

SYMPOSIUM REPORT

FIRST INTERNATIONAL SYMPOSIUM ON BREADFRUIT RESEARCH AND DEVELOPMENT

APRIL 16-19, 2007
NADI, FIJI

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Secretariat of the Pacific
Community (SPC)



Technical Centre for
Agricultural & Rural
Cooperation ACP-EU



Breadfruit Institute
(NTBG)



The International Centre for
Underutilised Crops



Global Facilitation Unit for
Underutilized Species
(GFU)



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SUMMARY

The First International Symposium on Breadfruit Research and Development took place in Nadi, 16-19 April 2007. Participants came from Africa (Benin, Ghana, Nigeria, Tanzania), the Seychelles, the Caribbean (Trinidad and Jamaica), Sri Lanka, and the Pacific (Fiji, Pohnpei [Federated States of Micronesia], Hawaii, Kiribati, New Caledonia, Papua New Guinea, Samoa, Tonga, Tuvalu, and Vanuatu), and Australia. Participants (listed in Appendix I) included researchers from national, regional, and international organizations, universities, government ministries, NGOs, the private sector, as well as Secretariat of the Pacific Community (SPC) staff.

This Symposium was the result of collaboration between international organizations including the Technical Centre for Rural and Agricultural Cooperation (CTA), the SPC Land Resources Division, the Breadfruit Institute of the National Tropical Botanical Garden (NTBG), the German Technical Cooperation (GTZ), the International Centre for Underutilised Crops (ICUC), the Global Facilitation Unit for Under-Utilized species, and the Global Crop Diversity Trust. The proceedings for this Symposium will be published by the International Society for Horticultural Science as part of the standing series of *Acta Horticulturae*.

Participants considered key issues related to breadfruit conservation, research, and development, and made recommendations concerning projects and future priorities. The meeting was structured around five major themes: 1) Breadfruit in Society, 2) Diversity and Conservation, 3) Germplasm Exchange and Crop Improvement, 4) Production and Production Constraints, and 5) Product Development and Marketing. The Symposium provided a venue for sharing experiences and information related to breadfruit and looking at ways in which the future of breadfruit, both as a food security crop and as a marketable commodity (domestic and export), could be strengthened. It was interesting to see that although breadfruit is considered an under-utilized crop, it is widely grown and a significant amount of work has been carried out with much information to be shared.

The Symposium consisted of 1.5 days of plenary where papers (Appendix II) were presented by the majority of participants. Aleki Sisifa, Director, SPC Land Resources Division, opened the proceedings with an excellent overview of breadfruit in the Pacific and how it has developed into an export commodity for some countries, such as Fiji and Samoa, yet remains an important food security crop especially for atoll countries. The keynote address was given by Dr Diane Ragone, Director of the Breadfruit Institute, National Tropical Botanical Garden (NTBG), whose enthusiasm for, and commitment to breadfruit is apparent to all who meet her. Her efforts have ensured that more than 120 varieties from the Pacific are conserved in the world's largest collection of breadfruit

(over 200 accessions) at the NTBG in Hawaii. On Tuesday afternoon the participants were treated to a very interesting field trip which was organized by Sant Kumar, General Manager, Nature's Way (Cooperative) Fiji Ltd. Participants were impressed by tours of a processing facility where fresh breadfruit is prepared for export to New Zealand and of Legalega Research Station for a marcotting (air-layering) demonstration and field plantings of breadfruit. An unexpected delight was the buffet with nine different dishes—all prepared with breadfruit!

The remainder of the Symposium was devoted to Working Groups and their reports to the larger group, a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis of breadfruit (Appendix III), and a Focus Session on the Global Crop Diversity Trust. The five Working Groups each addressed one theme of the Symposium, concentrating on issues generated from the presentations and discussions following the presentations. All groups were asked to identify possible projects, prioritize recommendations, and provide a report to the larger group. The Focus Session was devoted to discussing a global strategy for the conservation and utilization of breadfruit and sharing of breadfruit germplasm using the multilateral system on which the International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA) is based. In addition to the information generated from the sessions described above, meeting minutes were taken and summaries of the previous day always preceded each day's session.

GENERAL OBSERVATIONS AND RECOMMENDATIONS

This report includes a priority list of 36 recommendations which were discussed both by the entire gathering and in Working Groups.

