

# The International *Musa* Testing Programme<sup>1</sup>

## Discussion paper

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### Introduction

#### Background

This discussion paper reviews the adoption of the International *Musa* Testing Programme (IMTP), a project managed by the International Network for the Improvement of Banana and Plantain (INIBAP) Programme of the International Plant Genetic Resources Institute (IPGRI). It is one of two studies carried out during 1997 and 1998 by IPGRI as part of its impact assessment work. The IMTP provides *Musa* (banana and plantain) breeding programmes with information on the performance of new varieties under a range of environmental conditions and pest and disease pressures, and allows National Agricultural Research Systems (NARSs) to have early access to improved varieties. This paper critically examines the motivation underlying the participation of the various partners in the programme and examines the links needed to encourage adoption of new varieties by smallholders. It describes the constraints affecting the IMTP and the potential impact of the new varieties being evaluated. The evolution of the programme in response to the changing needs of its participants is also described.

#### IMTP goals

The IMTP was set up in 1990 in response to the need to provide farmers with banana and plantain varieties with better resistance to black Sigatoka, the major disease affecting *Musa* production. The specific purposes of the IMTP are to:

- coordinate the global evaluation of improved germplasm produced by *Musa* breeding programmes
- increase knowledge on resistance and tolerance mechanisms to some of the major diseases affecting *Musa*
- identify resistant *Musa* cultivars that can be recommended to NARS for further evaluation and possible release to smallholders
- increase the capacity of national institutions to evaluate improved varieties and to carry out research on banana and plantain for local consumption.

#### Phases I and II

The first phase of the IMTP (1990–1993) was funded by the United Nations Development Programme (UNDP) and involved the Honduran breeding programme Fundaciòn Hondurena de Investigaciòn Agrícola (FHIA). Seven hybrids were evaluated at six sites and, after global analysis of results, three of these hybrids (FHIA-01, FHIA-02 and FHIA-03) were recommended for further distribution and evaluation. The programme was well received by NARSs who requested a further phase, and this was developed by INIBAP and funded by

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UNDP. Although Phase II did not provide funding for the establishment and maintenance of the evaluation sites, a greatly increased number of NARSs and breeding programmes began to participate. At the time of the analysis, the project was entering its third phase, which added trials to evaluate resistance to yellow Sigatoka, Fusarium Wilt and nematodes. Thus the scope of the IMTP has expanded significantly over time, evolving and adapting to the changing needs of its participants. Several breeding programmes provided improved germplasm for testing and many NARSs participated in the evaluation trials.

### **Methodology**

The study used a variety of approaches and gathered information through questionnaires, interviews and a focus-group discussion. The target groups were the IMTP trial site managers and national evaluation programme (NEP) managers involved in further evaluation of the varieties released as a result of Phase I. The present study uses the 'illustrative' approach, as defined by Sechrest *et al.* (1996). This describes a process or series of events in order to obtain a clear understanding of the cause and effect relationships involved.

Information was obtained mainly from two questionnaires. The first was sent to the 20 IMTP trial site managers involved in Phase II; the reply rate was 90%. The second was sent to the 50 NEP managers who had requested hybrids from Phase I for further evaluation between 1993 and 1996. The reply rate was 53%. The IMTP trial site managers provided information on the effectiveness of the IMTP. Their questionnaire was designed to indicate how well they thought those responsible for breeding programmes understood their needs for improved material. In addition, they supplied their views on the feedback of information to the breeding programmes. Their motivation for participation, the benefits they accrued and the constraints they encountered were also recorded.

The questionnaire for NEPs aimed to collect feedback on the performance of the IMTP varieties and gathered information on other *Musa* evaluation activities conducted by NARSs. The percentages given below represent the proportion of responses to each question (in some cases, to particular sub-questions) out of the total number of respondents.

The focus-group discussion and individual interviews provided a good opportunity to explore certain issues in depth, adding value to the data gathered through the questionnaires. They allowed researchers to come into direct contact with programme participants and to involve them in the study. Additional IPGRI and INIBAP staff were interviewed to identify critical issues and to investigate and interpret the feedback collected. The focus-group discussion was held with five IMTP participants who were convened during the first *Musa* germplasm information system training workshop, which was held in Guadeloupe in October 1997.

