Assessment of the agri-food system for sustainability: recognizing ignorance

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In the era of knowledge-society, policy-makers use scientific, expert-based assessments to assist them in the decision-making process (Funtowicz and Strand, 2007; Kriebel et al., 2001). Overall, most conventional assessments follow the *Modern model* description of the relationship between science and policy: they assume that incertitude can be eliminated and science determines policy by producing objective, valid and reliable knowledge (Funtowicz and Strand, 2007). Most of them tend to regard incertitude as risk and are based on "reductive aggregative" tools typical of risk assessment. When these tools are used, generally linear deterministic explanations arise to explain the effects of policies on a given system. In that manner, systems are defined by two basic parameters: the knowledge of future events that might happen, referred to as *outcomes*, and the *likelihood* or probability associated with each of them (Stirling, 2007; Stirling, 2008). When there is a good knowledge of both parameters, we face a risk condition, and thus risk analysis techniques are appropriate tools (Stirling and Scoones, 2009). However, there are three other possible combinations of outcomes and likelihoods where our knowledge is not complete and we face incertitude: ambiguity, uncertainty and ignorance (Stirling, 2007; Stirling, 2008; Stirling, 2010). The existence of all the four levels of incertitude is widely accepted by actors involved in policy and scientific assessment in research areas such as environmental or public health, and in the use of some technologies (e.g. chemicals or biotechnology).

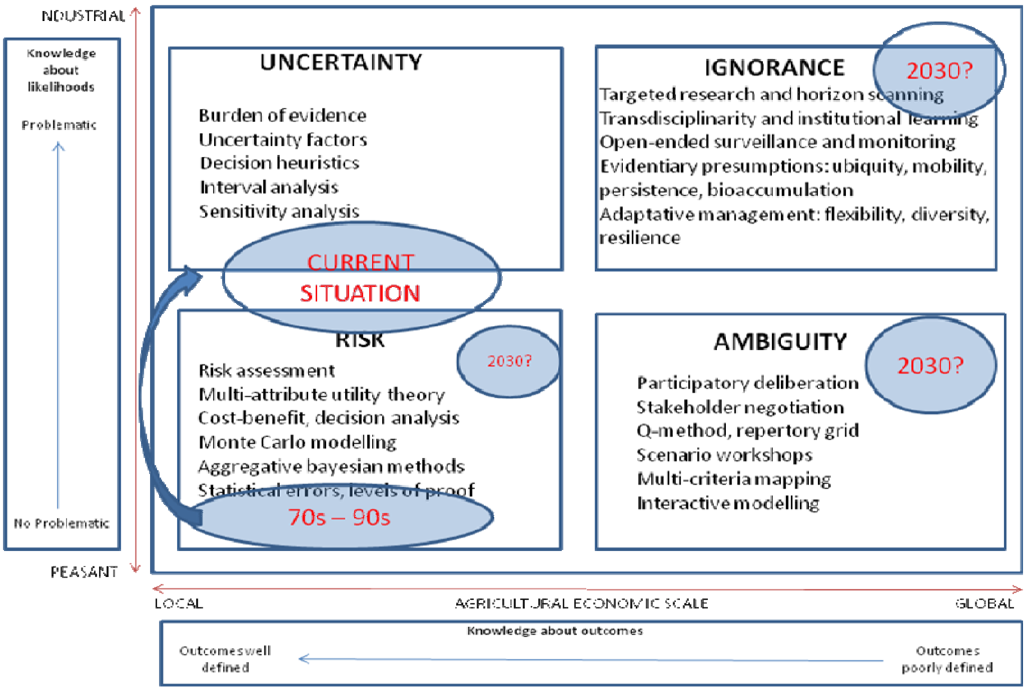
Agriculture is a complex activity directly affecting the quality of life of millions of people worldwide. Therefore, agriculture-related policies have strong implications to food security, food safety, poverty, biodiversity loss, global warming or water availability (IAASTD, 2009). Considering this, the process of decision-making in agriculture needs to be clearly defined, and policy objectives be clearly stated.