1. The Symposium participants commended the significant work carried out by Dr Ragone and the NTBG in collecting and conserving breadfruit over the past three decades. They acknowledged that this work contributes globally to breadfruit research and development and that the security of this collection should be ensured “in perpetuity”. The Symposium participants therefore recommended that the NTBG collection be part of the multilateral system (MLS) of the International Treaty as set out in Article 15, to facilitate the collection's continued conservation and use throughout the world.
2. Breadfruit for food security needs a higher profile at the national, regional, and international levels.
3. More funding is needed to support breadfruit conservation, research and development. Participants commented on the lack of interest given to breadfruit by donors. It was suggested that we work to educate donors about the value of breadfruit and its impact.
4. It is essential to get breadfruit on government agendas. Highlighting the role that breadfruit can play in food security, income generation, and other areas, such as livestock feed, marginal land use, and soil improvement, could be one way of getting increased governmental attention.

5. Engage forestry systems and programmes to work with breadfruit.
6. New ways to promote breadfruit are needed. An example would be featuring breadfruit in tourism programmes, such as the Jamaica breadfruit festivals. Such festivals could involve chefs competing to create the most innovative, tasty breadfruit meal. In the UK and USA, the purchase and consumption of food products is raised significantly whenever “famous” chefs are involved in promoting the product.
7. There is widespread interest in dwarf (short-stature) varieties. These varieties need to be identified and targeted for conservation, distribution, research and development.
8. Identify potential funding sources and opportunities for breadfruit. Possibilities include: carbon offsetting, government agencies, international food companies, private foundations, and individuals. Different levels of funding need to be targeted, that is, national, regional, and international. For national funding countries would have to give breadfruit priority. Although regional funding involves different donors for different regions, we expect great benefits through combining efforts.
9. Include breadnut in R&D efforts since this tree is easy to propagate by seed and the tasty seeds are a good source of protein.

Promotion, Information and Documentation

10. There is a need to collect and document breadfruit knowledge, encompassing all aspects of breadfruit in society, from traditional beliefs to agronomic practices. This documentation should be useful for both product development and awareness campaigns which should use common information, materials, and themes to be effective.
11. Promote the uses of breadfruit, both for food (including livestock and disaster food products), and non-food through food fairs, breadfruit festivals, posters, media releases on health benefits and product development. Youth need to be targeted in this campaign.
12. Promote and strengthen the use of breadfruit in agro-forestry practices and programmes.
13. Promote the nutritional benefits of breadfruit. More analysis and information is needed on more varieties (both ripe and mature). Special attention should be given to carotenoids-rich varieties, omega-3 and omega-6 fatty acid content and antioxidants; this information could be used to create awareness on the importance of breadfruit and increase production and consumption.

14. Engage the support of government for breadfruit through the development of national policies/frameworks.

Production, Product Development and Marketing

15. Develop trade agreements, promoting and supporting export and include import substitution policies, where necessary to support trade in breadfruit products.
16. Develop a variety of convenient products with extended shelf life to replace imported less-healthy staple foods and snack foods, targeting all age groups.
17. Choose innovative approaches for improving marketing—health, cultural, food security, environmental, or fair trade.
18. Consider using traditional methodology, such as fermentation, for product development, rather than concentrating all efforts on modern methodology.
19. Develop good production practices specific to each geographic area and different varieties of breadfruit; incorporate planting of different varieties to increase production and year-round availability.
20. Embark on commercial production by planting breadfruit orchards and experimenting with production techniques (e.g., pruning, harvesting, etc.)
21. Identify desired products and production practices designed specifically to meet the demand for “a product.” Develop packages of production practices for specific products which should be disseminated in a suitable form.
22. Produce a comprehensive production manual for export as well as simple leaflets for growing breadfruit in your backyard.
23. Produce information leaflets on how to prepare and cook breadfruit.

Germplasm Exchange and Crop Improvement

24. Establish the utility core in tissue culture at Canadian Conservation Research Institute for Sacred Plants (CCRISP: University of Guelph and British Columbia, Canada) and transfer the utility core to national and regional laboratories in Africa, Asia, Caribbean and the Pacific.
25. Transfer of the tissue culture multiplication protocol from CCRISP to labs in various locations, as appropriate, also providing technical training and supporting documentation for the transfer of tissue culture plants to greenhouses and subsequent field establishment.
26. Develop a standardized protocol for evaluating breadfruit which can be used for multi-locational studies. This would initially be used to evaluate the utility core collection.

27. Study and determine the genetic diversity of the NTB collection to identify a genetic core. Other desired traits should be taken into account in developing specialized core” collections. With increased problems of climate change, special attention should be given to include varieties with salt and drought tolerance..
28. Investigate methodology for extending seed shelf life to enable the exchange of seeds between other countries.
29. Investigate various propagation methods to supply planting materials of desirable varieties. Air-layering (marcotting), grafting, vegetative propagation by stem cuttings or root cuttings, *in vitro*, etc.
30. Evaluate varieties in countries for identified traits such as dwarfing (short stature), salinity tolerance, diseases (e.g., fruit rots) or tree decline.

