IV.12 Climate Prediction and Weather Forecasting

Nathaniel Logar

Agricultural science is often directed towards an identified application or need. However, a goal of application does not ensure a successful science program. For example, since 1989, the US spent approximately $2 billion dollars per year on climate change research that purportedly aimed to support decisions. However, there is little evidence that it produced a commensurate amount of useable information (Pielke Jr. and Sarewitz 2003), due to problems of legislative ambiguity, models of scientific thought and a tenuous relationship between the realities of modeling and needed information (see also Chaps. IV.3, IV.9 and IV.17). Unlike some other fields, such as theoretical physics or astronomy, agricultural and meteorological research have not historically been disconnected from concerns of application and use. However, creating linkages between research programs intended for decision support and benefit to societal actors, including agricultural producers and decision makers, is fraught with complexities of context, ideology, and institutional design.

The challenges of making predictions that are relevant to agricultural decision makers is to give them timely, salient information that links the knowledge accrual processes of the scientific supply side to the demand of decision makers. Designing research endeavors that can accomplish this is difficult because:

- Predictions, even when accurate, often fall in the wrong timeframe, or lack needed specificity.
- The uncertainties inherent in prediction may not be made apparent to those using the predictions.
- Science policy makers often misconstrue the context of application.

Evidence of the first two points is available in the case of climate models. In his article, "Overheated Claims", Roger Pielke Jr. makes the point that people who support action to mitigate climate change, including climate scientists, often rhetorically inflate the ability of climate models to predict the future. In the case

N. Logar (✉)
Belfer Center for Science and International Affairs, John F. Kennedy School of Government, Harvard University, Cambridge, MA, USA
e-mail: nat.logar@gmail.com

K. Stigter (ed.), *Applied Agrometeorology*, DOI 10.1007/978-3-540-74698-0_112,

for climate change model predictions, there has been a rash of scientists claiming that recent weather extremes have been consistent with model claims, despite large discrepancies between the spatial or temporal timescales of the weather events and the predictive capability of the models (Pielke Jr. 2008). Almost any foreseeable short-term weather event can fit into the longer term, lower resolution predictions of climate modelers.

However, if researchers tell decision makers that a specific weather event conforms to the prediction of the climate modelers, an average decision maker may come away with the impression that climate models are capable of predicting short term weather, and that they can continue to rely on their weather predictions in the future. Furthermore, decision makers may believe that the so-called conformity of the climate model to short term weather validates the longer term predictions of the model, and thus is a basis on which climate policy decisions can be accurately made. Neither of these things are necessarily true. Thus, the claims of climate modelers can bring decision makers to a place where they are either incorrectly placing faith in the models, or where they make a decision, the model is wrong, and the decision maker blames the modeler.

A large part of these possible complications is an artifact of inaccurate statements being made by modelers, but another contributing factor stems from policy makers funding predictive models, because they expect them to answer important policy questions, but not necessarily funding the right modeling to do so. Most climate models will not address anyone's concerns in regards to short term weather, but why is this important if meteorological organizations already exist to study such patterns? Most meteorological models, where predictions typically span a number of days, are not on the only prediction needed. Agricultural decision makers often require information on timescales related to climate variability ranging from seasonal to decadal, such as drought forecasts and ENSO predictions.

For example, one finding of a study on forecast application in northeast Brazil found that seasonal climate forecasting "has the potential to offer a dramatic opportunity for state and local level bureaucracies to embark on a path of proactive drought planning" (Lemos et al. 2002). However, much of the money spent on predicting climate goes to global climate models, which are not capable of the resolution needed for prediction regarding climate variability. Additionally, the pursuit of a seasonal forecast model is in no means a guarantor of success. Lemos et al. (2002) found problems with seasonal forecasts similar to those Pielke mentions. Both political overselling of the forecasts' ability, and a gap between forecast skill and information needed to make a decision, attenuated the effectiveness. Box IV.13 reviews the way Stigter (2004) read the lessons from Lemos et al. (2002).

Box IV.13

Stigter (2004) dealt with the lessons from Lemos et al. (2002) as follows. In this Brazilian example, drought forecasts have been directed towards small-scale rainfed agriculturists as well as state and local level policy makers in the areas of agriculture, water management, and emergency drought relief. Ceará state has the largest proportion of its territory characterized as semi-arid and is highly vulnerable to drought, which shaped culture, environment, politics and society. It is ravaged by poverty and over a century local and national governments have attempted to respond to the challenge of drought with limited success. It was also the first northeastern state to acquire technical expertise on regional climate science and to attribute climate forecasting to the mandate of a public institution.