Environmental researchers have well recognized the existence of major uncertainties to develop environmental policies for sustainable development (Carpenter et al., 2009) and to produce reliable, valid models and rigorous global indicators (Walpole et al., 2009). Particularly in agriculture, recognition of ignorance is well established, despite controversies (Jasanoff, 2005; Mayer and Stirling, 2004), in policies centred on the approval of new technologies (Böschen, 2009; Haslberger, 2000; Marjolein van Asselt and Vos, 2008). However, it is surprising that incertitude in the macroeconomics assessment of agricultural policies is still not well developed. Dominant perspectives in agricultural sciences and international policies implicitly assume a predictable, causal driven agri-food system. It has been suggested that such equilibrium-centred view provides inadequate insight into the dynamics of the agri-food system (Thompson and Scoones, 2009) since it does not account for factors such as the multifunctionality of agriculture (IAASTD, 2009), the complex relationships among actors (Ericksen, 2008), or the diversity of institutions (Ostrom, 1999). Although risk or uncertainty approaches are dominant at the international level, we believe that recognition of ignorance would be more appropriate.

What type of incertitude does apply to Agriculture?

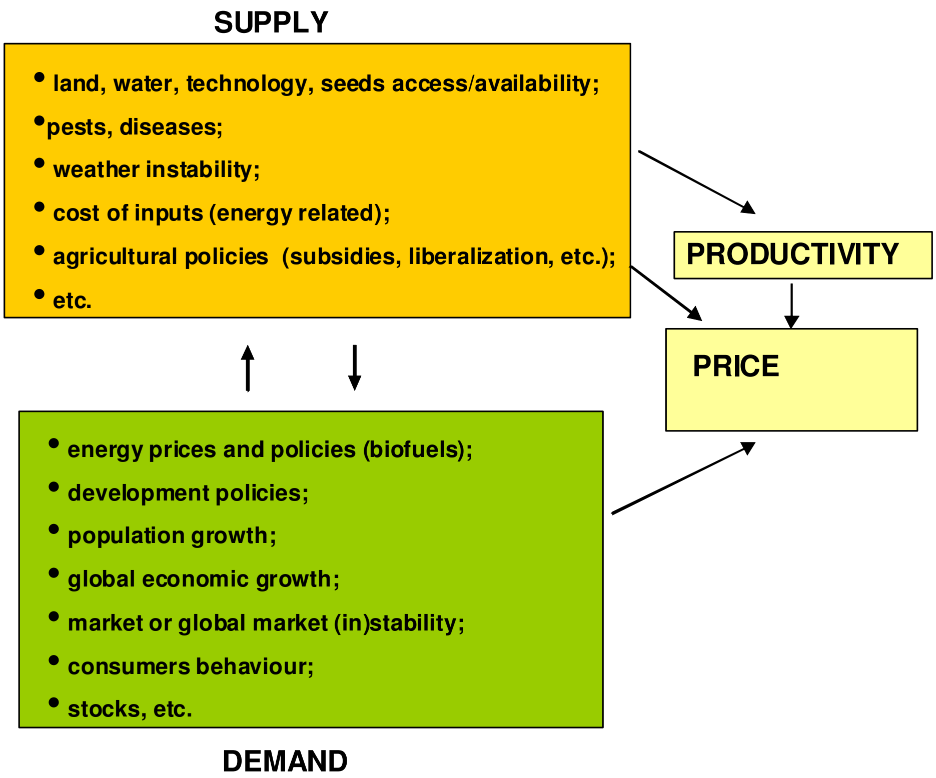
In general terms agricultural practices can be defined by two main components: the production systems and the economic scale. Considering these elements, we could state that agricultural practices have changed with the time from peasant production systems-local scale to the current situation of boosting industrial production systems-global scale. In this scenario, assessments have also been evolving from risk assessment (60s-70s) to uncertainty (current situation). Each type of incertitude (risk, uncertainty, ambiguity and ignorance) requires different technical and political approaches (Figure 1). Thus, the identification of the type of incertitude faced in the agri-food system is highly relevant. Overall, sources of incertitude in agriculture are diverse (Figure 2), affecting both prices and productivity of the agricultural systems, as well as the society and the environment. In agricultural markets, incertitude derives from (i) climatic shocks, (ii) agricultural productive activity, (iii) the behaviour of market participants, including short-term investors, and their interaction (Munier, 2009). Although natural risk may not be nowadays the bulk of the incertitude faced by farmers or by investors on agricultural commodities, weather instability or the difficulties to access land, water or seeds, are prone to be exacerbated by climate change (IPCC, 2007; Parrya et al., 2001; Vörösmarty et al., 2000). Furthermore, different types of agriculture can have different sources of incertitude. Incertitude may also be linked to actors' behaviour and can be intensified by dysfunction of institutions and policy, as well as by gaps of scientific knowledge.

