Supported by the CGIAR

The impact of the Musa International Transit Centre

IMPACT ASSESSMENT BRIEF NUMBER 4

Bioversity International's series of Impact Assessment Briefs aims to inform readers about the major results of evaluations carried out by the centre. The Briefs summarize conclusions and methods of more formal papers published in peer-reviewed journals.

The International Network on Banana and Plantain (INIBAP) was established in 1984 to "*initiate, encourage, support, conduct and coordinate research aimed at improving the production of bananas and plantains, to encourage the collection and exchange of documentation and information relating to bananas and plantains and to support training for researchers and technicians from developing countries*".

The INIBAP Transit Centre for *Musa* germplasm (ITC) was established at the Katholieke Universiteit Leuven (KULeuven), Belgium, in 1985 with the core objectives of:

- contributing to the secure, sustainable and long-term conservation of the entire Musa genepool and
- maintain genetic resources and related information in the public domain and providing a service for the safe movement of Musa germplasm.

Anne Vezina/Bioversity International

Measuring the impact of ITC

This brief presents the findings of a study published in 2010 that documented and assessed the performance of the ITC in terms of the conservation and distribution of *Musa* germplasm. It also analysed the costs of ITC operations, including possible future developments.

Conservation and distribution were evaluated based on data from ITC records. The service provided by ITC was evaluated based on direct feedback from its users or clients. Fifteen key informants were interviewed using semi-structured set of questions, either face to face or by phone. The sample included seven respondents from Eastern and Southern Africa, two from West Africa, five from South East Asia and the Pacific and one from the United States. Their responses were then used to develop a structured questionnaire for an on-line survey of all users of ITC services since 2000. E-mails inviting users to participate in the survey were sent to 218 e-mail addresses, and a total of 63 responses were received. Information on the utilization of the germplasm by the clients was used to determine what types of impacts have been created and the possible magnitude of some of the impacts.

Conservation

At the time of the study in 2007, the ITC held 1212 accessions of *Musa* germplasm, including representatives of 19 wild species, cultivated forms with accessions belonging to 15 groups and 40 subgroups and improved varieties comprising diploids (11 accessions), triploids (25 accessions) and tetraploids (81 accessions).

ITC distributes only germplasm that is free of virus and virus-like particles. In 2007, a total of 810 accessions (66.8%) were classified as virus-free. The remainder, mainly improved germplasm and cultivars with the B-genome, were classified as infected with viruses and are not available for distribution.

Distribution of germplasm since 1985

Between 1985 and 2007 ITC distributed 8353 samples of accessions to external users in 103 countries. Each sample comprised five plantlets of a given accession. Demand for accessions has increased steadily, rising from 28 different accessions in 1985 to a peak of 307 accessions in 2006. Since ITC was established users have requested over 1000 different accessions from the collection, or more than 75% of the entire collection. On average, samples of 33% of the virus-free accessions available for distribution are distributed each year.

Nearly two-thirds of requests were for cultivated forms – landraces, varieties and cultivars. Users mainly used these in trials evaluating them for traits such as resistance or tolerance of biotic stresses, agronomic characteristics and fruit quality. The traits of most interest were resistance to Black leaf streak disease (BLSD) and higher productivity.

Demand for improved materials (20% of samples distributed) is high compared with the small number of accessions of improved materials at ITC. This may be because improved materials have been evaluated intensively and hence a lot is known about their agronomic traits and resistance to biotic and abiotic stresses.

Seventeen percent of the disseminated germplasm is of wild relatives.

Three-quarters of samples distributed go to people and institutes in the main banana-growing regions: Africa (27%), the Americas (25%) and Asia and the Pacific (23%). The remainder are sent to users in Europe, mainly universities and advanced research centres. The largest groups of recipients are national agricultural research institutes (40%) and advanced research institutes, including universities (29%).

Utilization of germplasm and impacts created

Users' perceptions of the role and functions of ITC

Informants saw ITC as central to the conservation of *Musa* germplasm on a global level. However, several respondents expressed their concern that the collection does not yet represent the genetic diversity of banana sufficiently and stated that it should be expanded strategically, especially with regards to wild *Musa* species.

Users regarded as important and valuable the fact that the material is virus-indexed and is documented. They also stressed the relatively easy and cheap access provided by ITC. Many indicated that ITC was the only source available to them of germplasm supplied free of charge. This was especially important to scientists from national agricultural research institutions in developing countries.

Germplasm requested and its use

Breeding bananas is much more complicated than breeding most other crops, and very few organizations breed bananas. Consequently, most of the germplasm distributed by ITC is intended for use by farmers, and ITC is the only viable source of improved germplasm for many countries.

