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Sharing the non-monetary benefits of agricultural biodiversity

Ruth Raymond and Cary Fowler

Abstract

The Convention on Biological Diversity calls for benefits flowing from the use of biological diversity to be shared with the country of origin of the material. In the main, discussions around benefit sharing have focused on monetary benefits, with the sharing of such benefits often seen as a precondition to access. This approach, while welcome in its intent, has two inherent problems:

? It has led the significant non-monetary benefits that can be linked with the use of genetic resources to be downplayed or even disregarded;

? There is no agreed definition of 'country of origin.'

Even if the meaning of country of origin could be universally accepted, a commercial plant variety is likely to have hundreds, if not thousands, of useful properties arising from parents originating in many countries. A system of access to plant genetic resources that requires individual benefit-sharing agreements with the countries of origin of all such properties would be exceedingly complicated. The cost of these numerous negotiations, let alone of determining the monetary value of the contribution of each country's genetic resource to the commercial variety, would be staggering. Such a system would surely be a disincentive to commercialization (assuming the costs would be borne by the commercial entity—by no means a foregone conclusion). Importantly, it would also almost certainly impede the international flow of germplasm and thus the development of new crop varieties, an outcome that is in no one's interest.

Important non-monetary benefits can arise from international collaboration in the conservation and use of genetic resources. Non-monetary benefits include access to more germplasm and improved material than can be found in any one country as well as to training opportunities, new technologies and information arising from the use of exchanged material. International collaboration brings with it increased opportunities for developing joint strategies and activities for conserving and using genetic resources and for sharing responsibilities and costs. In general, the more parties that are involved in a collaborative relationship, the more widely the costs and benefits can be shared, thus reducing the burden and increasing the advantage to all partners.

While the authors argue strongly in favour of a multilateral approach to access and benefit sharing, they observe that important non-monetary benefits can also arise from bilateral arrangements. They describe a series of recent plant explorations in Ecuador, supported by the United States Department of Agriculture (USDA), as a good example of a bilateral arrangement that has yielded significant non-monetary benefits to both countries.

Networks, such as the International Network on Genetics in Aquaculture and the International Network for Genetic Evaluation of Rice, serve as multilateral exchange arrangements and the means for sharing resources, ideas, technologies and information amongst a wide range of participants. The Consultative Group on International Agricultural Research (CGIAR) provides a framework for a global multilateral system. In return for providing access to their germplasm, the CGIAR's partners gain no-cost access to value-added products, secure conservation, restoration, information and a wide range of basic and improved germplasm. Together, the Future Harvest Centres supported by the CGIAR exchange approximately 150 000 accessions and 500 000 samples of improved material each year, along with the related technology and information.

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Contents

I. Introduction

The fair and equitable sharing of the benefits arising from the use of biological diversity is perhaps the most important prerequisite for the long-term conservation and sustainable use of genetic resources for food and agriculture. It can also be an important way to promote economic development, particularly in developing countries.

Plants with certain characteristics—such as chemically unique and physically isolated plants with medicinal properties—lend themselves fairly readily to monetary benefit sharing. In this case, monetary benefits would be defined by contractual arrangements between a private company, for example, and a clearly identified country of origin. Other forms of benefits and a broader concept of beneficiaries might be more appropriate or even necessary in other circumstances. This paper examines various non-monetary benefits that might be generated and shared, consistent with the terms of the Convention on Biological Diversity. The examples are drawn from the field of agricultural biodiversity.

The transition from hunting and gathering to the practice of agriculture began some 10-15 000 years ago. At the time, people used many thousands of plants for food. A relatively small number of these were 'domesticated' through the process of selection over many generations. As human populations began to spread, domesticated plants travelled with them, encountering new environments and evolutionary pressures.

The Russian biologist, N.I. Vavilov, working in the 1920s and 1930s, postulated that there were eight major 'Centres of Origin' of domesticated crops. Vavilov noticed, as had others before him, that diversity in agricultural crops was not evenly distributed around the globe. These 'Centres of Origin', or, more precisely, centres of diversity, were generally large areas covering numerous countries. One of the most prominent scientists to have worked on crop origins and the distribution of diversity, Jack Harlan, argued that there are both 'centres' and 'non-centres', meaning that the distribution of diversity in some crops is so widespread as to render the term 'centre', meaningless.[1] In addition to these 'primary' centres and non-centres, 'secondary' centres of diversity are recognized for many crops. Maize, which is known to have its centre of diversity in Latin America, has a secondary centre of diversity in Africa, where a long history of cultivation has combined with distinct social and environmental factors to encourage the rise and persistence of impressive diversity.

