Recognising ignorance in decision-making

Strategies for a more sustainable agriculture

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Agriculture is a complex system and a global activity that affects the lives of billions of people. Low agricultural productivity, for example, can lead to hunger or even famine, and have an impact on stock exchanges or food prices, which can themselves trigger political events. Many variables can affect agriculture and thus people's livelihoods and the environment, such as the climate or water availability, as well as political decisions or economics. Agricultural policies therefore have serious implications for food security and safety, poverty, biodiversity loss, global warming and the availability of freshwater (IAASTD, 2009).

Given this complexity, political and economic decisions that affect agriculture need to account for many factors and state policy objectives very clearly. The decision-making process often includes risk assessment in order to minimize negative and unforeseeable effects. However, given the enormous importance of agriculture and food production for the global population, it is prudent to ask whether standard, scientific risk-assessment procedures are sufficient, or whether other methods are required that are better-suited to dealing with unpredictable outcomes and unknown factors.

Our knowledge-based society is characterized by the use of evidence-based assessments and expert advice to assist policy-makers in decision-making (Funtowicz & Strand, 2007). Conventional assessments regard the various types of uncertainty as 'risk', and use 'reductive-aggregative' tools. Such tools reduce the many complex and indeterminate dimensions of any system (here, agriculture) to two quantifiable parameters: the knowledge of future events,

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referred to as 'outcomes', and the probability of those outcomes occurring (Stirling, 2008). These parameters are then 're-aggregated' to yield a simple scalar representation of 'risk'. These approaches assume that science can produce objective, valid and reliable knowledge, thus avoiding the states of uncertainty described later. Furthermore, they generally produce linear, deterministic explanations for the effects of policies on a given system. If we know enough about outcomes and probabilities in a given system, we face a so-called 'risk condition' that can be managed by using risk-analysis techniques (Stirling & Scoones, 2009). However, if our knowledge of outcomes and/or their probability is incomplete, we face one of three other possible situations that are not manageable with classic risk analysis: ambiguity, uncertainty and ignorance (Stirling, 2007, 2008; Stirling & Scoones, 2009). In areas such as environmental or public-health research and decision-making, most actors now acknowledge that all four types of uncertainty exist, and that each requires a different strategy to be handled.

Dominant perspectives in agricultural science and international policy implicitly assume that the food-production system is predictable and causally driven. Despite some controversies,

ignorance is only recognized in policies focusing on the approval and use of new technologies. Methods to incorporate uncertainty into the macroeconomic assessment of agricultural policies are not yet well-developed. This equilibrium-centred view might not provide adequate insight into the dynamics of agri-food systems because it does not account for several factors, including the multi-functionality of agriculture, the complex relationships between actors or the increasing volatility of agricultural commodity prices (Clapp, 2009).

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The management of each type of uncertainty—risk, uncertainty, ambiguity and ignorance—requires a different approach (Fig 1). It is therefore crucial to identify the type of uncertainty present in agricultural systems. There are many sources of uncertainty that affect both prices and productivity, as well as society and the environment (Fig 2). In agricultural markets, uncertainty is caused by the variability of agricultural productivity and the behaviour of participants in markets, including short-term investors. Natural risks, such as weather and pests, are no longer the most-significant problems faced by farmers or investors, even though weather instability is likely to be exacerbated by climate change (IPCC, 2007; Parry *et al*, 2001;

Fig 1 | Methodological responses to different forms of incertitude. Based on Stirling (1999).

Vörösmarty *et al*, 2000). Furthermore, different types of agriculture can be affected by different sources of incertitude. Incertitude can also be caused by the behaviour of actors, and increased by insufficient regulation, poorly implemented policy or gaps in scientific knowledge.

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The types of incertitude most-widely recognized by those who model agricultural systems are risk and uncertainty (Munier, 2009). In our opinion, risk analyses are not appropriate for the development of agricultural policies, because they rely on incomplete knowledge, contradictory information, conceptual imprecision and divergent frames of reference. Furthermore, many natural and social processes that affect food-production systems are intrinsically complex or indeterminate. Modellers should frame their analyses to assume uncertainty or, as we suggest, ignorance. Doing so would help policy-makers to understand and deal with the element of 'surprise' that is characteristic of the ignorance condition. For instance, the variability of global food prices—such as

the unexpected increase in 2007–2008 or the increase of wheat prices in 2010—illustrates the importance of considering surprise, and is indicative of the state of incertitude within which international agricultural policies are developed.