### **Results and discussion**

#### **Participation**

The main reasons given for taking part in the IMTP were to acquire improved *Musa* germplasm and to respond to farmers' needs for varieties with improved performance (72% of respondents indicated 'very important' for both statements). The IMTP allowed NARSs to evaluate material under their own conditions and to make recommendations for farmers in their respective regions. In 41% of the IMTP trial sites surveyed, no other national *Musa* evaluation trials took place and the IMTP was therefore the sole mechanism for evaluating improved varieties in that country. An important reason for participation given by NARSs was to help them establish links with researchers from international and regional agricultural research centres and other advanced research institutes (53%). The opportunity to influence future strategies of *Musa* breeding programmes was another reason for participation (40%). For breeding programmes donating germplasm, the most important reason for participation was to obtain international publicity for the best hybrids and to have them evaluated as widely as possible. While breeding programmes may have other

opportunities to evaluate their material locally, the IMTP is unique in its global coverage and capacity to facilitate the transfer of material between regions. In addition, the programme provides an opportunity for breeding programmes to compare their materials with interesting hybrids from other programmes.

Of the trial site managers surveyed, 87% encountered some problems in participation. For the national institutes surveyed, the most serious limitation was multiplying sufficient planting material to establish trials. Other factors affecting participation were difficulties in collecting evaluation data (often due to lack of personnel), the presence of off-types in material received, and delays in receiving germplasm. Further difficulties were caused by a lack of information on management of the varieties being evaluated and the poor suitability of some varieties for local conditions and tastes.

### **Linkage between the IMTP, breeding programmes, NARSs and farmers**

The IMTP links *Musa* breeding programmes to NARSs who have direct contact with farmers. For the IMTP to be efficient, it is important that all participants have a good understanding of each other's roles and needs through an effective two-way flow of information.

National institutes involved in IMTP evaluation trials suggested the following characteristics should be addressed in developing improved varieties (in order of importance):

1. Disease resistance (88%)
2. High yield (86%)
3. Pest resistance (71%)
4. Taste in general (68%)
5. Adaptation to local tastes (54%)
6. Shelf life (50%)
7. Export quality (41%)
8. Cooking and processing quality (33%)
9. Growth habit, e.g. height (39%) and suckering (22%)
10. Drought resistance (25%)
11. Cold tolerance (18%)
12. Multipurpose use (10%).

Participants felt that breeding programmes had a 'very good' understanding of the national systems' needs for disease resistance and yield improvement. However, their understanding of the need for resistance to pests, fruit flavour, post-harvest characteristics, type and use, growth habit and drought resistance were rated as 'moderately good'.

Over 80% of the institutions participating in the IMTP were also responsible for national extension activities related to evaluation trials, such as germplasm multiplication and distribution, information dissemination, and continued maintenance and evaluation of demonstration plots. However, the nature of the link between the IMTP and the farmers depends upon whether the institute carrying out the evaluation has an international, regional or national mandate. Where programmes have a regional or international mandate, the link with farmers is through national level institutes, who are responsible for providing planting material to farmers, which may result in delays caused by coordination problems between international and regional institutes and NARSs. Thus, farmers have faster access to improved IMTP varieties when the evaluation trials are carried out directly by NARSs.

According to the surveys, 44% of the IMTP trial sites were visited by farmers (58% in the case of national institutions and 17% in the case of breeding programmes). They requested planting material at 86% of these sites. IMTP trial sites were, therefore, an efficient way of publicizing the material. However, only 42% of the trial sites were able to supply farmers with planting material. This was either because the sites did not have enough planting material to satisfy farmers' demands, or because the site managers felt the material needed further evaluation before it could be distributed.

Farmer involvement provides a useful mechanism for feedback through NARSs to breeding

programmes, with farmers supplying information regarding the acceptability and performance of the varieties under evaluation. Evaluations were conducted in farmers' fields in 72% of cases and on-station in 44% of cases, when farmers were invited to participate in field days. As in the case of IMTP trial sites, 62% of NEPs were asked by visiting farmers for planting material and 45% of them charge for it.

Feedback from NEPs indicated that INIBAP made its most valuable contribution to variety evaluation by providing information on improved varieties, by providing virus-indexed planting material to national programmes and by providing training and information on evaluation techniques (mentioned by 88%, 75% and 67% of NEPs, respectively). The value of the information provided by INIBAP was confirmed by the fact that 42% of NEPs selected *Musa* varieties for testing on the basis of this information.

Participants felt that Phase I of the IMTP had little impact on building capacity in the institutions that were selected because they had well-developed breeding and research capacities. Nevertheless, the survey showed that 64% of participants in Phase II felt they would benefit from further training in documentation and database management, 57% in *in vitro* propagation (tissue culture) and 50% in data analysis.