As regards individual crops, both genetic diversity in general, and specific characteristics are generally found in more than one country. Thus, the country where a crop variety or farmer landrace is collected may not correspond to the biological 'country of origin' of the species, the variety or any particular characteristic it displays.

It is important to note that the term 'country of origin' has been used in many different ways over the years. As employed by the Convention on Biological Diversity, the term has a particular meaning, which is rather different from how the term has been commonly used. The Convention defines 'country of origin' as "the country which possesses those genetic resources in *in-situ* conditions." And, in the case of domesticated or cultivated species, it defines *in-situ* conditions as "the surroundings where they have developed their distinctive properties."

As noted above, Vavilov's Centres of Origin cannot be considered as synonymous with either centres or countries of origin. More to the point, the Vavilov Centres, as defined by Vavilov and employed by scientists since then, do not refer to the place of origin of a 'distinctive property,' the relevant feature in the Convention's definition of country of origin. Instead, they refer to the country where

[1] Harlan, Jack. Agricultural Origins: Centers and Noncenters. Science. Vol. 174 (October 29, 1971).

a crop or a species might have originated and where diversity is found. They make no attempt to inventory the country of origin of specific distinctive properties within those crops. During the thousands of years that have passed since the transition to agriculture first began, we know that distinctive properties have arisen outside of centres of origin and diversity. Indeed, they may have arisen on multiple occasions in multiple locations. Mutations producing valuable characteristics may take place more than once in history and in more than one site or country.

Rice, for example, is grown in over 100 countries today. More than 100 countries have contributed materials to existing *ex situ* collections held in facilities such as that operated by the International Rice Research Institute (IRRI) in the Philippines. Lacking a detailed history of different rice varieties over the last 15 000 years or more, it is difficult to know with any degree of certainty exactly where a particular distinctive property in rice first arose.

Genebank records may be misleading when it comes to identifying a country of origin for a distinctive property as defined by the Convention. First, genebank records document the origin of accessions, not specific individual properties that might be contained in the accession. A rice variety held in a genebank might have come from Thailand, but a particular characteristic of that variety might have arisen or have been developed in another country, or across many countries. Moreover, 'country of origin' as used in many genebank records frequently refers to the country that supplied the material. For example, rice collected in Thailand by the United States Department of Agriculture (USDA), may end up as 'country of origin: US,' in an *ex situ* collection somewhere in Europe. Further complicating the complicated, similar or identical varieties or accessions may be listed under multiple records in *ex situ* collections. The 6 million accessions currently in *ex situ* storage are known to contain many duplications.

In summary, identifying precise countries of origin of distinctive properties within the world's agricultural biodiversity is immensely complicated, and in many if not most cases impossible. If one were to succeed in doing so, however, further complications would arise in any negotiations over access and benefit sharing.

In a commercial crop variety, a distinctive property for which a precise country of origin can be identified is likely to be but one of hundreds or even thousands of properties exhibited by the variety. If access to each distinctive property necessitates separate benefit sharing agreements with individual countries of origin, the process of developing new crop varieties will become exceedingly complicated.

Breeding programmes are often carried out over many years and frequently involve hundreds, if not thousands, of crosses and many different parents. For example, VEERY wheat was the product of 3170 different crosses involving 51 parents from 26 countries. The line itself has been used in the breeding of a number of varieties.[2] How do we determine the value of each of the parents used in developing VEERY? How do we determine the value of each distinctive property within each of the parents? How do we determine the value of the components of VEERY when it is crossed with other lines in another breeding programme? Adequate quantitative and qualitative measurements do not exist to allow us to answer these questions. Lacking such answers, it is difficult to imagine the basis upon which negotiations would proceed concerning access and benefit sharing for multiple genetic resources from multiple countries of origin, as defined by the

[2] Access to Plant Genetic Resources and the Equitable Sharing of Benefits: A Contribution to the Debate on Systems for the Exchange of Germplasm. Issues in Genetic Resources, No. 4, Rome: IPGRI. June 1996.

Convention. How could the monetary value of the genetic resources supplied by each country be determined either before or after completion of the breeding programme?

There is no question that the genetic resources used in fashioning a new crop variety have value. But fixing the monetary value of those resources and apportioning the value among many different contributions to the final cultivar cannot be done accurately enough at present to recommend bilateral forms of benefit sharing in many, if not the majority of, cases involving agricultural biodiversity. Still, other approaches are possible. Tangible non-monetary benefits can be generated and shared, as the next section of this paper will demonstrate.