Uncertainty and ignorance differ in terms of our knowledge about outcomes (Fig 1). For international agricultural policies, outcomes are the result of policy objectives in different areas: food security, prices or production, climate change, agricultural research, and so on. However, there is little consensus about what these outcomes should be (Ericksen, 2008). Some international peasants' organizations demand that agricultural policies should support a culturally acceptable and adequate food and the right of peasants to participate in the decision-making process (La Vía Campesina, 1996); they are focused on rights. The policies of the United Nations Food and Agricultural Organization (FAO) aim to increase nutrition and agricultural productivity, improve the lives of farmers and their families and contribute to economic growth (www.fao.org); they are more focused on markets. There are other examples of expected outcomes, in which even one actor can have different expectations in different contexts (Table 1).

As there are no common expected outcomes, it is not possible to assign

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probabilities to each one. In such circumstances, recognition of ignorance is the most-appropriate approach. This situation "emerges in complex and dynamic environments, where agents [peasant movements, international institutions, countries, corporations] may themselves influence supposedly exogenous events [GDP growth, trade tariffs, agriculture support] and where the very identification of a particular course of action can exert a reflexive influence on the appraisal of alternatives" (Stirling, 1999). Agricultural systems fit this description well. In this situation, 'surprise' should be considered as an intrinsic rather than exceptional component, and future surprises should be incorporated as part of the expected outcomes of international agricultural policies.

To provide an example of the way in which risk or uncertainty alone do not provide an adequate basis for developing international agricultural policies, we analysed the price and production

predictions made by the Agricultural Outlook report, produced by the Organization for Economic Cooperation and Development (OECD) and the FAO (Rivera-Ferre & Ortega-Cerdà, 2010). The Agricultural Outlook is one of the most-influential agricultural reports worldwide; it is an important reference for many international institutions and a primary source of information for the development of agricultural policies. The Agricultural Outlook approach addresses uncertainty by using uncertainty and risk techniques.

A comparison of the predictions (up to five years) of the Agricultural Outlook report and the trends for most internationally traded agricultural products between 1999 and 2008 revealed that, despite technical improvements in the models and historical experience, the accuracy of the predictions has not improved significantly (Rivera-Ferre & Ortega-Cerdà, 2010). The differences between the predicted and real agricultural commodity prices ranged between 17% for the ongoing campaign and 28% for five-year predictions. It is important to note that the margin of benefits for producers in the agricultural sector is less than the range of the predictions; thus, we must acknowledge the limitations of these projections.

Ignorance requires the democratization of knowledge-production and decision-making mechanisms

The differences for agricultural production were much lower—3–7%—indicating that climate is not a main source of uncertainty and can be relatively well predicted. Schmidhuber & Tubiello (2007) modelled the impact of climate change on food prices, and found that such price changes were, on average, much smaller than those caused by socioeconomic factors. Yet, we should not underestimate the impact of climate change on agricultural production at a local level (Battisti & Naylor, 2009; Parry *et al.*, 2001). The difference between the accuracy of predictions for prices and production also showed that human-induced uncertainty—for example, short-term investments, speculation and socioeconomic development pathways—could have more influence on agricultural commodity prices than do weather or production (Munier, 2009; Piesse & Thirtle, 2009).

Fig 2 | Sources of uncertainty in agriculture.

A more-sustainable agricultural system should therefore develop policies that recognize ignorance. This should not necessarily lead to ‘political paralysis’ (Stirling, 2007), but it could help to develop a more sustainable system. Ignorance is a part of the theory of risk as much as the concept of risk itself (Stirling, 1999). The recognition of ignorance could help risk managers to introduce new principles—for instance, those proposed by the adaptive-management paradigm—that could lead to different actions. For example, the precautionary principle is a fundamental tool to confront states of ignorance. Precaution provides a normative guide for policy-making in states of ignorance and allows the use of an array of analytical methods (Foster *et al.*, 2000; Stirling, 2007), as well as recognizing that different and contextual findings might result in different assessments of the same issue (Stirling, 2010). Some of these tools include a variety of plausible hypotheses and strategies, rather than looking for one solution; exploring a wide range of alternatives, which can be valid for different contexts; actions that are robust to uncertainties and are informative and reversible; and more public participation (Kriebel *et al.*, 2001; Ludwig *et al.*, 1993). In the context of agriculture, policy-making and assessments should explore alternatives that reduce uncertainty and the potential for damage to both society and the environment.

Including these elements in the development of international agricultural policies

implies important changes. Actions that try to decrease uncertainty include policies that support the ability of countries and communities to develop their own agricultural policies. Voluntary and flexible policies would be more suitable than closed, long-term, unchangeable structures and strategies with unpredictable effects (Munier, 2009; Westhoff *et al.*, 2004). Furthermore, local and regional production and consumption schemes could be prioritized over international relations in order to minimize surprises. Exploring a range of alternative production systems—that are based on diversity, as a strategy to reduce vulnerability—would be another consequence of accepting ignorance.

