The Need for an Intervention Decision Model

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The Consultative Group on International Agricultural Research (CGIAR) needs to develop a comprehensive, quantitative model to assess the value of intervention decisions. The Intervention Decision Model (IDM) will be the basis for prioritizing interventions, determining how to measure the impact of interventions on development outcomes, and calculating the value of the research itself.

Background

The CGIAR is a collaboration of 15 research centers and hundreds of partner organizations that investigate sustainable development. The Group has launched a series of new Consortium Research Programs designed to tackle cross-cutting issues in agricultural development across the globe, towards achieving the ultimate development outcomes of less rural poverty, better food security, better nutrition and health, and sustainably managed resources. The Consortium Research Program on Water, Land and Ecosystems (http://wle.cgiar.org/), which is initiating this research initiative, addresses the problems of water scarcity, land degradation and loss of ecosystem function, which together constrain food production and cause poverty and environmental damage. However the approach described here is applicable to any CGIAR research.

The CGIAR, its partners, donors and other institutions attempting to solve big, complex problems like sustainable development face the following challenges.

1. **Estimate the impact of intervention:** Institutions engaged in research and development should always have more ideas than they have resources. Given limited resources, how should interventions be prioritized? Which interventions will reduce risk, increase security, and improve lives the most? These decisions are always made with significant uncertainty about acceptance of a new intervention, the future risks if the intervention is not funded, the costs of the intervention, the long-term impacts (positive and negative) of any change to a system, including the trade-offs between agricultural productivity and the environment, and so on. Yet, there is still need to make recommendations about how to use limited resources. In the face of so many uncertainties, how should researchers and development specialists decide which interventions to recommend?

2. **Determine how to measure and monitor development outcomes:** There are vast combinations of data that could be gathered about the productivity and health of an agro-ecosystem and the livelihoods that they support – but not all metrics will be of equal value when it comes to supporting important intervention decisions. Of all of the variables that might be an indication of the desired development outcomes, some will have more direct impact on real decisions. Some variables will also have higher value than others for detecting early on whether an intervention is on track so that corrective actions can be taken in time. And even if a variable may have an impact on intervention decisions, costs of gathering data will vary greatly. How should researchers determine what data gathering costs are justified?

3. **Show the value of research:** Donors would often rather directly fund intervention programs than support research. Yet research is critical in determining whether interventions will have the intended effects. How can researchers show how the expense of research is justified by better intervention decisions and improved outcomes, and how can donors know whether their investments are yielding the desired impacts?

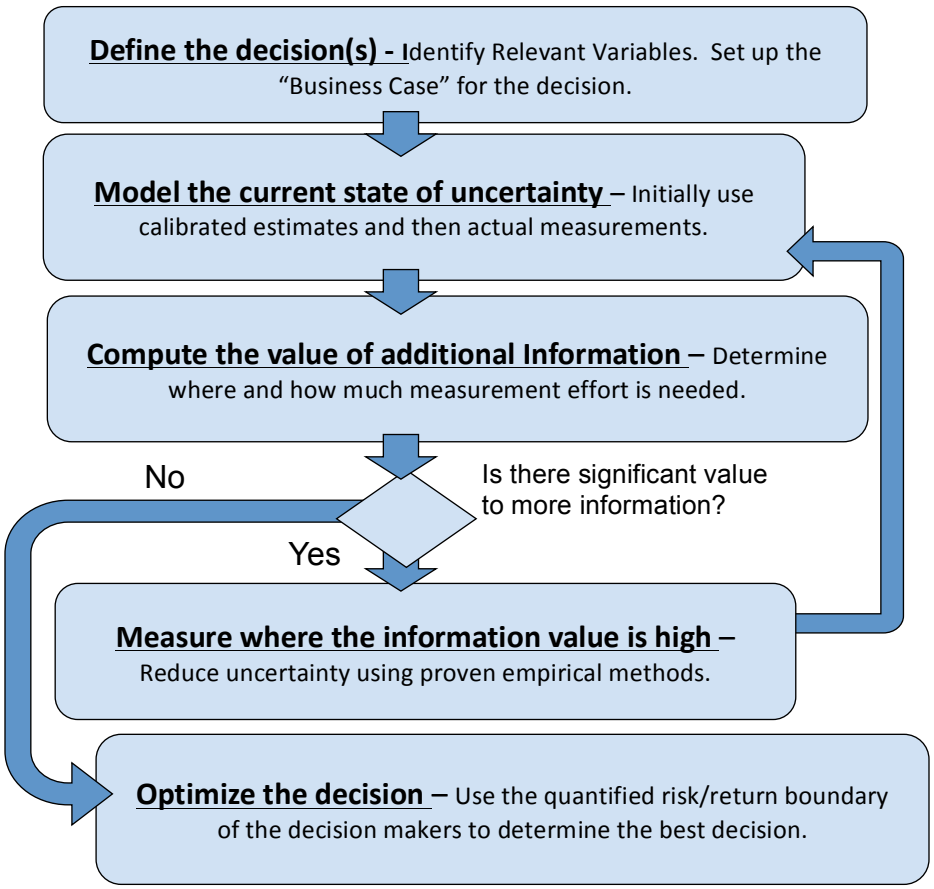
The Method: Applied Information Economics

