RESEARCH AT A GLANCE

# Biotechnology and Genetic Resource Policies

## What Is a Genebank Worth?

Brief 7

## Introduction: A Taxonomy of Genebank Value

Melinda Smale and Bonwoo Koo

*"I am awed by how little economics can contribute at present to the valuation of genetic resources. A natural explanation is that since most of the genetic resources of interest do not trade in markets, there are no prices. And it is unlikely that price data will soon appear."*

(Gardner Brown Jr., 1991)

### It's Not as Easy as 1, 2, 3…

How much is a collection of plant genetic resources worth? Why do economists hesitate to place a value on it? Plant genetic resources generate economic value with multiple dimensions that are difficult to conceptualize. Only a few of these dimensions can be measured and related to a market price that is a basis for valuation. Scientific nuances complicate measurement. For example, the definition of the genetic unit to be valued depends on the crop and the farming-system context, and whether the units can be added together depends on how closely they resemble one another. Economics research, rather than accounting, is necessary to estimate the costs and benefits of the resources maintained in genebanks. Most genebanks have been publicly financed, and in the past there has been little demand by those who fund them to conduct economics research. Recently, however, demand for assessing the value of such collections appears to have heightened with changing intellectual property regimes and emerging biotechnology applications.

Broadly speaking, plant genetic resources can be conserved *ex situ* (out of their place of origin) by any one of several technical means, or managed *in situ* (in their place of origin), on farms or in wild reserves. The research briefs assembled here highlight published research about the value of *ex situ* collections held in genebanks. This first brief summarizes the way economists approach the topic.

### An Economist's Taxonomy of Value

Economics is a utilitarian[1] discipline focusing on human society rather than biological systems. The economic value of plant genetic resources therefore derives from human use, although human use can refer not only to food, fiber, and medicinal production but also to aesthetic, ecosystem, and social-support functions (Brown 1991).

[1] Relating to utility, or fitness for some purpose such as a product or service.

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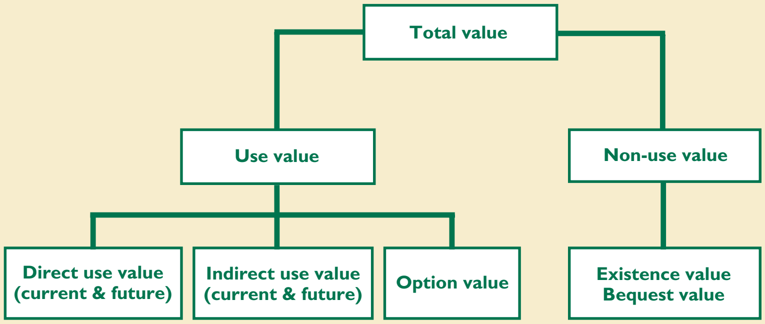
Plant genetic resources are natural resources and physical assets, generating streams of benefits-in-use through crop production and reproduction by farmers and professional plant breeders. Economists who assess the value of natural resources such as wildlife habitats and endangered species have developed a "taxonomy" that may also be used to classify the value of plant genetic resources (Figure 1). Congruent with this taxonomy, the total value derived from plant genetic resources is broadly categorized into *use value* and *non-use value*.

**FIGURE 1 Sources of value from plant genetic resources**




Use value may be direct or indirect. *Direct use value* derives from the food, fiber, and medicinal products to which plant genetic resources contribute, including the amenity value associated with their quality. *Indirect use value* reflects the contribution of plant genetic resources to surrounding habitats or ecosystems. Both direct and indirect use values have current and expected future dimensions. Another use value known as *option value*, implies the flexibility to deal with unexpected future demand for the resources (Fisher and Hanemann 1986).

Non-use value, compared with use value, reflects the satisfaction individuals or societies may derive simply from knowing that something exists, independently of whether or not it is used (Krutilla 1967). For example, *bequest value* refers to the utility individuals gain from knowing that future generations will have the opportunity to enjoy an asset. Endowing a genebank as a trust for future generations is a recognition of bequest value. *Existence value* is another type of non-use value.

It is difficult to imagine, however, that many people (other than a few scientists) take pleasure merely from the assurance that plant genetic resources are housed somewhere in a genebank. Instead, plant genetic resources are conserved precisely because they are thought to embody genes and gene combinations of current and future use to human society. We would argue that, unlike an endangered species or a scenic wonder, most of the value associated with the plant genetic resources in a genebank collection relates to their use rather than their existence.

## Can We Measure the Values?

Only some of the dimensions of economic value associated with plant genetic resources are measurable by summing up quantities and prices. We can use methods for imputing the value of component parts or attributes of goods (such as "hedonic analysis") to ascertain the current value for productivity enhancement of crop genetic resources embodied in crop varieties (Evenson, Gollin, and Santaniello 1998). Yet a genebank collection, in contrast to a breeder's working collection, exists to a large extent in order to respond to future, often unforeseen challenges. As a consequence, the expected future use value or option value of a genebank collection is an important component of its total value.