A first lesson drawn by the authors was that an emergency technology "was appropriated and pressed into service of a policy making apparatus designed to reduce the impacts of severe droughts". Policy makers started to exaggerate the potential usefulness of the science product, "therefore creating a situation of cultural dissonance between science and local knowledge and belief systems that quickly eroded the value of the information". A second lesson drawn was the failure that the government wanted to use the forecast to manage agriculture for the farmers, particularly by interfering in the availability of seeding material, instead of leaving decisions on planning etc. to the farmers. This gave unnecessary resentment and has been abandoned. The third lesson that the authors of this case study want to draw is "that the forecast is limited by the socio-economic conditions of the beneficiary population". Most farmers in Cereá are so vulnerable to climatic variability that they are unable to respond to raw climatic predictions, irrespective of the quality and the precision of the forecast.

The authors of the case study indicate that the researchers have now changed their focus from items around the start of the rainy season to studies of dry spells and pre-season weather/climate patterns (response farming, easing preparations). The authors conclude overall that in the Cereá case study, the limits of the use of climate information in policy making derive in part from the levels of skill and direct usefulness of the science products themselves and in part from the necessity for a policy making apparatus to learn how to apply it usefully. In comparison to farming communities, the authors' assessments for the future give a more positive outlook for success with the use of forecasting products for "intermediate" organizations: (i) policy making government extension programs; (ii) drought relief organizations; (iii) water resource management bodies; (iv) infrastructure planning and infrastructure maintenance institutions.

The Brazilian case indeed shows that as a consequence of insufficient knowledge of the conditions that actually shape the livelihood of farmers, we have too often insufficiently taken into account local adaptive strategies; not made the right choices in the use of contemporary science; indeed not understood the overwhelming effect of inappropriate policy environments

(Stigter 2004). Fortunately, more recently a new sense of objective, rational professionalism has supplanted the old patronage and clientilism system, and the delivery of government services to states like Cereá has been held to new accountable standards (Finan 2003).

A compounding issue involves fomenting reconciliation between the stated goals of a research program and what it can plausibly deliver. If the US Climate Change Science Program (CCSP) promises decision support, but largely fails in that, it suffers in terms of the salience of its product and the perceived legitimacy of the organization, both of which are important characteristics of science that successfully link scientific knowledge to actionable outcomes (Cash et al. 2002).

In many countries, such as the United States, climate models are advocated for, funded, and developed in institutions that are explicitly focused on providing decision aids to policymakers. Both the interagency CCSP and its constituent federal institutions promise useful climate information. For example, the US Agricultural Research Service (ARS) promises to "develop and provide adaptation, mitigation, and management strategies to the individual farm, ranch, and rural community, and to natural resource decision-makers to allow them to derive optimal benefit from the positive aspects of global change and deal effectively with the detrimental effects" (ARS 2000).

Above, it was mentioned that science decision makers often fail to account for the context of application, promising relevant knowledge but failing to address how relevant information will reach decision makers. After study of the climate research programs within the ARS, it is evident, as one ARS staff member said, that "Global climate change is a Washington, DC policy maker issue. It's not a farm issue" (Follett, personal communication 2005). The ARS mandate charges it with providing useful information to farmers. At the same time, it receives a certain amount of money that it must devote to climate change, despite this characterization as a non-issue, and is thus left with a challenge in deciding what to prioritize.

Part of the reason for this problem, and for many problems in the prioritization and execution of public science, is that the views of the people who are supposed to be benefiting from the science are not fully taken into account. Much of the policy that drives predictive science in the US is the result of political decisions made at the national level, like Presidential directives (Office of the Press Secretary 2002). In the US, long term climate prediction is not "on the radar" (Follett, personal communication 2005; Hatfield, personal communication 2005) for many farmers, since it is not tied to production issues. But if it is going forward anyway, science decision makers are obviously not fully or accurately accounting for the context in which the science will find use. Lemos et al. (2002), working on seasonal forecast models, also found that the political and scientific process failed "to take into account end users' needs and decision making behavior". See also Box IV.13.

While long-term planning and anticipatory research is important in addition to short-term productivity, farmers must see plausible productivity benefits from science programs that are aimed at them. Often, they do not. The Minnesota Corn Growers are a regional farmers' association that interacts frequently with scientists in the ARS. They participate to the extent that they are willing to send members to ARS strategic planning meetings, such as those for research in Soil Resource Management or Water Resource Management. However, they have also interacted with members of the ARS global change research program, and have declined to send members to meetings in the past, because they do not consider climate change as a productivity issue, and thus cannot justify the cost (Baker, personal communication 2005). Thus, you see an organization that is focusing predictive resources on a topic area, but an invested stakeholder group that sees no benefit coming from the area, to the point where they refuse to take part, despite being given the opportunity to shape the path research might take.