The CGIAR Program on Water, Land and Ecosystem has found a consolidated approach that will address all three of these issues. The solution will involve the use of a method called Applied Information Economics (AIE). Applied Information Economics was developed as a science-based method developed for addressing investment dilemmas that are large, risky, and full of difficult measurements. AIE uses a unique approach to assess major business decisions, and even "intangibles" like information-value have proven economic formulae that are exploited by AIE.

AIE synthesizes several quantitative methods from economics, actuarial science, decision theory and statistics. AIE has been applied to over 70 real major decisions, of high uncertainty and complexity in both government and commercial organizations. Hubbard Decision Research has previously applied these methods to problems as diverse as IT investments, logistics, environmental policy, new pharmaceutical products, projects in the entertainment industry, the value of industry standards, and engineering and mining risks.

Unlike traditional methods that produce arbitrary "scores" or unrealistic Return-on-Investment analyses, AIE conducts a "Risk/Return" analysis with the same degree of rigour used by actuaries to estimate loss rates in insurance pools. The method involves five steps – define the decision(s), model what you know now, compute the value of information, measure what matters, make better decisions.

Figure 1: The Steps of The Applied Information Economics Process



- *Define the Decision(s):* As obvious as this step may first appear, it is the key to better understanding what to measure and real decisions are often different from what they first appear to be. Is the dilemma whether to simply approve a project or *how* to conduct a project given multiple combinations of alternatives? Or is the decision a matter of *when* to approve a given initiative? The costs, benefits, timing, risks and even external factors are identified and the real decision is clarified.

- *Model What We Know Now:* Cost estimates, forecasts of benefits, project risks, and other variables in a typical big investment decision are almost never known exactly. The uncertainty about some variables, especially long term forecasts, can seem extreme. But the consequences of even extremely uncertain variables are assessed using "Monte Carlo" simulation and a special method for training experts to assess probabilities. The Monte Carlo method is a method for conducting decision analysis by sampling variables that do not have exactly known values (i.e. most variables in a model). This initial model is effectively a snapshot of the current state of uncertainty about a problem before additional measurements are made.

- *Compute the Value of Information:* Not all variables in a decision model are worth measuring and those worth measuring are often a surprise to the decision makers. In fact, normally a kind of "measurement inversion" exists in most decisions – that is, the most uncertain variables tend to be ignored while the variables that usually receive a lot of attention frequently have less bearing on the decision. With AIE, every variable in a model will have an "information value" that allows identification of high value variables in a decision. This approach targets only the variables in a decision that are the most likely to significantly reduce overall uncertainty in the decision.