We can, with some compromise and a number of caveats, calculate a present value of *expected* future benefits from direct use of germplasm in crop improvement for commercial agricultural systems. We do so by combining the probability of finding useful material with its expected productivity benefit once found and incorporated into new varieties (for example, see Brief 9). Algorithms or numerical rules of thumb can be used to establish upper and lower limits on genetic contribution of any particular progenitor in the pedigree of a commercial variety, and these often serve as best estimates (Pardey et al. 1996). The time required to search for and incorporate useful genes into well-adapted germplasm affects the magnitude of expected benefits in a major way because of the time value of money.

Option value is conceptually distinct from expected future use value and also more challenging to assess empirically. For example, we might use the past incidence of changes in rust disease pathogens or other major pest outbreaks to predict the expected future value of certain types of genebank accessions[2] as new sources of resistance for a known pest. However, there are some pests and other environmental events for which we have no prior knowledge at all. The option value of a genebank accession arises from this uncertainty—but determining its magnitude can be difficult. In any case, option value cannot be negative in sign.

Even if we succeed in counting up the use values that can be approximated through analysis of market prices and quantities, we are likely to underestimate their total value because of their multiple dimensions. Fortunately, we err only on the side of caution. There is another reason, however, why estimates based on market prices underestimate the value of plant genetic resources. Plant genetic resources are public goods, and market prices generally fail to capture the full value of public goods. While recent changes in intellectual property rights may alter the public-good nature of plant genetic resources used in crop improvement, the problem of relying on market prices to assign value to streams of direct use benefits from breeding will persist.

A large body of economic theory has been compiled to guide the estimation of nonmarket values. For example, methods developed by environmental economists can be used to elicit the prices that individuals would be willing to pay if they could trade a nonmarket good on a market. We might conjecture, however, that very few individuals understand plant genetic resources well enough to provide credible responses to such questions. To do this type of economics research properly, an adequate number of responses are needed from those who both consume and produce plant genetic resources. Otherwise, our best estimates may be "glancing blows" that "miss the center of the problem or the potential value of genetic resources" (Brown 1991, 230). Finally, there are many current and future uses of genebank accessions other than their direct use in breeding new crop varieties, and many of these uses are also contributions to other types of public goods, including knowledge (see Brief 11; Dudnik, Thormann, and Hodgkin 2001).

Overviews and surveys discussing the sources of economic value in plant genetic resources are numerous, including Pearce and Moran (1994), Swanson (1996), and Koo and Wright (2000). Alongside conceptual overviews of the sources of value, several theoretical economic models have addressed the value of genetic resources (Brown and Goldstein 1984; Weitzman 1993; Polasky and Solow 1995; Simpson, Sedjo, and Reid 1996; Evenson and Lemarié 1998; Rausser and Small 2000). There are few published examples that use actual data to estimate the economic value of genebank collections. In perhaps the first, Evenson and Gollin (1997) traced the flow of rice germplasm from the collection housed at the International Rice Research Institute into improved varieties grown in the developing world. At that time, they estimated that adding 1,000 catalogued accessions to the collection would generate an annual income stream with a value of $325 million at a 10 percent discount rate. Subsequent studies (Briefs 8 and 9) indicate that benefits to large collections through crop improvement of extensively bred crops are high even when they are rarely used, given that the accessions are viable and distinct.

## Can We Count Costs Instead?

The costs of genebank operations are relatively easy to count and estimate compared with the benefits of the collections they house. Methods have been developed to estimate the costs of conserving accession by applying microeconomic principles of production economics (see, in particular, the work by Pardey et al. 2001). If the costs of conserving an accession are shown to be lower than any sensible lower-bound estimate of the corresponding benefits, for many decisions, it may not be necessary to undertake the expensive and challenging exercise of precisely estimating benefits to justify the existence and size of the genebank (Koo, Pardey, and Wright 2003: Brief 6 of this series).

[2] An accession is a sample of planting material stored in an *ex situ* collection of genetic resources. Because of the way they are sampled and regenerated, accessions may or may not be unique and are not necessarily homogeneous.

## How Can Economics Contribute to Management of Genebanks?

In fact, the fundamental economic issue involved is not the absolute magnitude of the benefits from conserving plant genetic resources. A library is a good analogy (Brown 1991). The problem is not in assigning a value to the books we have read, but in deciding which ones to keep from the many we have not yet read, especially given that our descendants will have very different tastes and will live in a very different world.

Given how little we know about the value of the world's plant genetic resources, we can still use economics principles in making decisions. For example, fixed budgets in many genebanks mean that we cannot conserve everything, and there are trade-offs associated with our choices. How do we choose? If all plant genetic resources had equal value, then those that cost the least to preserve would be those that should be preserved (Brown 1991). For the same conservation costs, those more likely to be used sooner rather than later are worth more, because of the time value of money. Those that are close substitutes have less value than those that are rare or genetically distant (Simpson, Sedjo, and Reid 1996). Rich societies and benevolent social decisionmakers tend to value the distant future more than do poor societies and any single decisionmaker. Krutilla (1967) argued that when little is known about the cardinal value of benefits, scientific estimates should be used as proxies for ranking the potential value of candidates for conservation. The decision to manage each original sample of seed or plants as an accession is not necessarily optimal for efficient conservation or utilization, and managers have the option to combine or split accessions based on a combination of genetic and cost criteria (Sackville Hamilton et al. 2002). Some of these pressing management issues can be addressed through the application of economic principles.

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