Figure 1. Methodological response to different forms of incertitude related with agricultural policies



Modellers may acknowledge the existence of incertitude in agriculture that can affect policy decision-making and farmers' decisions (Just, 2001; Lagerkvist, 2005; Quiggin and Chambers, 2006). Generally, the type of incertitude more widely recognised by modellers are risk and uncertainty (Munier, 2009). In our opinion, risk analyses are not appropriate for assessment directed to international agricultural policies because there is incomplete knowledge, contradictory information, conceptual imprecision and divergent frames of reference. Furthermore, many natural and social processes affecting food systems are intrinsically complex or indeterminate. The analysis should be better framed assuming either uncertainty or ignorance. We believe that agricultural incertitude, affecting economical, ecological and social international decisions, may be better described if we recognized the ignorance condition. This recognition could facilitate the understanding of the importance of the element of 'surprise', characteristic of this condition. For instance, patterns of global food prices, (e.g. the unexpected changes of 2007-2008 agricultural international prices and subsequent global food crisis, or the 2010 increases of wheat prices) illustrate the importance of surprise and are indicators of the incertitude in which international agricultural policies are developed.

Figure 2. Sources of incertitude in agriculture.



Uncertainty and ignorance differ on the existing knowledge about outcomes (Fig. 1). In the case of international agricultural policies, outcomes are the result of the policy objectives defined by diverse institutions regarding the role of agriculture in different areas (food security, climate change, food prices, food production, agricultural research, etc.). The fact is, however, that there is poor consensus among actors about what should these outcomes be, with their expectations varying widely (Ericksen, 2008). Some international peasants' organizations state that agricultural policies outcomes should aim at accomplishing a culturally adequate food and the right of peasants to produce food and participate in the agricultural policy decision-making (LaVíaCampesina, 1996). To FAO, policies should aim at raising levels of nutrition, increasing agricultural productivity, improving live of rural people and contributing to the growth of world economy (FAO, 2008). But growth is not included in peasant's expected outcomes and the same occurs with participation and cultural adequacy for FAO expectations. Other examples can be found in the expected outcomes of international agricultural research policies, where even one group of actors in different contexts can have different expectations (Table 1).
Since expected outcomes are not common, there is no possibility of getting a common projection and assign probabilities to each outcome. Under this circumstance, recognition of ignorance is most appropriate. 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). Agri-food systems do fit well with this description. In this situation, 'surprise' should be considered as an intrinsic, rather than exceptional, component of the system, and future surprises should be incorporated as part of the expected outcomes of international agricultural policies.

Table 1. Expected outcomes of international policies for agricultural science (based on Thompson and Scoones, 2009).

Expected outcomes	Actors										
	F	WB	FAO	NGO	OECD	EC*	DC*	TNC	DA	WTO	UNEP
Production-innovation	X[1]	X[3]	X[4,5]	X[7, 8]	X[10]	X: IN, BR, CN	X: NG, NP, KH, HN, UG	X[13]	X[14, 15]		X[17]
Growth		X[3]	X[4,5]	X[7]	X[11]	X: IN, BR, CN	X: NG, NP	X[13]	X[14, 15]	X[16]	
Agroecological	X[2]		X [6]	X[9]		X: BR, CN	X[12]: HN, VE				X[17]
Participatory	X[1, 2]		X [6]	X[8,9]		X: BR	X: VE, HN		X[14]		X[17]

*EC and DC data have been collected from the institutional webpage of their corresponding Agricultural Departments.