- *Measure What Matters:* Once the high-value measurements are identified, a variety of empirical methods can be used. Contrary to what is sometimes assumed, relatively little data or simple observations may be required for extremely uncertain variables. AIE often uses efficient "Bayesian" methods, which exploit prior knowledge and can be used even when data is messy or sparse. The measured variables will have less uncertainty and then the model of uncertainty can be updated.

- *Make Better Decisions:* The output of the Monte Carlo model, updated with targeted measurements, is compared to the risk/return preferences of the organization or decision maker. Research shows that the actual risk aversion and other preferences of decision makers changes frequently and unconsciously. Different preferences are applied to different investments even when management or believes they are being consistent. AIE addresses this major source of decision error by quantifying and documenting preferences such as risk tolerance and the value of deferred benefits so that the results of analysis can be assessed in a controlled, uniform manner. Finally, sometimes decisions have large combinations of outcomes and have to be part of a portfolio of decisions. When necessary, AIE applies optimization methods to determine the best decision even from a large set of alternatives.

The Intervention Decision Model

This process simultaneously addresses all three challenges. Even uncertain and difficult to measure interventions can be assessed and prioritized. And because of the information value calculations, the best agro-ecosystem health metrics can be identified and the value of research itself can be articulated.

In order to get this process started, classes of typical intervention decisions will need to be modeled in this structured way. To this end, the CGIAR proposes developing the Intervention Decision Model (IDM). The IDM will be a guide to all of the major intervention decisions in sustainable agriculture and ecosystem management. It consists of four major components: a model for all major classes of interventions, the model for forecasting the outcomes of those decisions, a set of "preference curves" that represent risk aversion and other policy choices, and the quantified values engine that combines them all for recommendations.

- *Proposed Programmatic Interventions*: The IDM will cover all major types of intervention decisions including improvements to smallholder irrigation, better floodwater and aquifer management, design of new benefit sharing schemes for water and land in large river basins, improvements to rainfed-productivity including crop and rangeland-productivity, investment plans for waste management, and climate change adaptation or mitigation strategies. These could be implemented as direct infrastructure investments, policies, training or incentive programs. Investments in these areas have impacts that improve incomes in both the near and long term as well as improve access and security for water, energy, and food. The IDM will include all of these types of decisions.