Diversity, Conservation and Utilization.

31. Carry out surveys and establish inventories of existing germplasm for each country, (to include distribution and uses of the germplasm).
32. Consider and develop strategies for encouraging farmers to report on and conserve desirable naturally occurring diversity (*in situ* conservation).
33. Develop a minimum set of descriptors to document and describe breadfruit; possibly photographs, covering leaf (e.g., size, glossiness, degree of lobing, number of lobes, depth of sinuses) and fruit at maturity (e.g., dimensions, mass, skin texture, flesh colour, latex colour), fruit quality, and seed number and size.
34. Develop tissue culture and cryopreservation methods for exchange and conservation, and transfer technology where appropriate.
35. Develop best practices for tree management in genebanks and germplasm exchange. The latter would obviously require conclusive evidence as to what viruses of breadfruit exist, if any. Countries would also have to be willing to share germplasm so any policy issues would have to be clarified.
36. Adopt the strategy proposed for global conservation of breadfruit and develop the necessary project proposals and sourcing required to fund the prioritized activities.

SPECIFIC OBSERVATIONS AND RECOMMENDATIONS FROM WORKING GROUPS

Breadfruit in Society

This group agreed that breadfruit must remain central to the culture of a society, because it is an important element of sustainable livelihoods and food security. A number of key issues were highlighted as being crucial to ensuring that breadfruit remains culturally important, namely:

- Establish national policies to strengthen the importance of breadfruit in the culture.
- Conduct a baseline survey to document the importance of breadfruit in society.
- Promote breadfruit through various activities at the community level.
- Strengthen research and development activities and ensure results are disseminated to communities.
- Diversify the use of breadfruit in society (food, feed, medicine, woods, etc.).
- Establish regional policies/frameworks on breadfruit.

On the issue of overcoming any “social stigma” associated with breadfruit in some parts of the world, the group felt this could be addressed by developing “convenience” breadfruit products and raising breadfruit’s visibility through school curricula, communication strategies and public awareness.

Concern was expressed at the loss of local knowledge on breadfruit in some parts of the world. Local knowledge is important because it can guide appropriate conservation strategies, form the basis of research and aid the development of acceptable innovations. It can also support promotional efforts. Documentation of local knowledge urgently needs to be done; the extent of knowledge documented should range from traditional beliefs and uses (including non-food), to recipes, to basic agronomic knowledge.

In order to ensure that breadfruit has a role in future society, the group identified the following as important considerations:

- Conserve breadfruit diversity—nationally, regionally and globally.
- Consider the impact of land use planning, especially in urban areas.
- Research and development into commercial breadfruit production.

The role of breadfruit in society would be strengthened if it is recognized as a component of agro-forestry. Several suggestions were made as to how this could be achieved. Documentation of practices where breadfruit is already a component of agroforestry is very important, as well as the need to develop agroforestry practices/programmes involving breadfruit (based on different geographical areas, societal needs, etc.).

The group identified some possible project areas including:

- Develop a regional project to establish national inventories, including traditional knowledge.
- Assist governments in developing national policies for breadfruit conservation and utilization, incorporating nationwide breadfruit planting campaigns.
- Implement a global project on breadfruit planting material and management.
- Develop and evaluate outreach approaches to ensure community participation in any project.
- Develop breadfruit as a disaster relief food product (e.g., nambo as produced in Temotu Province in the Solomon Islands).
- Investigate the potential of breadfruit as livestock or poultry feed.

The major recommendations from the Breadfruit In Society group were:

1. Collect and document breadfruit knowledge, encompassing all aspects of breadfruit in society, from traditional beliefs to agronomic practices.

2. Promote the uses of breadfruit, both for food, (including livestock and also disaster food products) and non-food.
3. Promote and strengthen the use of breadfruit in agro-forestry practices and programmes.
4. Engage government support of breadfruit by developing national policies/frameworks.
5. Carry out research and development into commercial breadfruit production.

Production and Production Constraints

This group focused on the various systems of production, namely home gardens and cultivated orchards. In home garden or backyard production, the aim is to produce food for household and community consumption. In cultivated orchards, the aim is to produce fruit for commercial purposes, whether fresh or processed, and for both domestic and export markets.

The group recognized the need to determine and document the growing conditions for breadfruit (i.e., suitable temperature, altitude, and availability of water and suitable soil). This would enable regions/countries to determine where breadfruit could be grown (assuming it is not grown now) and could help in areas where there are food security issues, such as in parts of Africa. Many countries and regions are cultivating local “well-known” varieties so new varieties are needed to extend production and address soil/environmental constraints. In addition, production techniques require optimization, including propagation, tree management (pruning, mulching), and harvesting, etc.

