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# STRATEGIC ENVIRONMENTAL ASSESSMENT

## Assessing the Environmental Impact of Biotechnology

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**Meeting the food needs of the world's growing population while reducing poverty and protecting the environment is a major global challenge. Private- and public-sector organizations must decide how to spend limited agricultural research funds in order to achieve maximum impact with regard to finding sustainable solutions to ending hunger and poverty. Considerable funds are spent for public research with the aim of developing genetically modified (GM) crops that serve the needs of the poor. However, past experience with developing new agricultural technologies to combat hunger and poverty—for example, the Green Revolution—shows that it is essential to take environmental concerns into account in order to develop technological solutions that are sustainable in the long run. In order to make commercialization of GM crops possible, considerable efforts are made to assess the economic and social impact of investment in agricultural biotechnology and the establishment of regulatory systems for biosafety in developing countries. Yet few attempts have been made to systematically account for environmental issues when deciding on plans, programs, and research priorities for GM crops. Potentially, Strategic Environmental Assessment (SEA) could be used to ensure that environmental considerations are evaluated in the research and priority-setting process.**

Project-based risk assessments or Environmental Impact Assessments (EIAs) of biotechnology are used to evaluate specific developments when the technology is ready for commercialization, but there is a need to develop comprehensive analyses of plans at an earlier stage of development to justify the investment of potentially large amounts of public monies in specific biotechnologies. This provides the rationale for the use of SEA in development-related investments to integrate environmental considerations with poverty alleviation potential, gender and other social issues that may impact the choice of crop and trait, and governance and legal factors. This would be done at the planning level when alternative biotechnology options are under consideration. However, few attempts have been made to define how an SEA process for biotechnology would work. The purpose of this policy brief is to start to map out a process for undertaking such assessments. Comprehensive analyses also consider the impacts of not approving novel products.

The SEA methodology is set out in Figure 1 and includes qualitative and quantitative analysis, management, participation, and communication.

## QUALITATIVE ANALYSIS

During the qualitative assessment stage, evaluators identify plans and programs that are likely to have significant environmental effects and therefore should be subject to environmental assessment. At this stage, expert opinion and stakeholder consultation are used to identify potential objectives, alternatives, and impacts (Figure 1). Broadly, the qualitative analysis considers the identification of objectives (e.g., those established by legislation and those established by stakeholder consultation), the identification of a set of technology alternatives, and an assessment of alternatives in light of the objectives. For example, expert panels could use decision support methods such as the Analytic Hierarchy Process (AHP), Multi Attribute Utility Theory (MAUT), or other multi-criteria techniques to assess alternative policy options against established objectives. The aim of multi-stakeholder and group decision approaches is to identify and develop consensus around preferred investment options.

The key benefits of these approaches are:

- aligning investment decisions with objectives or goals;
- implementing a structured, methodologically repeatable, relatively low-cost, and rapid decision-making approach;
- leveraging local, regional, and global expertise;
- improving communication; and
- building consensus.

## QUANTITATIVE ANALYSIS

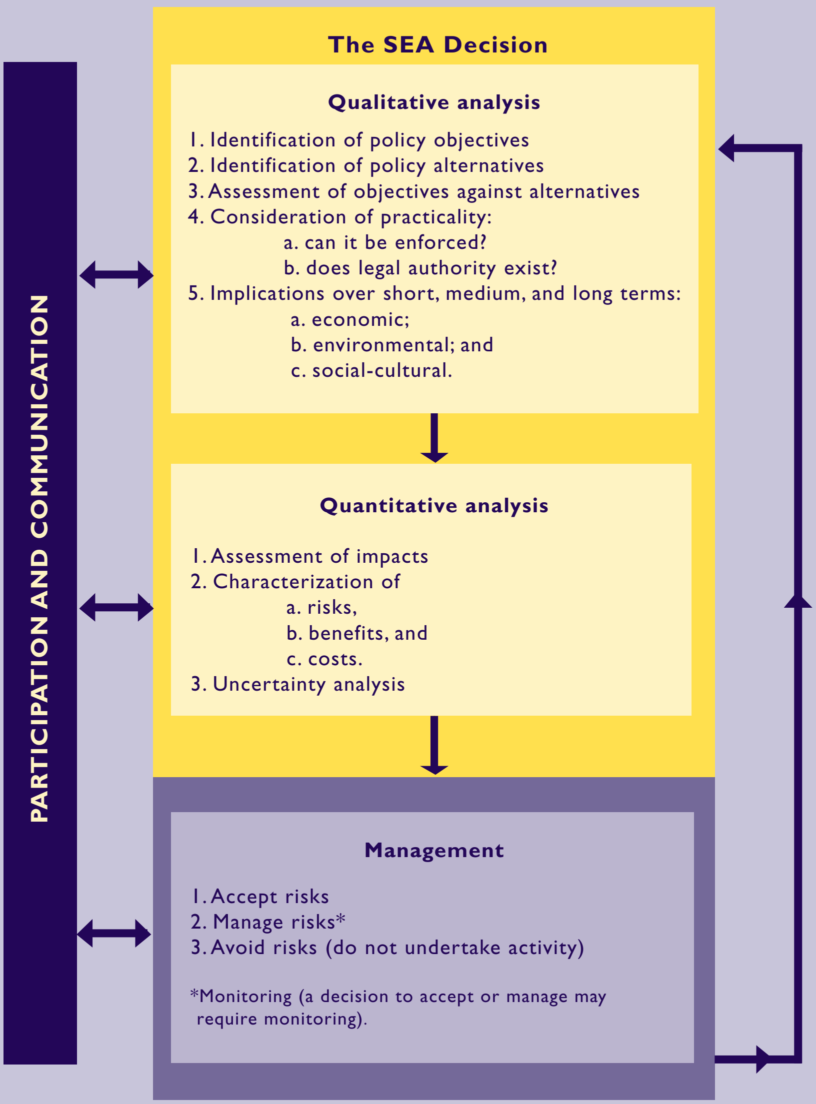
Evaluators may or may not proceed with quantitative analysis depending on the results of the qualitative assessment. However, quantitative analysis may be used to provide rigorous support for the qualitative assessment, which is based primarily on expert opinion and consultation with stakeholders and the community. At this stage, specific data requirements and methods must be identified. Typical data requirements for an SEA include: information on the crop's biology and ecology, the gene product, and potential land use changes. This information allows evaluators to address concerns about potential invasiveness, spread, and toxicity.