[1]IFAP. (2009). International Federation of Agricultural Producers; [2]La Via Campesina. (1996). Declaración final de la II conferencia internacional de La Vía Campesina en Tlaxcala; [3]World Bank. (2007). Agriculture for Development. Washington DC, p.386; [4]FAO. (2004) Agricultural Biotechnology. Meeting the needs of the poor? Rome, p.209; [5]Taylor, J.E., Zezza, A., Gurkan, A.A. (2009) Rural Poverty and Markets. Agricultural Development Economics Division. The Food and Agriculture Organization of the United Nations; [6]FAO. (2009). Organic Research Centres Alliance. Rome; [7]Bill & Melinda Gates Foundation (2008). Development Program: Agricultural Development. Working to Break the Cycle of Hunger and Poverty; [8]Oxfam. (2009). Investing in Poor Farmers Pays. Rethinking how to invest in agriculture; [9]FEOI. (2008). Food Sovereignty Program. Friends of the Earth International; [10]OCDE. (1999). Modern Biotechnology and the OECD; [11]OCDE (2008) Agriculture: Improving Policy Coherence for Development; [12]Beauregard, S. (2009). Food Policy for People: Incorporating food sovereignty principles into State governance. Case studies of Venezuela, Mali, Ecuador, and Bolivia. Urban and Environmental Policy Institute. Occidental Collage, Los Angeles, CA, p.94; [13]IAFN. (2007). The International Agri-Food Network; [14]European Comisión. (2002). Fighting rural poverty. European Community policy and approach to rural development and sustainable natural resources management in developing countries. COM (2002) 429 final; [15]USAID. (2010) Agriculture; [16]WTO. (2010) Understanding the WTO: the agreements. Agriculture: fairer markets for farmers; [17]IAASTD. (2009). Agriculture at a Crossroads: Global Report. Island Press, Washington DC.

Failure of predictions: The Agricultural Outlook Report

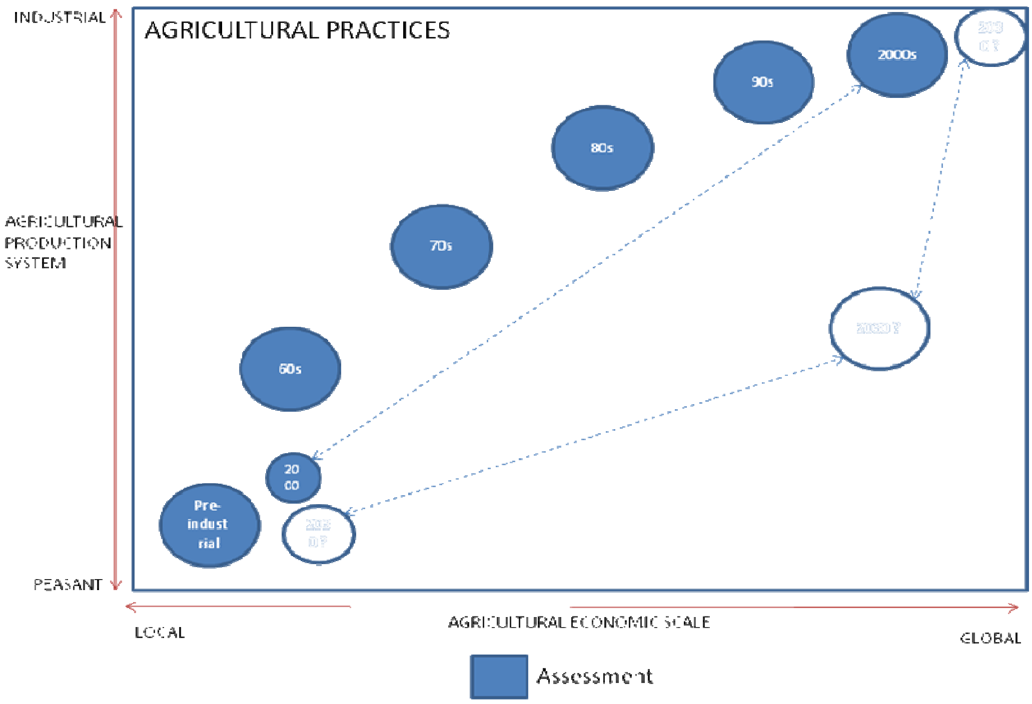
To provide an example of how risk or uncertainty can rarely provide an adequate basis to develop international agricultural policies, we analyzed the success of the price and production predictions of the Agricultural Outlook (AO) report of the Organization for Economic Co-operation and Development and FAO (Rivera-Ferre and Ortega-Cerdà, 2010). The AO is one of the most influencing agricultural reports worldwide, considered a major reference for the most relevant international institutions and a primary source of information to develop international agriculture policies. The AO approach addresses incertitude by using uncertainty and risk techniques: OECD-FAO AGLINK-COSIMO model complemented with scenario and sensitivity analysis (OECD, 2009). After comparing the AO predictions and real trends for the most traded agricultural products between 1999 and 2008, we showed