General constraints were identified as:

- Availability of land or competition for land.
- Lack of interest from government, farmers, and the target population.
- Availability and knowledge of planting material.
- Limited knowledge of production techniques.
- Poor or no research in areas such as salinity tolerance or fruit rot management, etc.

The group looked at ways in which traditional production systems could be improved; the following “needs” were identified:

- Raise awareness about the qualities of breadfruit.
- Plant different varieties to increase production and provide year round availability.
- Develop good production practices specific to the area and for different varieties of breadfruit.
- Address specific needs (i.e., salinity-tolerant varieties, fruit rot problems, nutrient deficiencies, etc.).
- Include breadfruit in agro-forestry projects.

The group identified a number of constraints to commercial production, namely: lack of interest in the crop; no real experience with commercial breadfruit orchards; availability of planting material and knowledge of planting material; limited and un-dispersed knowledge of good production practices in an orchard setting; and feasibility (e.g., What is the

minimum farm size?). Discussion led to determining what needs to happen for commercial production to both expand and improve. The following suggestions were made:

- Plant breadfruit orchards and experiment with production techniques—pruning, harvesting, etc.
- Keep good records and make the information of successes and failures available globally.
- Successful growers should lead by example.

There is no point in improving production without taking the market into account. With this in mind, the group highlighted the following:

- The focus for commercial production should be in countries where there are resources and infrastructure to support industry.
- Market identification is obviously crucial.
- Identify desired products and production practices designed specifically to meet the demand for “a product”.
- Packages of production practices should be designed/available to meet this market.
- Make product information available and disseminate this in a suitable form.

Information is key to developing any crop and the group discussed how better use of information could help both backyard and commercial production. Documentation of information is essential both as a comprehensive production manual for export and simple leaflets are needed for growing breadfruit in your backyard. Extension officers need knowledge on breadfruit production and should also be excited about sharing it.

The Production and Production Constraints group identified a number of projects for potential funding:

- Develop suitable production guides and carry out “train the trainer” workshops. All information generated from this project must be disseminated to a wide range of stakeholders—villagers, farmers, exporters, etc. The focus of this project would be “From tree to table”.
- Establish national multi-purpose breadfruit collections, which would be multi-functional, serving as germplasm collection, semi-commercial orchard demonstration, agro-tourism, or information center.

Product Development and Marketing

The group identified an urgent need for a database to keep track of breadfruit products. Papers presented at the Symposium revealed that there is significant information “out there” but it is not easily accessible and therefore not utilized. In discussing the products, an attempt was made to distinguish between the wide range of products available on the basis of whether they were still at the research and development stage or were good marketable products. For example, the role of breadfruit as a weaning food was considered to be still at the R&D stage, whereas minimal processing, although not yet being marketed, showed promise. In contrast, fresh fruit is generally the most marketable product.

In considering how best to support product development and marketing, the group focused on lessons learnt to determine the key problem areas, identified as:

- People’s perception of breadfruit is poor and therefore there is an urgent need to increase awareness about its positive attributes.
- Lack of varieties for all-year-round production makes it difficult for R&D efforts.
- Limited R&D on extending the shelf life of breadfruit.
- Very poor documentation on all relevant information on breadfruit products.
- Limited range of products for targeting all age groups—infants, adolescents, and aged (geriatrics).

On the issue of marketing, and how to better market breadfruit, the group suggested the following approaches as options for making progress:

- Stress the sensory, health, cultural, food security, environmental, and fair trade aspects of breadfruit, and label appropriately.
- Organize promotional activities—cooking competitions, media activities (jingles, drama sketches, etc.).
- Appeal to patriotic instinct for local patronage.

One of the major problems identified by all Symposium participants was the disinterest of youth in breadfruit. The group gave special consideration to this issue and felt that youth must be targeted. Increased consumption of non-traditional foods and the increasing consumption of “junk” foods were identified as common throughout the participating countries and a problem that was contributing significantly to the rise in lifestyle diseases. Suggestions as to how the attitude of youth towards breadfruit could be influenced are:

- Endorsement by popular sporting icons (rugby-Fijian, soccer-Indians, NFL-Polynesians), stressing breadfruit as caloric/energy food.
- Stress breadfruit as a food beneficial to health.
- Raise infants on breadfruit-based formulas.
- Produce cookbooks/manuals with traditional and modern recipes.