The quantitative risk assessment literature consistently emphasizes the need to rank the magnitude of consequences and the probability of those consequences within a given time frame. Risk can therefore be viewed as the triplet ($s_i$, $p_i$, $x_i$), where $s_i$ is the risk scenario, with each $s_i$ having a probability ($p_i$) of occurring and a consequence ($x_i$) if it occurs. Strategic environmental assessment is then the process of identifying the risk scenarios, their probabilities, and consequences, and then investigating the effect of uncertainty on the probability and consequence estimates. We ask the following questions:

- What can happen ($s_i$)?
- How likely is it to happen ($p_i$)?
- What are the consequences should the risk scenario ($s_i$) occur ($x_i$)?
- How confident are we in our estimates of $p_i$ and $x_i$?

Typically, decisions are made with incomplete information or intrinsic variability, which leads to uncertainty. This uncertainty needs to be incorporated into the analysis in order to assess its impact on a decision. There are a number of ways of incorporating uncertainty about parameter values and assump-

**Figure 1—A Strategic Environmental Assessment (SEA) paradigm for biotechnology plans or programs**




Note: The SEA process involves qualitative and quantitative research assessment methodologies integrated with communication, participation, and management.

tions into models to help characterize risk. One useful approach is scenario (i.e., what-if) and sensitivity analyses that assess the effect of uncertainty simply by altering the parameter values and repeating the calculation.

# MANAGEMENT

There are three principal options available for managing risk:

1. Accept the risk and recognize that a benefit-cost-risk trade-off was made.
2. Manage or control the level of risk, for example by using confinement strategies and monitoring.
3. Avoid the risk by not undertaking the activity.

With biotechnology the potential risks generally can be mitigated using risk-management strategies that may make some proposed activities acceptable. Measures might include isolation distances (distances based on existing information from the unmodified crop and the intended genetic modification), detasseling or removal of floral parts, bagging of flowering parts, temporal isolation, termination before flowering, guard rows/pollen trap rows/wind breaks, and measures to prevent seed dispersal from the area. Other measures may be appropriate depending on the biology of the unmodified plant, the nature by which pollen and seeds are dispersed, and the intended genetic modification (the intended phenotype).

# PARTICIPATION AND COMMUNICATION

One of the principles of SEA is that it should be transparent and open. In line with this principle, participation is generally considered to be an essential step in an SEA procedure. Participation implies that "sufficient information on the views of all legitimate stakeholders (including the affected public) is available early enough to be used effectively in the preparation of the strategic decision" (Dalal-Clayton and Sadler 2004, 15). The principles of openness and transparency also require documentation that makes the results understandable and available to all parties affected by the decision. How the results of the SEA are taken into account in decisionmaking should also be communicated to the stakeholders.

There are various forms in which public and stakeholder participation can be organized in an SEA. Birner and Alcaraz (2004) reviewed a number of approaches that have been applied in Europe for assessing biotechnology, including small-scale citizen juries (Switzerland), a national-level dialogue among organized stakeholders (Germany), internet platforms with self-selected participants followed by conferences (France, EU), and large-scale public deliberation (United Kingdom). Stakeholder consultation processes on biotechnology have also been organized for developing countries.

# CONCLUSION

Few comprehensive analyses along the lines described here appear to exist in the literature. However, if informed decisions about the value of GMOs are to be made, it will be crucial to have integrated SEAs using qualitative and quantitative assessments that take into account gene flow, toxicity, decision analysis, and uncertainty estimation. We believe that such a process is likely to lead to more transparent and defensible decisionmaking in international agricultural research.

### FOR FURTHER READING

Dalal-Clayton, B., and B. Sadler. 2004. Strategic Environmental Assessment: A Sourcebook and Reference Guide to International Experience. London: Earthscan, OECD, UNEP, IIED. Online at: www.iied.org/spa/sea.html.

Birner, R., and G. Alcaraz. 2004. Policy Dialogues on Genetically Modified Crops in Europe: Insights for African Policy Dialogues on Biotechnology. Background paper. Online at www.ifpri.org/africadialogue/pdf/policydialoguespaper.pdf.

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