II Sharing non-monetary benefits

Discussions around benefit sharing tend to focus on monetary benefits, disregarding the significant non-monetary benefits that can arise from the use of genetic resources. These benefits may be hidden and are often taken for granted. They occur at the global, national and local levels. They include social benefits, such as improved quality of life, food security, lower food costs, increased productivity, expanded market opportunities and the hedge against social and economic stresses that genetic diversity provides. They also include environmental benefits, such as the protection of habitats and ecosystems and the reduction of genetic vulnerability.

This paper focuses on the benefits that might result from international cooperation in the conservation and use of plant genetic resources. In the discussion that follows, it is assumed that continuous access to genetic resources is a fundamental condition for such cooperation.

The benefits of collaboration in genetic resources have brought many countries together in partnership over the years. The provision of cash benefits tends to be linked to bilateral exchange arrangements, while non-monetary benefits can be linked to both bilateral and multilateral arrangements. The basis for access will often determine the range and extent of benefits to be shared.

Non-monetary benefits include increased access to technologies and to information arising from the use of exchanged material. A principal benefit of international exchange is access to more germplasm and improved material than can be found in any one country. The value of this benefit lies in the fact that all nations, no matter how well endowed in genetic resources, depend heavily on the agricultural biodiversity found outside their borders.

This interdependence with regard to genetic resources has led many countries to establish exchange alliances—bilateral and multilateral—with other nations around the world on the basis of common interests in crops, regions or agro-ecosystems. China, for example, has established germplasm exchange relations with more than 90 countries. The United States maintains significant germplasm collections and maintains an open exchange policy with nearly all countries, distributing about 40 000 accessions abroad each year.[3]

The Future Harvest Centres supported by the Consultative Group on International Agricultural Research (CGIAR)[4] provide a framework for a global multilateral exchange system. The Centres exchange landraces, promising varieties and elite breeding lines with national agricultural research systems and other partners for their evaluation and use in different ecosystems. Each year, nearly 150 000 germplasm accessions from the in-trust collections of the CGIAR and approximately 500 000 samples of improved material are distributed by the Centres, the large majority going to developing countries. Like the genetic resources themselves, all related passport, characterization and evaluation information is available without restriction.

The value of the benefits arising—in particular—from multilateral access to genetic resources can perhaps best be understood by imagining the situation that might exist in the absence of such access. The world's largest and most complete collection of rice—located at the International Rice Research Institute (IRRI) in the Philippines—includes more than 80 000 rice samples from 111 countries. The collection includes, among others, 8454 samples from Indonesia, 799 samples from Sierra Leone and 849 samples from Brazil. For any one country to have access to the same range of rice diversity through bilateral arrangements it would be necessary to conclude agreements with 110 countries. For all countries represented in the IRRI collection to have access to all of this material, a total of 12 210 bilateral agreements would be necessary.

There have been few attempts to quantify the non-monetary benefits currently flowing to both providers and users of germplasm as a result of its international exchange. However, the qualitative benefits of international cooperation are generally well known. In addition to access to genetic resources they include:

? increased opportunities for developing joint strategies for the conservation and use of genetic resources and for sharing responsibilities and costs regionally and / or globally;
? facilitation of research partnerships and the pooling of resources needed to exploit particular genepools effectively;
? access to relevant technologies developed by partner countries;
? access by germplasm providers to information, e.g. on special traits or multi-location testing data, on material that they have supplied as well as on material supplied to them by partners.
? a supportive climate for innovation and for collaborative research;
? training opportunities at a wide range of specialized institutions.

In the case of multilateral exchange arrangements, such benefits will generally not be directly tied to access to a specific germplasm exchange transaction.

As noted, bilateral arrangements might well give rise to significant non-monetary benefits as well as monetary benefits in certain circumstances. These could include the range of benefits described above. However, since bilateral benefit sharing will be specific to a particular exchange transaction, the benefits

[3] Background Documentation for The State of the World's Plant Genetic Resources, 1996. p. 184.

[4] The Consultative Group on International Agricultural Research is an association of countries, international and regional organizations, and private foundations dedicated to supporting a system of agricultural research centres around the world. Sixteen centres are currently supported by the CGIAR.

can be tailored to the particular needs and interests of the partners at that time.

There are few documented cases of specific bilateral benefit-sharing transactions as such arrangements are often confidential. The following example however provides a glimpse of a bilateral project that links non-monetary benefit-sharing to plant exploration.