In line with promoting breadfruit, the group identified the need for new products, such as:

- A variety of convenient products with extended shelf life to replace imported less healthy staple foods and snack foods.
- Products using traditional methods (such as fermentation) as well as using modern methodology.
- Where applicable—use fermented breadfruit products as a replacement for traditional fermented products from starchy staples like cassava or taro.
- Alcoholic beverages using breadfruit.

Note: Appropriate machinery for industrial processing would have to be developed to support product innovation.

The group felt that effective promotion of breadfruit has to be supported by national governments, and to achieve this each government should:

- Initiate trade agreements to promote export of value-added products.
- Establish an import substitution food policy.
- Promote breadfruit as a food that will assist in the achievement of Millennium Development Goals and poverty/hunger alleviation.

- Fund R&D projects for product development.

The Product Development and Marketing group prioritized their recommendations as follows:

1. Trade agreements which promote and support export and import substitution policies are necessary to support the trade of breadfruit products.
2. Documentation is essential both as information for product development and to increase awareness.
3. A variety of convenient breadfruit products with extended shelf life are needed to replace imported less healthy staple foods and snack foods, and these should target all age groups.
4. Promotional activities are required to improve people's perception of breadfruit and to support marketing —youth need to be targeted in this campaign.
5. To improve marketing, different approaches (e.g., health, cultural, food security, environmental and fair trade) should be taken.

Germplasm Exchange and Crop Improvement

This group discussed various systems/mechanisms for exchanging germplasm, especially to achieve easy access to the breadfruit collection held at NTB. Bearing in mind the Symposium presentation about tissue culture work at CCRISP and the success in developing an *in vitro* system based on bioreactors, with the potential to generate large numbers of plants, the group felt that CCRISP is best placed to establish the initial tissue cultures of the NTB accessions, with special emphasis on the utility core. These cultures will then be distributed to laboratories, either national or regional, for further multiplication and distribution. In order to achieve this, NTB will either have to supply CCRISP with marcots and/or root suckers, or the CCRISP will have to establish tissue cultures directly from the trees in the NTB field genebank, using the Breadfruit Institute Field Station tissue culture laboratory. A potential timeframe was suggested, with September 2008 being highlighted as when the 20 utility core varieties will be conserved in tissue culture and have been disseminated to recipient laboratories for further multiplication.

The group also discussed a breadfruit improvement programme that could be put in place once the utility core has been widely distributed. Participating countries could compare this core with local varieties, using a standardized protocol. These multi-locational trials would focus on a range of traits (e.g., yield, taste, fruit quality, seasonality, adaptability, drought and salt tolerance). This information would then be made widely available to assist countries/growers in selecting varieties for specific needs.

The Germplasm Exchange and Crop Improvement group made the following recommendations:

1. Establish the utility core in tissue culture at CCRISP.
2. Transfer the utility core to national and regional laboratories in Africa, Asia, Caribbean and the Pacific.
3. Transfer the tissue culture multiplication protocol from CCRISP to labs in various locations, as appropriate.

4. Develop and provide technical training and supporting documentation for the transfer of tissue culture plants to greenhouse and field establishment.
5. Develop a standardized protocol to evaluate breadfruit varieties which would initially be used to evaluate the utility core collection.
6. Carry out DNA fingerprinting of the NTBG collection to facilitate the identification of a genetic diversity core.
7. Address any quarantine issues pertaining to the exchange of breadfruit germplasm.
8. Investigate methods for extending seed shelf life to enable the exchange of seeds between countries.

Diversity and Conservation

The main recommendations from this group were:

1. An inventory of existing germplasm for each country including distribution and uses of the germplasm.
2. Develop a minimum set of descriptors to document and describe breadfruit.
3. Acknowledge the importance of nutritional composition. More analysis should be conducted and information made available.
4. Conservation strategies consistent with each country's resources—*in situ*, *ex situ*, and *in vitro*. Support for conservation should be linked to demonstration of usefulness and economic viability.
5. Diversity and conservation to be supported by product development and commercial activities.
6. Awareness activities on the usefulness of breadfruit (i.e., food fairs, media releases on health benefits, product development, etc.) together with training in processing and production, encouraging *in situ* conservation and funding for *ex situ* conservation.
7. Breadfruit needs to be included in agro-forestry systems such as live staking for yams or black pepper. An example would be livestock feeding in mixed farming systems.
8. Consideration and possible development of strategies to encourage farmers to report on and conserve desirable naturally occurring diversity.
9. Expand strategies for the current utility core at NTBG; especially how completely the core reflects the entire Pacific range (e.g., atolls, mid-altitude range, etc.).