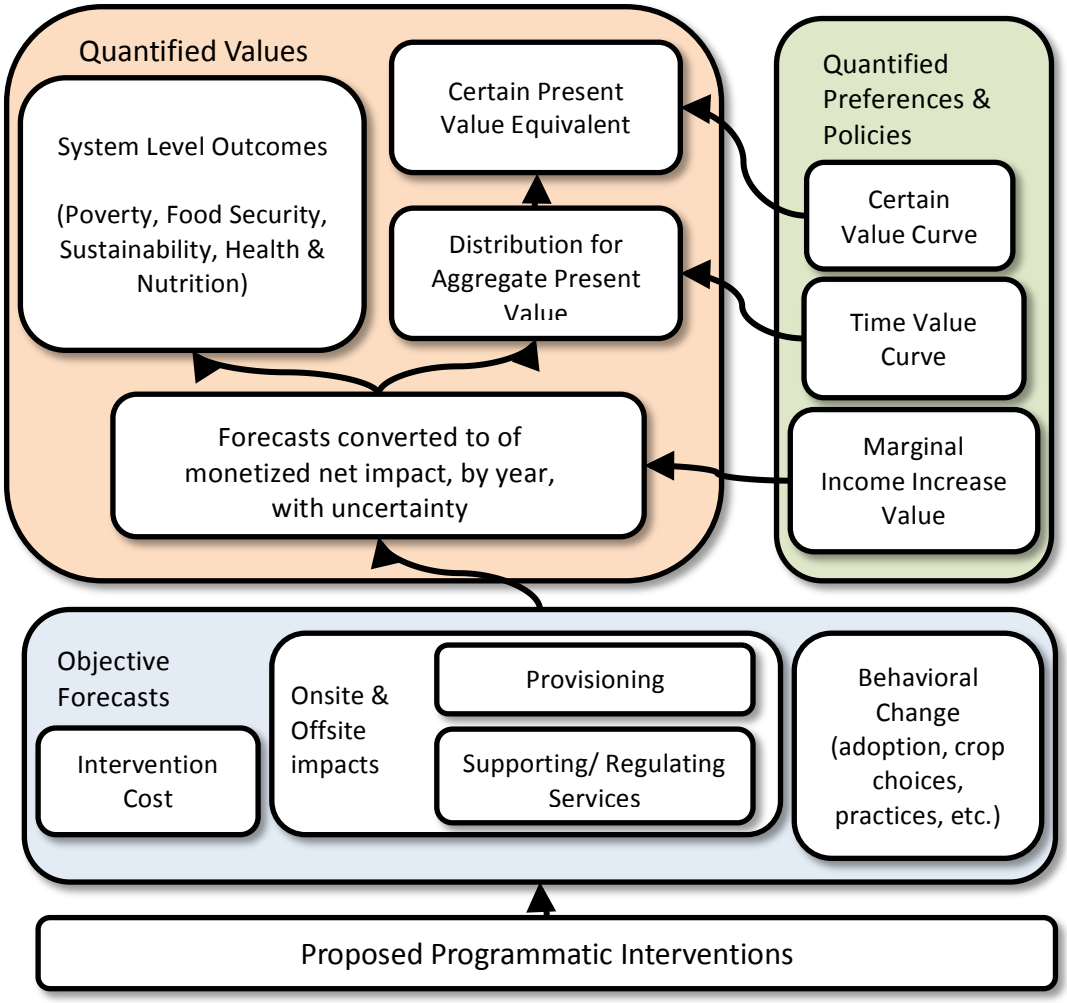
- *Objective Forecasts*: The costs of the intervention may be uncertain and the long term effects of any intervention will be uncertain. The IDM will determine the uncertainty of onsite and offsite impacts as well as behavioral factors like the adoption rate of a new practice or how incentives change behavior. Some of the elements of this model will be based on known science such as yield improvements from additional irrigation. But some factors, such as long term changes in behavior will be much more uncertain. Quantifying the difference in this uncertainty will be critical in determining what to measure and what to monitor to track intervention performance.

- *Quantified Preferences & Policies*: Preferences about what risks are acceptable, how to value long-term effects, or the value of equitable improvements in income, need to be quantified and documented as a matter of policy. These preferences are captured as a set of "utility curves" that make policies – such as the relative value of a near-term certain impact vs. a long term and uncertain impact – unambiguous. Such clarity will mean that various interventions can be evaluated against the same standards of risk aversion and other preferences.

- Quantified Values: Ultimately, the effects of an intervention and the quantified preferences are combined into a single monetized value so that interventions of different types and sizes can be compared. Each intervention creates a set of estimated impacts over a period of time. The

timing and uncertainty of these impacts are adjusted so that they can be rolled into a single number. The quantified values can also adjust outcomes for differences in how benefits of a program are distributed equitably. Separately, the IDM can assess the likely impacts on individual System Level Outcomes: poverty, food security, nutrition and health, poverty, and sustainability.

Figure 2: Outline of the Intervention Decision Model



Summary

Given the critical nature of the decisions the CGIAR supports, perhaps the single most important task ahead is to determine the best way to make decisions. Uncertainties and risks must be quantified, policy preferences must be clarified, and the measurements most important to the decisions must be identified. The IDM will be a major advance in this direction.

For further information on this concept note, please contact either Keith Shepherd (k.shepherd@cgiar.org) at the World Agroforestry Centre or Doug Hubbard (dwhubbard@hubbardresearch.com) at Hubbard Decision Research.