III. Bilateral sharing of non-monetary benefits: an example from Ecuador[5]

In 1995 and 1996, two explorations supported by the USDA were conducted in Ecuador to collect native peanut landraces. These explorations included personnel from the Ecuadorian national programme, INIAP. The mission yielded over 200 accessions of native peanut varieties.

While the establishment of a comprehensive national peanut collection was of interest to the Ecuadorian partners at INIAP, they were also keen to receive benefits that would allow them to better conserve, study and use these genetic resources. It was agreed that Ecuadorian scientists should be involved in follow-up to the mission. A project was initiated to multiply and characterize the germplasm in Ecuador, under contract to USDA. The increased seed was divided between Ecuador and the USA. In the process, Ecuadorian students and technicians received training and experience in peanut diversity and germplasm management.

The benefits to Ecuador as a result of the project included the establishment of a comprehensive, fully increased, documented and characterized national peanut collection and the training of Ecuadorian scientists in internationally accepted methods of peanut germplasm management and documentation. Professional ties between peanut researchers in Ecuador and the USA are expected to have long-term reciprocal benefits. Additional benefits include the provision of training on collecting methods, including sampling strategies and the documentation of indigenous knowledge, provision of training on the identification of gaps in genetic resources collections, and the replenishment of the Ecuadorian collection. A new state-of-the-art genebank, financed by the United States Agency for International Development (USAID), was constructed in Ecuador following recommendations by project participants.

5 This section relies heavily on information taken from Williams, K.A. and D.E. Williams. 2001. Evolving Political Issues Affecting International Exchange of Arachis Genetic Resources. Peanut Science (in press).

IV. Networks

Further benefits will accrue to Ecuador in the future. An initiative involving USDA and two CGIAR Centres[6] is using Geographical Information Systems (GIS) technology to correlate the cultivated peanut genetic diversity in Ecuador with environmental and socioeconomic data. Upon its completion, the Ecuadorian national programme will receive a GIS package that maps the distribution of peanut diversity and will allow matching of the environmental requirements of landraces to other locations for possible introductions. This package will also assist in planning further germplasm collecting trips in Ecuador and in identifying areas where there is high risk of genetic erosion. In another follow-up activity, a catalogue of the unusually diverse peanut landraces present in Ecuador is being produced and is expected to substantially enhance the potential usefulness of the national collection. The catalogue is also anticipated to be a valuable tool for monitoring these resources on-farm.

To be realized, benefit sharing requires effective mechanisms for apportioning the benefits themselves. The determination of the appropriate mechanism largely depends upon the nature of the access arrangements between and among countries. Benefits can flow directly from recipient to source country in the case of a bilateral benefit sharing agreement or, in the case of multilateral exchange arrangements, can be distributed through networks or similar relationships linking countries.

Genetic resources networks link the activities of national programmes, research institutes and others with common interests. Today, about 150 countries are involved in some form of genetic resources networking, and the networks themselves have become fora for sharing resources, ideas, technologies and information. They are proving an efficient means for enabling countries to share the responsibilities and costs of training, conservation and technology development, and for promoting the establishment of joint conservation strategies based on common affinities.

As in the Ecuador example, important non-monetary benefits can arise from bilateral agreements. These can be precisely targeted to the needs and interests of the source country. However, they will probably be more limited than those arising under multilateral arrangements — such as networks — simply because the more countries that are involved in exchanging, using and improving genetic resources, the more benefits there will be to go around.

The following examples describe some of the benefits currently being shared through the mechanism of international networks.

The International Network on Genetics in Aquaculture

The International Network on Genetics in Aquaculture (INGA) was established in 1993

[6] The International Plant Genetic Resources Institute (IPGRI) and the International Center for Tropical Agriculture (CIAT)

to promote the development of national fish breeding programmes in Asia and Africa.

INGA provides a forum for its 13 member countries[7] to exchange information, technologies and genetic resources. The network's activities are governed by a Steering Committee, which meets annually to formulate plans for collaborative research activities.

INGA's members have received multiple non-monetary benefits as a result of their involvement in the network. These include:

? Coordinated exchange of fish germplasm among member countries for research and breeding. For example, a genetically improved farmed Nile tilapia has been transferred to six member countries for research studies and an improved common carp from Vietnam has been transferred to Bangladesh, India, Philippines and Thailand.

? Assistance to member countries in the development of national breeding programmes. The National Tilapia Breeding Program of the Philippines was established with the help of INGA. In Vietnam and Indonesia, national breeding programmes for various finfishes have been developed with technical assistance from Norway.