The group agreed that seeds could play a role in conservation, but also acknowledged the difficulties, namely the issue of recalcitrance and that seedling evaluation for desirable traits is a long-term activity, and also requires land.

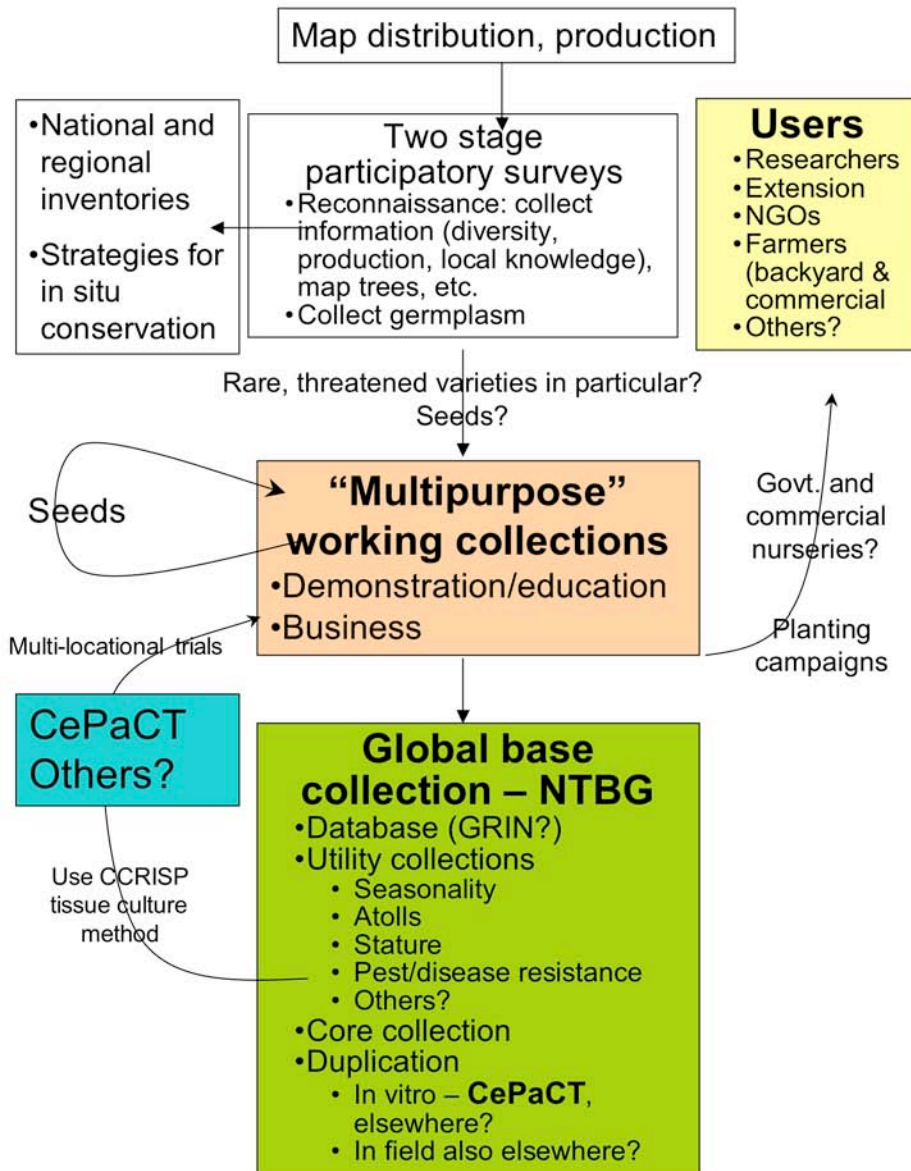
The Diversity and Conservation group recommended the following possible projects:

- Develop inventories for each country or (where appropriate) region, e.g., Caribbean.
- Nutritional analysis of available diversity starting with existing *ex situ* collections.
- Where resources are available, upgrade tissue culture laboratories (e.g., Fiji and Vanuatu) for conservation (duplication), evaluation and germplasm distribution. Sustainability of these laboratories must be considered.

Focus Session on Global Crop Diversity Trust & Breadfruit Conservation Strategy

In addition to the Diversity and Conservation Working Group, one session of the Symposium was devoted to developing a global strategy for conservation of breadfruit. An introduction to the Global Crop Diversity Trust opened this session followed by discussions in which the Symposium participants looked at how best the conservation and utilization of breadfruit could be achieved on a global scale. An important activity undertaken during the Symposium was to compile information on current *ex situ* breadfruit collections (Appendix IV).

The diagram below summarizes the outcome of these discussions.