In the case of the ARS, much of the money that is distributed to agricultural climate research is devoted to understanding the responses of soil carbon storage to different regimes, which stems from a statement made by President Bush in 2002 (Office of the Press Secretary 2002). While increasing the organic material in soils can benefit farmers regardless of climate change, the precise quantification of how much carbon a soil can hold is an issue specific to climate change. Farmers may only see benefit from this aspect of the research if the political field changes to alter policy so that they are being paid for sequestering carbon.

Thus, while work that helps farmers increase soil organic matter, and thus mitigate climate change, is a "win-win" situation, in that benefits accrue despite any action on climate (Kimble et al. 2003), precise carbon accounting might only be successful with further political action. At the same time, there are other decision support tools, perhaps on regional or seasonal climate forecasting, that could enable improved outcomes now. The political situation has defined the current arena so that research is being done that will not maximally benefit farmers until an uncertain future political choice changes farm legislation to pay farmers for carbon sequestration (Logar and Conant 2007).

Designing useable forecast systems, given the complications of context, politics, and forecast skill, is difficult. Some of these factors are unalterable at the level of research project prioritization. However, research planners can work in some ways to improve the fit between the supply of science and the information needs of the users, simply through more interaction and consideration of user needs, especially at the levels where new modeling ventures are being instituted and deployed.

Many authors have discussed the relationships between improved agricultural outcomes and the projects of research. Several authors have found better results from scientists collaborating with users (Gadgil et al. 2002; Siepen and Westrup 2002) and from competent management of the boundary between agricultural science and the managers it serves (Cash 2001). However, collaborative processes do not guarantee success (Korfmacher and Koontz 2003). Thus, investigating the whole policy context, including the expectations set by policy makers and the potential for the prediction to have sufficient skill, along with user needs, is important to gain a comprehensive view of how supply of science might match demand.

References

ARS (2000) Global change national program action plan. Agricultural Research Service, Beltsville, 23pp

Cash DW (2001) In order to aid in diffusing useful and practical information: agricultural extension and boundary organizations. Sci Technol Human Values 26:431–453

Cash DW, Clark W, Alcock F, Dickson N, Eckley N, Jager J (2002) Salience, credibility, legitimacy and boundaries: linking research, assessment and decision making. John F. Kennedy School of Government, Harvard University, Cambridge, 23pp

Finan TJ (2003) Climate science and the policy of drought mitigation in Cereá, northern Brazil. In: Strauss S, Orlove B (eds) Weather, climate, culture. Berg, Oxford, pp 203–216

Gadgil S, Seshagiri Rao PR, Narahari Rao K (2002) Use of climate information for farm-level decision making: rainfed groundnut in southern India. Agric Syst 74:431–457

Kimble JM, Everett LR, Follett R, Lal R (2003) Carbon sequestration and the integration of science, farming and policy. In: Kimble JM, Lal R, Follett R (eds) Agricultural practices and policies for carbon sequestration. Lewis Publishers, Boca Raton, pp 3–11

Korfmacher KS, Koontz TM (2003) Collaboration, information, and preservation: the role of expertise in farmland preservation task forces. Policy Sci 36:213–236

Lemos MC, Finan TJ, Fox RW, Nelson DR, Tucker J (2002) The use of seasonal climate forecasting in policymaking: lessons from Northeast Brazil. Clim Change 55:479–507

Logar N, Conant R (2007) Reconciling the supply and demand for carbon cycle science in the US agricultural sector. Environ Sci Policy 10:75–84

Office of the Press Secretary (2002) President announces clear skies and global change initiatives. Statement of George W. Bush at the National Oceanic and Atmospheric Administration, Silver Spring, MD, 14 February. http://www.whitehouse.gov/news/releases/2002/02/20020214-5.html

Pielke Jr RA (2008) Overheated claims. Financial Post. June 17. http://network.nationalpost.com/np/blogs/fpcomment/archive/2008/06/17/overheated-claims.aspx

Pielke Jr RA, Sarewitz D (2003) Wanted: Scientific leadership on climate change. Issues Sci Technol, Winter Issue:27–30

Siepen GL, Westrup J (2002) Communicating vegetation management science to land managers and other stakeholders. Rangel J 24:170–181

Stigter CJ (2004) The establishment of needs for climate forecasts and other agromet information for agriculture by local, national and regional decision-makers and users communities. In: Applications of climate forecasts for agriculture. Proceedings of the RA I (Africa) Expert Group Meeting in Banjul, the Gambia (December 2002). AGM-7/WCAC-1, WMO/TD-No. 1223, WMO, Geneva, pp 73–86