? Enhanced research capacity. For example, a training course on quantitative genetics — sponsored by the United Nations Development Programme and the World Fish Center (ICLARM) — was held in 1995 in the Philippines and attended by 32 participants from 11 INGA member countries.

? Regional research and training programmes. A three-year collaborative programme to evaluate improved tilapias involved five member countries in Asia. Two research programmes covering Asia and Africa commenced in 1997.

? Information disseminated among member countries. Relevant news and literature on genetics and biodiversity are regularly sent to member countries.

The International Network for Genetic Evaluation of Rice (INGER)

About 1000 scientists in 95 countries of Asia, Africa, and Latin America and three Future Harvest Centres[8] are working together through the International Network for Genetic Evaluation of Rice (INGER). The Network provides rice researchers worldwide with access to the promising varieties and elite breeding lines that have become the basis of unprecedented increases in rice productivity over two decades.

Variety trials and observational nurseries for pest resistance and tolerance soil and climatic stresses are conducted annually in more than 600 experiment stations around the world. The network targets varietal adaptation to favourable (such as irrigated) environments, and to less favourable (such as rainfed lowland, upland, drought-prone, and flood-prone) environments where hundreds of millions of the poorest people live.

The benefits that have come to INGER members as a result of their involvement in the network include:

? Genetic flows within and between continents. Since 1975, more than 40 000 entries have been evaluated through INGER. Of these, breeding lines originating from programmes in 34 countries, as well as from Future Harvest Centres, have been released directly as 575 varieties in 62 countries.

[7] Bangladesh, Peoples Republic of China, Côte d'Ivoire, Egypt, Fiji, Ghana, India, Indonesia, Malaysia, Malawi, Philippines, Thailand and Vietnam. ICLARM, a Future Harvest Centre, acts as Member-Coordinator for the Network.

[8] The International Rice Research Institute (IRRI), the West African Rice Development Association (WARDA) and the International Center for Tropical Agriculture (CIAT)

- ? Increase in genetic diversity and enhanced sustainability. Only three rice varieties released before 1965 had more than four different landraces in their pedigree. The varieties released through INGER since 1976 can be traced to five or more landraces, and 75 of these have more than 15. In practical terms, this has had the effect that most of the modern varieties have multiple resistances to insect pests and diseases, thereby reducing the need for chemical pesticides.
- ? Increased production worldwide, particularly in less developed countries. About 65 million hectares globally are planted to improved varieties from INGER nurseries, accounting for an annual increase of about 100 million tonnes of unmilled rice. This has led to about a 60% increase in rice production worldwide. Less-developed countries, in particular, have greatly benefited from INGER. Out of 12 varieties released in Cambodia, 10 came directly through INGER. These varieties are cultivated on almost 100 000 hectares. In 1995, Cambodia became self-sufficient in rice production for the first time in 25 years.

V A 'hidden' benefit of multilateral exchange

An important — and largely hidden — benefit of multilateral exchange is in fact an indirect monetary benefit. In general, the more parties that are involved in an endeavour — be it germplasm conservation, exchange or breeding — the more widely the transaction costs can be shared, thus reducing the burden on individual parties. Bilateral exchange arrangements can have very high, even prohibitive, costs, especially when one considers the monitoring and enforcement mechanisms required to ensure that they are being honoured. The costs of such mechanisms and those associated with the development of complex Material Transfer Agreements and potential litigation are formidable. In the case of regional networks and global exchange arrangements, the broader the scope of the arrangements, i.e. the wider the range of material they cover, and the more institutions and individuals that are party to them, the lower will be the transaction costs to individual members. The issue of the transaction costs related to bilateral and multilateral exchange arrangements has been dealt with at length in a previous IPGRI report[9].

[9] Options for Access to Plant Genetic Resources and the Equitable Sharing of Benefits Arising from their Use. IPGRI. 1997. Unpublished.

VI. Conclusion

Too square a focus on the monetary benefits that may arise from the use of genetic resources runs the risk of discounting the very substantial non-monetary benefits that are associated with international collaboration, particularly on a multilateral basis. The value of these benefits — which are well recognized in the Convention on Biological Diversity — is likely to far exceed any cash return that might result from the use of the genetic resources. Even if cash benefits were to be explicitly linked to use, the difficulty of identifying the true 'country of origin' in many cases — as described in the introduction to this paper — would raise the problem of who has the ethical right to receive them. The probable result is that any monetary benefits would be eaten away in the legal and technical processes of attempting to discover the rightful beneficiary.

Comments and queries on the contents of this paper are welcome and should be addressed to:
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