As a result of this discussion, the work that has been achieved by Dr Ragone in conserving the collection at NTBG was commended and the Symposium participants acknowledged that this work contributes globally to breadfruit research and development and that the security of this collection should be ensured “in perpetuity”. The Symposium participants therefore recommended that the NTBG collection be part of the multilateral system (MLS) of the International Treaty as set out in Article 15, to facilitate the collection’s continued conservation and use throughout the world.

During the discussions on the global strategy, a number of activities were identified in priority order to achieve some of the aspects of the global strategy, and others in order to fill in the gaps of knowledge that exist. Following the workflow of the above chart, recommended activities are:

1. Develop standardized descriptors and protocols. This will entail surveying, morphological description, nutritional analysis, agronomic evaluation to standardize protocols for multi-location testing and documenting local knowledge.
2. Carry out diversity studies to determine how genetically diverse the utility core collection is. Identify a true genetic core. Attention should also be given to nutritional analysis, starch characterization, salinity tolerance and drought tolerance.
3. Develop tissue culture and cryopreservation methods for exchange and conservation, and transfer technology where appropriate.
4. Develop best practices for tree management in genebanks and germplasm exchange. The latter would obviously require conclusive evidence as to what viruses of breadfruit exist, if any. Countries would also have to be willing to share germplasm and so any policy issues would have to be clarified.
5. Research on seed storage and handling. Possible guidelines for this work could be sourced from the information available for jackfruit.
6. Improve overall awareness on all aspects of breadfruit.
7. Establish an Information Clearing House.
8. Establish a Breadfruit network.

Information was seen as an important cross-cutting issue. The NTBG volunteered to carry out and publish a comprehensive literature review on breadfruit and act as an information clearinghouse. CTA volunteered to set up a mailing list including all symposium participants. It was agreed that it would be important to reach out to other breadfruit researchers who were not able to come to the Symposium and include them in the mailing list. These would be the first steps towards establishing a global breadfruit research and development network. It was also decided that there should be an accession level information system for breadfruit collections, possibly building on the NTBG’s use of GRIN.

Appendix I: List of Participants and Affiliations.

- Dr Gail S H Baccus-Taylor, Senior Lecturer/Researcher, Food Science & Technology Unit, University of the West Indies, St Augustine, Trinidad & Tobago, West Indies.
- Dr Richard Beyer, Consultant, Food Science Consulting, Fiji.
- Mr Dickson K Gamedoagbao, PGRRI – Plant Genetic Resource Institute, Ghana.
- Dr Lois Englberger, Island Food Community of Pohnpei, Federated States of Micronesia.
- Mr Roger Goebel, Development Horticulturist, Centre for Wet Tropics Agriculture, Department of Primary Industries and Fisheries, Australia.
- Dr Gualbert Gbèhounou, Docteur Ingénieur Agronome, Spécialiste de la Protection des Végétaux et Malherbologiste, Benin.
- Mr Luigi Guarino, Global Crop Diversity Trust, Italy.
- Dr Kerith D Golden, Senior Lecturer, University of the West Indies, Mona, Department of Basic Medical Sciences, Jamaica, West Indies.
- Mr Manaia Halafihi, Chief Agronomist, Department of Agriculture & Food, Ministry of Agriculture, Forests and Fisheries, Kingdom of Tonga.
- Ms Emily Montenegro Ilaoa, Manager Plant Tissue Culture, American Samoa Community College, Community and Natural Resources, American Samoa.
- Mr Sant Kumar, General Manager, Nature’s Way Co-operative (Fiji) Limited, Fiji.
- Mr Stéphen Lebegin, Tropical Fruit Crops Physiologist, Programme Cultures Fruitières de Pocquereux, Institut Agronomique néo-Calédonien, Nouvelle Calédonie.
- Mr Adelino Lorens, Chief, Agriculture, Office of Economic Affairs, Pohnpei State Government, Federated States of Micronesia.
- Prof. Amon Maerere, Professor & Head, Department of Crop Science & Production, Sokoine University of Agriculture, Tanzania.
- Mr Roy Masamdu, Biosecurity & Trade Facilitation Officer, SPC Land Resources Division, Fiji.
- Dr Indrani Medagoda, Senior Research Officer, Fruit Division, Horticultural Crop Research & Development Institute, Sri Lanka.
- Mrs Mermedah Moustache, Director General, Crop Development and Promotion Division, Ministry of Environment and Natural Resources, Seychelles.
- Mr Poasa Nauluvula, Principal Research Officer, Sigatoka Research Station, Ministry of Agriculture, Fisheries & Forests (MAF), Fiji.
- Dr Muriel Navarro, Vanuatu Agricultural Research and Technical Centre (VARTC), Republic of Vanuatu.
- Mrs Flora Christine Nelson-Quartey, CSIR – Crops Research Institute, Ghana.
- Dr Taiwo O Omobuwajo, Professor & Head, Department of Food Science & Technology, Obafemi Awolowo University, Nigeria.
- Mr Cenon Padolina, Regional Forest Genetic Resources Officer, SPC Forests & Trees Programme, Fiji.
- Mrs Mere Bitu Prasad, Gene Bank Manager-Agronomy, Koronivia Research Station, MAF, Fiji.
- Dr Alan Quartermain, Dean of School of Natural Resources, The University of Vudal, Papua New Guinea.
- Dr Diane Ragone, Director, Breadfruit Institute, National Tropical Botanical Garden, Hawaii, USA.