One of the main implications of recognizing ignorance would be structural changes in the governance of the agri-food system (Godfray *et al.*, 2010), which includes not only international agricultural policies, but also policies on development, research and climate change (IAASTD, 2009; Rivera-Ferre, 2008). Ignorance requires the democratization of knowledge-production and decision-making mechanisms (Craye & Funtowicz, 2009). Our limited ability to make accurate projections indicates that policies and knowledge creation should move from an expert-driven approach to a more-open perspective. New scientific approaches have been used to deal with some agricultural problems that are better framed in a state of ignorance and

Table 1 | Expected outcomes of the international policies for agricultural science set by various actors

Expected outcome	Actors										
	Farmers	WB	FAO	NGO	OECD	Emerging-market countries	Developing Countries	TNC	Development agencies	WTO	UNEP
Production-innovation	(IFAP)	(WB, 2007)	(FAO, 2004; Taylor <i>et al</i> , 2009)	(Gates Foundation, 2008; Oxfam, 2009)	(OECD, 1999)	India Brazil China	Nigeria, Nepal, Cambodia, Honduras, Uganda	(IAFN)	(EC, 2002; USAID)	—	(IAASTD, 2009)
Growth	—	(WB, 2007)	(FAO, 2004; Taylor <i>et al</i> , 2009)	(Gates Foundation, 2008)	(OECD, 2008)	India Brazil China	Nigeria, Nepal	(IAFN)	(EC, 2002; USAID)	(WTO)	—
Agro-ecological	(La Vía Campesina, 1996)	—	(FAO, 2009)	(FOEI)	—	Brazil China	Honduras, Venezuela, (Beauregard, 2009)	—	—	—	(IAASTD, 2009)
Participatory	(IFAP; La Vía Campesina, 1996)	—	(FAO, 2009)	(FOEI; Oxfam, 2009)	—	Brazil	Honduras Venezuela (Beauregard, 2009)	—	(EC, 2002)	—	(IAASTD, 2009)

Filled cells indicate that the outcome is expected from the policy document referenced, or is a goal of the organization or country listed. Data for emerging-market and developing countries have been collected from the institutional web pages of the corresponding agricultural departments. Table is based on Thompson & Scoones, 2009. EC, European Commission; FAO, Food and Agriculture Organization of the United Nations (www.fao.org); FOEI, Friends of the Earth International (www.foei.org/en/what-we-do/food-sovereignty); IAFN, International Agri-Food Network (www.agrifood.net); IAASTD; International Assessment of Agricultural Knowledge, Science and Technology for Development; IFAP, International Federation of Agricultural Producers (www.ifap.org); NGO, non-governmental organization; OECD, Organization for Economic Co-operation and Development; TNC, transnational corporations; UNEP, United Nations Environmental Program; USAID, United States Agency for International Development (http://www.usaid.gov/our_work/agriculture); WB, World Bank; WTO, World Trade Organization (http://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm3_e.htm).

for knowledge development and decision-making (Ravetz, 2002; Funtowicz & Strand, 2007), but they have not been developed for and used in international agricultural policy decision-making.

Traditional knowledge has been suggested to be better-suited for coping with the uncertainty and unpredictability that are seen as intrinsic characteristics of natural systems

Yet, scenario-building exercises for agriculture, which are typical of uncertainty analysis, are a useful tool for policy-making when applied to the analysis of key factors in food production, such as regional or global agricultural markets or environmental change, including climate change (Porter *et al*, 2010). For instance, one option to reduce incertitude by using classical approaches adopted for uncertainty states would be to create a panel of stakeholders to analyse scenarios for different policy strategies, in order to reach a consensus regarding policy outcomes.

This would allow moving from ignorance towards uncertainty, as it could produce common outcomes for practical situations. Other possible actions include the creation of structures, both national and international, through which peasants could provide their specific knowledge, which would support the promotion of traditional agricultural knowledge as part of international agricultural policies. Traditional knowledge has been suggested to be better suited for coping with the uncertainty and unpredictability that are seen as intrinsic characteristics of natural systems (Mazzocchi, 2006). Institutional diversity (Ostrom *et al*, 1999) is another useful tool for dealing with ignorance.

Given the relevance of international agricultural policies to the lives of millions of people and their impact on the environment, the framework used to perform scientific analysis and develop such policies has to be clearly defined. This framework has not yet recognized ignorance. This might be the reason that international policies have so far failed to address key problems for agriculture, such as poverty, hunger or environmental decay. By using different analytical

frameworks—for example, the ignorance state—different policies that, potentially, would offer better solutions to these problems and lead to a more-sustainable system, could be developed.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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