> *"ITC is the only viable source of improved germplasm for many countries"*

Informants commonly evaluated germplasm from ITC for agronomic traits and distributed promising material to farmers (Figure 1). Key agronomic characteristics of interest included tolerance of biotic stress (30%) – including diseases and pests –, adaptation to specific local conditions and consumer acceptability, including processing quality (24%), yield characteristics (15%) and tolerance of abiotic stress, such as wind, cold, salinity and drought (13%). Interestingly, respondents expect tolerance of abiotic stresses to be the most important germplasm traits in future.

Other key uses include morphological or molecular characterization, and applied and fundamental research.

Impacts and beneficiaries of germplasm received

Beneficiaries

Respondents identified the banana research community and farmers as the principal beneficiaries of germplasm received from ITC. Consumers, production industries and processing industries also benefit from research being carried out with germplasm from ITC, although less directly than farmers.

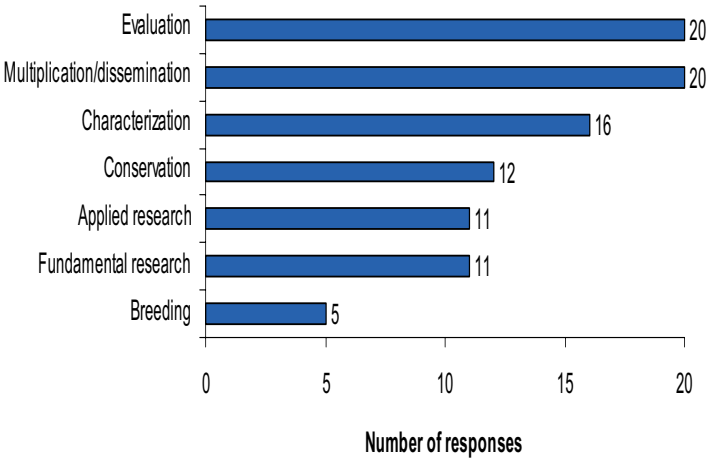

Figure 1. Use of germplasm requested (multiple answers possible).

Determining how many people have benefited from germplasm from ITC is difficult. Some respondents mentioned only the number of farmers who directly collaborated in a project while others stated that all banana farmers in their country benefited. In total, 23 respondents from different countries gave estimates of numbers of beneficiaries, totally 76 000 farmers. However, actual numbers are likely to be much larger; for example, one study documented about 0.5 million banana farmers in Tanzania who benefited from germplasm from ITC between 1995 and 2004.

Impacts

Users of germplasm from ITC indicated that the principal impacts achieved through its use were increased banana yields and reduction of losses due to pests and diseases, leading to higher farm income. Nearly a quarter of survey respondents stated that the use of virus-indexed material from ITC helped to prevent the introduction of new diseases into their country or region (Figure 2).

Material from ITC also contributed to advances in research, such as improved knowledge about the *Musa* genome and diversity and improved virus indexing and therapy methods, and capacity building. A literature search showed that the ITC taxonomical reference collection of 36 accessions featured in a large proportion of publications dealing with characterization and genomic analysis. ITC accession codes also feature extensively in banana research literature, providing an important mechanism for ensuring comparability and repeatability of research through clear germplasm identification.

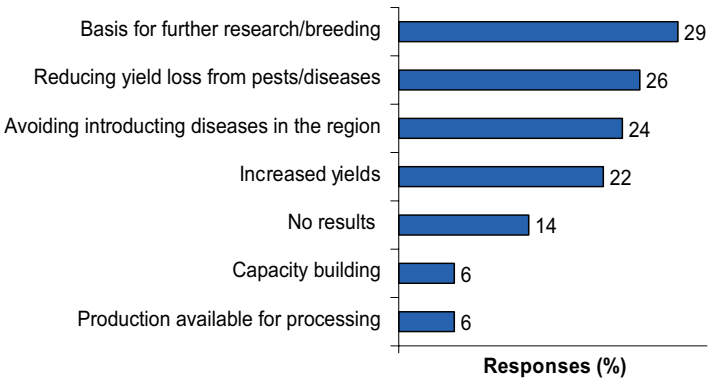

Figure 2. Germplasm impacts (Multiple responses possible)

About 38% of the respondents said that they would not have been able to carry out their research or development project without access to germplasm from ITC. Another 22% stated that they would have faced severe difficulties in organizing research, including time delays and increased costs to find the germplasm from other sources. Only one in ten of the respondents felt that the availability of germplasm for ITC had little effect on their ability to pursue their research.

About 21% of respondents noted that the diversity of banana germplasm available for breeding or for use by farmers would be much more limited without access to the ITC distribution service.

