanities departments

in academia also tend to be higher<sup>23</sup>. In 2013, US\$92 million out of the US National Science Foundation's total annual budget of US\$5.5 billion was provided to the social and economic sciences combined<sup>24</sup>.

A small but noteworthy body of literature exemplifies the value of social scientific research to the understanding of climate change adaptation and its barriers in agriculture, and to the development of effective strategies. A growing number of studies have focused on the perceptions and behaviours of farmers in developing countries in particular. A much smaller body of research has revealed the substantial influence of gender, social networks and institutions on adaptation outcomes, suggesting the need for significantly more research in these areas. Increasing methodological sophistication and data availability further enhance the utility and potential for the integration of the social sciences into interdisciplinary research endeavours, and their ability to inform policy.

Taking advantage of the full value offered by the social sciences demands confronting three interrelated barriers to its uptake: norms and practices within scientific bodies that are not compatible with social scientific forms of inquiry, disciplinary resistance within the social sciences and insufficient financial support. □

*Debra Davidson is in the Department of Resource Economics and Environmental Sociology, University of Alberta, Edmonton, Alberta T6G 2H1, Canada. e-mail: [debra.davidson@ualberta.ca](mailto:debra.davidson@ualberta.ca)*

#### References

1. Stern, P. & Dietz, T. *Nature* **521**, 161 (2015).
2. Hackmann, H., Moser, S. C. & Clair, A. L. S. *Nature Clim. Change* **4**, 653–655 (2014).
3. Rosenzweig, C. *et al. Proc. Natl Acad. Sci. USA* **111**, 3268–3273 (2014).
4. Challinor, A. J. *et al. Nature Clim. Change* **4**, 287–291 (2014).
5. Moore, F. C. & Lobell, D. B. *Nature Clim. Change* **4**, 610–614 (2014).
6. Tai, A. P. K., Martin, M. V. & Heald, C. L. *Nature Clim. Change* **4**, 817–821 (2014).
7. Altieri, M. A., Nicholls, C. I., Henao, A. & Lana, M. A. *Agron. Sust. Dev.* **35**, 1–22 (2015).
8. Manandhar, S., Vogt, D. S., Perret, S. R. & Kazama, F. *Reg. Environ. Change* **11**, 335–348 (2011).
9. Lyle, G. *J. Rural Stud.* **37**, 38–49 (2015).
10. Prokopy, L. S. *et al. Environ. Manage.* **56**, 1–13 (2015).
11. Nyantakyi-Frimpong, H. & Bezner-Kerr, R. *Glob. Environ. Change* **32**, 40–56 (2015).
12. Fisher, M. & Carr, E. R. *Glob. Environ. Change* **35**, 82–92 (2015).
13. Jost, C. *et al. Clim. Dev.* **8**, 133–144 (2016).
14. Tranter, B. K. & Booth, K. I. *Glob. Environ. Change* **33**, 154–164 (2015).
15. McCright, A. M. *Pop. Environ.* **32**, 66–87 (2010).
16. Mandryk, M., Reidsma, P., Kanellopoulos, A., Groot, J. C. & van Ittersum, M. K. *Reg. Environ. Change* **14**, 1463–1478 (2014).
17. Sova, C. *et al. Environ. Sci. Policy* **54**, 463–474 (2015).
18. Dowd, A. M. *et al. Nature Clim. Change* **4**, 558–563 (2014).
19. Perez, C. *et al. Glob. Environ. Change* **34**, 95–107 (2015).
20. Bidwell, D., Dietz, T. & Scavia, D. *Nature Clim. Change* **3**, 610–611 (2013).
21. Rickards, L. A. *Nature Clim. Change* **5**, 392–393 (2015).
22. Xu, X., Tan, A. M. & Zhao, S. X. *Scientometrics* **104**, 673–684 (2015).
23. Whitley, R. & Glaser, J. (eds) *The Changing Governance of the Sciences: the Advent of Research Evaluations Systems* (Springer, 2008).
24. Golub, A. We need more mainstream social science, not less. *LSE Blog* (4 September 2013); <http://go.nature.com/qS97Wp>

#### Additional information

Supplementary information is available in the online version of the paper.