that despite the technical improvements performed in the models, and the historical expertise obtained, the final prediction accuracy has not improved significantly (Rivera-Ferre and Ortega-Cerdà, 2010). Regarding **agricultural commodity prices**, differences between predictions and reality ranged, on average, between 17 per cent for the ongoing campaign, and 28 percent for the five-year predictions (15 and 27 per cent if the 2007-2008 increases were not considered). It is important to remark that the margin of benefits for producers in the agricultural sector is less than the inaccuracy of the predictions, and thus, we must acknowledge the limitations of these projections. For **agricultural production**, differences were much lower, varying between 3 and 7 per cent, indicating that, indeed, weather is presently not the major source of incertitude at a global scale and can be relatively well predicted. (Schmidhuber and Tubiello, 2007) found that after modelling the impact of climate change on food prices, price changes expected from the effects of global warming were, on average, much smaller than price changes from socio-economic development paths. Still, we can not underestimate the impact of weather on agricultural production at a local scale, being climate change one of the most important factors threatening food security (Battisti and Naylor, 2009; Parrya et al., 2001). The difference between the accuracy of predictions for prices and production also showed that human-induced incertitude (e.g., short-term investments and speculation, socio-economic development paths) could have more impact on international agricultural commodity prices than weather or production (Munier, 2009; Piesse and Thirtle, 2009).
Since policy implications in agriculture deal with the food of millions of people, as well as with environmental decisions linked to global environmental change (Ericksen, 2008), models serving as reference in agriculture and international policies *"should not dispense with modeling expectations or risk attitudes in their connections with the different situations of the agriculture production and prices"* (Munier, 2009).

Assessment for policy-making under "ignorance": steps towards a more sustainable agri-food system

Where will agricultural practices be in the future in terms of production systems and economic scale is difficult to predict and different scenarios can be built to adjust the assessment to the future. A realistic assumption for the near future would be a scenario with a moderate evolution of agricultural practices, going from global to regional, and a coexistence of both levels of agricultural production systems (peasant and industrial; Figure 3). Yet, sources of incertitude will persist. The recognition of ignorance can lead us towards a more sustainable system. Ignorance is founded just in the theory of risk as rigorously as it is the concept of risk itself (Stirling, 1999). The adoption of ignorance introduces new challenges in the assessment of international agricultural policies. The first step to confront the analysis of agriculture and food in an ignorance scenario is the recognition that agriculture is a socio-ecological complex system, where social and biophysical drivers can affect social and ecological aspects of agro-ecosystems (Carpenter et al., 2009; Turner et al., 2003). Some characteristics of SES include: far-from equilibrium, self-organizing, non-linear, multivariable, high level of incertitude, not all factors can be controlled, and cross-scale in time and space. Given that, the analysis of agriculture-related problems should be complex, and the solutions diverse, i.e., panaceas simply do not exist (Ostrom et al, 2007). This is currently not happening now. Simplistic, monoscale and static analyses tend to define problems in natural systems as mostly technical, and thus, they rely on technical solutions. On the contrary, a SES framework introduces in the scientific analysis of the problem social and political issues, and recognizes that social derived incertitude is in many occasions higher than incertitude derived from nature (Tyre and Michaels, 2010). A second step after ignorance recognition (with the need to manage incertitude) and the use of SES analysis in agriculture sustainability is the call for multidisciplinary research (Odum, 1989; Ludwig et al. 1993; Turner et al, 2003; Carpenter et al., 2009; IAASTD, 2009) being vital to avoid powerful interests that oppose social change. The relevant information to analyze social, ecological and economical agricultural systems to propose policies for sustainable development is enormous but it is fragmented, including natural, agricultural, social, humanities and economical sciences.