Evaluation of service provided

Respondents identified long-term conservation of *Musa* diversity, dissemination of clean, disease-free germplasm and facilitation of international exchange of germplasm as ITC's most important roles and activities. In general, ITC's services and germplasm were rated equal to or superior to those of other sources.

> ***"the principal impacts ... were increased banana yields and reduction of losses due to pests and diseases, leading to higher farm income"***

Perceptions regarding information availability

Key informants surveyed reported that a major weakness of ITC was the lack of information about the germplasm held at the centre, although this was not reported as an issue by the majority of survey respondents. The most common problem was difficulty identifying germplasm with particular characteristics. To overcome this would require documenting much more characterization and evaluation data. Considering the large number of users carrying out evaluation trials with ITC germplasm, it should be possible to develop a mechanism whereby users' evaluation data is incorporated into ITC's documentation systems, including MGIS. This would also help identify duplicate accessions and materials that have few useful characteristics and hence could be put into long-term storage only.

The two most important sources of information cited by survey respondents were direct inquiries to ITC or Bioversity and personal communications. This places a high workload on ITC staff and also implies that information systems such as *Musa*logue, other germplasm catalogues and MGIS are less useful than expected.

Germplasm from other sources

ITC was the most important and most recent source of germplasm for 13 out of 15 of the key informants. However, about 60% of survey respondents reported obtaining germplasm from elsewhere, mainly national or regional collections, commercial providers and tissue-culture laboratories.

Some 15% of survey respondents reported an interest in germplasm that ITC could not provide. Most of this was B-genome material that incorporates BSV. However, this material was generally also not available from other sources either.

The costs of conservation and distribution of *Musa* germplasm at ITC

The report examines the costs of operating the ITC, and analyses a number of possible scenarios. These include the expansion of the collection from its current size of approximately 1200 accessions to 2000 accessions, reducing the number of cultures per accession maintained in medium-term storage *in vitro*, and substitution of medium-term conservation by cryopreservation. The results show that conservation and distribution of *Musa* germplasm are expensive compared with crops conserved and distributed as seed, because constant monitoring, periodical subculturing *in vitro* and multiplication of accessions on demand are very labour intensive. Expanding the collection and reducing the

This brief is based on Garming H., Roux N. and Van den Houwe I. 2010. *The impact of the Musa International Transit Centre: Review of its services and cost-effectiveness and recommendations for rationalization of its operations*. Bioversity International, Montpellier, France.

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number of plants per accession held *in vitro* would reduce the annual cost per accession by about 19%, from €136 to €110. Placing materials that cannot be distributed because of being infected with BSV in cryopreservation offers potentially large savings, halving the average cost of conservation of accessions held in liquid nitrogen for 20 years.

The cost analysis also shows that cryopreservation is not a cost-effective substitute for *in vitro* conservation of accessions that are kept for distribution. This is due to two factors: 1) preparing accessions for cryopreservation is a long process and very labour intensive, and hence is costly, and 2) regenerating *in vitro* plantlets from a cryopreserved accession is equally slow and costly.

Conclusions and recommendations

Overall, the respondents made lists 12 recommendations for improving ITC and its services:

1. Expand the collection, especially with respect to wild species.
2. Encourage stakeholders to share germplasm to complete the collection.
3. Establish/ support existing regional collections for easier access and back-up function.
4. Continue with cryopreservation for backing-up the whole collection.
5. Use regeneration and field verification project as starting point for further research on maintaining genetic integrity and avoid off-types.
6. Improve documentation: upgrade with characterization and evaluation data and photos.
7. Better links between ITC and MGIS, updates and user-friendliness of MGIS.
8. Encourage more systematic feedback from users about germplasm evaluation results.
9. Establish regular updates on ITC activities, new germplasm or new information about germplasm available.
10. Reconsider moratorium on the distribution of BSV infested accessions; investigate trade-off between risks and benefits, probably country and case-specific.
11. Consider sets of accessions to be exclusively held in cryopreservation and eliminated from *in vitro* collection.
12. Invest in characterization (morphological and molecular) and evaluation in order to increase germplasm use and to allow for rationalization.

The study also identified a number of research topics that would enhance future impact assessment efforts. These include:

- studies of introduction of germplasm from ITC, including yield increases and control of pests and diseases and capturing information on the availability of germplasm from other sources and the costs of acquiring it;
- case studies on landraces and traditional cultivars to determine the risk of their extinction, and market information on them in comparison with new varieties;
- surveys of researchers citing ITC accession codes to determine the extent to which ITC germplasm facilitated their research, particularly comparability of results with previous studies; and
- valuation of benefits of wild species to breeding programmes.

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