### **Constraints**

Budget limitations hampered the effectiveness of the IMTP. Some activities that had been planned could not be developed. For example, research for improvement of rapid screening methodologies, production of a catalogue of selected hybrids and training of regional scientists and technicians in *Musa* germplasm evaluation. The annual global meeting for review of the IMTP results was replaced by a global meeting at the end of each phase (every three years). Funding for Phase II did not include the evaluation trials themselves. Training activities were organized on an informal basis, which included exchanging information and expertise during meetings and site visits.

Feedback of evaluation data from the IMTP trial sites to INIBAP headquarters was slow and impeded the progress of global analyses. Of the respondents experiencing difficulties in participating in the IMTP, 54% had problems collecting data. They related this to a lack of financial and human resources (38%) and/or to problems in following the IMTP technical guidelines (33%). Respondents also reported problems in understanding the technical guidelines and in collecting the quantity of data required.

The evaluation protocols were revised following recommendations from the second global IMTP meeting in March 1997, and two levels of evaluation (in-depth and simplified) were introduced in preparation for Phase III. The simplified evaluations will allow additional NARSs to participate as there is only a minimal level of expertise in disease evaluation and a relatively low level of resources (staff and financial) is required. However, in-depth evaluations will still be conducted at sites where the necessary expertise and resources are available.

According to 57% of the national institutes surveyed, difficulty in multiplying sufficient planting material was the greatest constraint to the establishment of IMTP evaluation trials. Lack of planting material also limited the dissemination of improved varieties to farmers. In the 62% of cases where facilities were available for *in vitro* propagation, they were not devoted solely to bananas and plantains. In addition, the use of private propagation laboratories was limited by a lack of funds. INIBAP has taken action to overcome this bottleneck by establishing regional multiplication centres.

The surveys indicated that lack of documentation limited effective participation in the IMTP in 38% of sites. The problem included a lack of data to accompany improved germplasm entering the programme and the fact that in order to gain publicity, breeding programmes may offer varieties before they have been sufficiently evaluated and documented. Furthermore, the selection criteria for the inclusion of germplasm in the IMTP have not always been made clear to participants. In response, the IMTP coordinator developed a database on IMTP candidate clones, which was made available to all participants.

Some varieties included in the IMTP were not suitable for local needs and 41% of respondents noted this as a limiting factor. In the past, all IMTP varieties were tested at all sites. However, in Phase III, a greater number of varieties and evaluation sites were involved and evaluators were able to test the varieties most likely to meet the demands of their local consumers.

The expansion of the IMTP could result in management problems. While large numbers of sites will yield useful data for statistical analysis, global meetings with large numbers of participants are expensive and difficult to organize. A change in management and meeting structure will be required as the programme expands and adopts a more regional focus.

### **Potential impact of improved hybrids**

One of the assumptions of the IMTP was that releasing improved germplasm to the *Musa* research community would stimulate the further testing of material through the establishment of NEPs. Indeed, the study found that NARSs were very willing to undertake further evaluation of IMTP varieties and INIBAP has received many requests from NARSs for the three FHIA varieties recommended during Phase I. By the end of 1996 these varieties had been distributed to more than 50 institutions. In addition, 82% of respondents felt that the area planted with them was likely to increase. In general, respondents felt that the FHIA hybrids, especially FHIA-01, were, or would be, well accepted in their country because of their resistance/tolerance to pests and diseases and their high yield and vigour. However, acceptability of flavour varied according to local preferences.

Although farmers are frequently involved in the evaluation trials, the new varieties have yet to reach farmers' fields on a large scale. This is due mainly to the nature of the crop, which has slow multiplication rates by conventional means and long harvest cycles. However, there are a few countries where more concerted efforts have been made to promote the production of the new varieties. In Cuba, for example, FHIA varieties have performed well against black Sigatoka in a large-scale testing programme and, by 1997, FHIA hybrids were grown on 6000 ha. FHIA-01 has been released in Australia as the commercial variety 'Goldfinger' and it is showing good production potential in subtropical areas. Costa Rica has also begun testing the organic production of FHIA hybrids.

Information on farm income was very difficult to obtain because most of the varieties were still being evaluated. However, in the Seychelles, farm profit from growing the new varieties was double that obtained from native varieties. In Australia, the price of FHIA-01 reached US\$10–20 per 13 kg carton, which is about US\$5–10 greater than for 'Cavendish' (the standard commercial cultivar) in the subtropics. The improved disease resistance of the FHIA hybrids gives farmers increased yields without the high cost and negative environmental impact of pesticides. An independent study from IITA (Ortiz and Vuylsteke 1994) showed that a variety with resistance to black Sigatoka can have a comparative advantage in terms of farmer gains over fungicide treatment of 10:1 during normal periods of supply and 5.5:1 in periods of scarcity. The best hybrid had a 225% increase in yield over an untreated, nonresistant variety.