Figure. Time-line of *Agricultural assessment demand* at a global scale related with agricultural practices



In terms of management, recognition of ignorance could help introducing new principles, as those proposed by the *adaptive management* paradigm (Costanza et al., 1998), leading to different specific actions. For example, precautionary principle is important when ignorance states must be confronted. Precaution provides a general normative guide to policy-making under ignorance state and points to a broad array of methods for analysis (Foster et al., 2000; Stirling, 2007). Some suggested elements to confront ignorance based on the precautionary principle include (Kriebel et al., 2001; Ludwig et al., 1993): consider a variety of plausible hypotheses and strategies, not only one solution is valid for problems facing the agri-food system; explore a wide range of alternatives, which can be valid for different contexts; favour actions that are robust to *uncertainties*, that are informative and reversible; and increase public participation in decision making. In this sense, our actions should explore alternatives that reduce incertitude and potential damages caused by international agricultural policies to both society and environment.

In practical terms, the adoption of these elements to develop international agricultural policies implies major changes. Actions aiming at decreasing or adapting to incertitude can include the formulation of policies supporting countries' and communities' ability to develop their own agricultural policies. In this case, voluntary and flexible policies would be perceived as better than closed and long-term unchangeable structures whose impacts are difficult to predict (Munier, 2009; Westhoff et al., 2004). Furthermore, local and regional production and consumption schemes may be prioritized over international long-chain relations, whose relative importance should not be as high as it is now in order to minimize the unexpected surprises. Exploring a wide range of alternative production systems, based on diversity as a strategy to reduce vulnerability, would be another consequence of accepting the ignorance condition.

Still, one of the major implications derived from the recognition of ignorance would be the accompanied structural and innovative changes in the governance of the agri-food system (Godfray et al., 2010), including international agricultural policies, but also other policies linked to agriculture and food, such as development policies, agricultural research policies or climate change (IAASTD, 2009; Rivera-Ferre, 2008). Ignorance requires democratizing the knowledge-base production and decision-making mechanisms (Craye and Funtowicz, 2009). The present limits of the projection capabilities require that policies and knowledge-creation should move-on from an expert-driven approach to a more open perspective. Post-normal science has been used to deal with some agricultural problems that are better framed in an ignorance state (Ravetz, 2002), as well as with knowledge development and decision making (Funtowicz and Strand, 2007), but it has not yet been developed in the international agricultural policies. Yet, we must recognize here that scenario-building exercises for agriculture, typical in uncertainty analysis, are a useful tool to help in the policy-making decision process when applied to the analysis of major drivers, such as regional or global agricultural markets, against low or high impacts of environmental change (including climate change) on agriculture (Porter et al., 2010) and food security. For instance, one first option to reduce incertitude while using the classical approaches valid for uncertainty states would be to create an international panel of stakeholders, under the UN umbrella, to analyse the scenarios built for different policy strategies, in order to reach a consensus regarding policies' outcomes. This action would allow moving from ignorance towards uncertainty state since common outcomes for practical situations could be achieved. Other possible actions include the creation of structures, both at national and international levels, where peasants providing specific local knowledge's could support knowledge-making and supervision. Recognition of this extended knowledge may support the promotion of traditional agricultural knowledge as part of international agricultural policies. Traditional knowledge has been suggested as better suited for coping with the uncertainty and unpredictability that are viewed as intrinsic characteristics of natural systems (Mazzocchi, 2006). Institutional diversity (Ostrom et al., 1999) can also be a useful tool under this circumstance.

In conclusion, given the relevance of agricultural international policies for the life of millions and the impact on the environment, the framework used to perform scientific analysis and develop such policies has to be clearly defined. Until now, this framework has not recognized the existence of the ignorance condition. This might be the reason as to why such policies fail to address major international problems linked to agriculture, such as poverty, hunger or environmental contamination. Using a different analytical framework, i.e., ignorance state, could favour different policies that, potentially, could offer better solutions to these problems and lead us to a more sustainable system.

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