## **Conclusions**

### **Achievements of the IMTP**

The IMTP involves a large number of partners and collaborators, from farmers to breeders. It is a very good example of a collective effect being greater than the sum of its parts, as no single institute could have achieved such wide coverage on its own. Participants feel that the IMTP is achieving its objectives, particularly those of:

- providing information to breeding programmes and plant pathologists
- establishing links between researchers
- facilitating the flow of germplasm between countries

- providing information on banana varieties to NARSs
- influencing banana breeding strategies
- identifying potential constraints to the adoption of new varieties by farmers.

Although it is too soon to be able to measure the effect of improved varieties on global banana and plantain production, some major achievements of the IMTP to date (based on the results of this case study) can be stated:

- It is the only mechanism to allow the worldwide multilocational evaluation of improved germplasm for resistance to the most serious diseases affecting *Musa* production. It forms a valuable link and mechanism for feedback between farmers and breeding programmes.
- It has influenced a greater exchange and evaluation of germplasm at the international level.
- It facilitates feedback from NARSs to breeding programmes and vice versa, and encourages closer collaboration between the partners in *Musa* improvement.
- It allows NARSs to have early access to disease-resistant and highly productive *Musa* germplasm, thereby speeding up the dissemination of germplasm to farmers. Adoption of a wide range of new varieties is also encouraged through the NEPs conducted by NARSs. The IMTP varieties have great potential to help farmers raise their incomes and reduce their need for applications of pesticides.

### **Phase III of the IMTP**

Discussions at the global meeting in 1997 made it clear that the objectives and *modus operandi* of the IMTP were no longer appropriate for the needs of the growing number of national programmes wishing to participate. Phase III was thus designed to address many of the constraints affecting the earlier phases. The results of this survey suggested the following additional improvements:

- Two levels of evaluation. The majority of NARSs should conduct simplified evaluations, while in-depth evaluations could be carried out at a limited number of sites where the expertise and resources are readily available.
- Simplified evaluation guidelines. These would require a minimum level of expertise in disease evaluation and a relatively low level of resource allocation by national programmes, thus allowing a larger number of NARSs to participate.
- More incentives for trial sites to feed back evaluation data for global analysis. INIBAP should encourage participants to use the evaluation guidelines and should ensure that evaluation data are collected and fed back to headquarters.
- Adequate information on candidate clones prior to their inclusion. This issue is being addressed by INIBAP and a database structure for information on the IMTP candidate clones has been agreed.
- Address regional needs. INIBAP acknowledges that there is little to be gained from evaluating varieties outside the regions where they are likely to be cultivated. In future, NARSs should select the material they wish to evaluate according to local needs and preferences.
- Mass propagation of planting material for IMTP trial sites. INIBAP is encouraging the establishment of regional multiplication centres to receive *in vitro* cultures of the varieties in most demand in each region. At the time of this study, three centres had been established that were capable of mass-propagating planting material and supplying NARSs with a larger number of plants than the INIBAP Transit Centre in Leuven, Belgium.
- Capacity building. As the number of participating institutes increases, there will be a need for formal training and workshops to increase their capacity to interpret disease symptoms, follow evaluation guidelines correctly and ensure efficient data collection

and interpretation.

- Monitoring the IMTP. Further impact assessment studies should be an integral part of the programme and should focus on adoption of new varieties by farmers and their economic impact once they have been widely distributed. Feedback should be collected systematically, based on impact indicators from participants and from the main beneficiaries.

This study highlights the importance of involving the target beneficiaries at the project planning and development stages. In addition, regular contact with the participants in the IMTP has proved invaluable in assessing and improving the design of the programme.

#### **References**

- Ortiz, R. and D. Vuylsteke. 1994. Plantain breeding at IITA. The improvement and testing of *Musa*: a global partnership. Pp. 130–156 in Proceedings of the First Global Conference of the International *Musa* Testing Programme held at FHIA, Honduras, 27–30 April 1994 (D.R. Jones, ed.).
- Sechrest, L., M. Stewart, T.R. Stickle and S. Sidani. 1996. Effective and persuasive case studies. Health Services Research Institute. Cambridge, MA.