Appendix I: List of Participants and Affiliations (continued).

- Ms Takena Redfern, Agricultural Officer, Agriculture Division, Ministry of Environment, Lands & Agricultural Development, Republic of Kiribati.
- Dr Laura B Roberts-Nkrumah, Lecturer/Researcher, Department of Food Production, University of the West Indies, St Augustine, Trinidad & Tobago, West Indies.
- Ms Judy Rouse-Miller, Lecturer/Researcher, Department of Life Sciences, University of the West Indies, St Augustine, Trinidad & Tobago, West Indies.
- Prof. Clement K Sankat, Professor & Dean, Faculty of Engineering, University of the West Indies, St Augustine, Trinidad & Tobago, West Indies.
- Mr Aleki Sisifa, Director, SPC Land Resources Division, Fiji.
- Mr Kyle Stice, Trade and Development Office, Fiji.
- Dr Mary Taylor, Coordinator Genetic Resources, Centre for Pacific Crops & Trees, SPC Land Resources Division, Fiji.
- Ms Valerie Tuia, Curator, Centre for Pacific Crops & Trees, SPC Land Resources Division, Fiji.
- Mr Philip Tuivavalagi, Principal Officer, Crops Development, Commercial & Export, Ministry of Agriculture, Samoa.
- Mr Uatea Vave, Senior Agricultural Officer – Extension, Ministry of Natural Resources, Tuvalu.
- Mr James Wiseman, President/CEO, DigitalMedia Hawaii/Pacific, Hawaii, USA.
- Dr John Woodend, Programme Co-ordinator, EU-ACP Technical Centre for Agricultural and Rural Cooperation (CTA), The Netherlands.

SPC Support Staff and Observers

- Mr Kalisito Biaukula, Principal Agricultural Officer (Western), MAF, Fiji.
- Mr Sairusi Bulai, Adviser, Forests & Trees Programme, SPC Land Resources Division, Fiji.
- Mr Nicholas Conner, Principal Conservation Economist, Environment and Conservation Economics Section, Department of Environment and Conservation, Australia.
- Mr Tevita Kete, Plant Genetic Resources Officer, Centre for Pacific Crops & Trees, SPC Land Resources Division, Fiji.
- Mr Viliame Mainawalala, Agricultural Officer, MAF, Fiji.
- Ms Reapi Masau, Project Assistant – CePaCT, Centre for Pacific Crops & Trees, SPC Land Resources Division, Fiji.
- Mr Joji Nabalarua, Video Editor/Camera Operator, SPC Regional Media Centre, Fiji.
- Mr Tamani Nair, Radio Producer, SPC Regional Media Centre, Fiji.
- Mr Aremogam Pillai, Farm Business Adviser, MAF, Fiji
- Mrs Suliana Siwatibau, Fiji.
- Mr Luke Tirimaidoka, Quarantine Department, MAF, Fiji.
- Mr Larry Thomas, Coordinator, SPC Regional Media Centre, Fiji.

Appendix II: List of Presenters and Title of Presentations.

Presenter	Presentation Title	Theme*
Gail Baccus-Taylor	Breadfruit (<i>Artocarpus altilis</i>) studies: Food Science & Technology Unit, University of the West Indies, St. Augustine, Trinidad	PDM
Richard Beyer	Breadfruit as a candidate for processing.	PDM
Lois Engleberger	Conservation and documentation of breadfruit cultivars in Pohnpei, Federated States of Micronesia.	Regional Overview
Dickson Gamedoagbao	Conservation and use of breadfruit: Ghanaian perspective.	DC
Gualbert Gbehounou	Why does <i>Artocarpus altilis</i> still remain a backyard tree in the Republic of Bénin?	BIS
Roger Goebel	Breadfruit - the Australian scene.	PDM
Kerith Golden	The amino acid, fatty acid and carbohydrate content of <i>Artocarpus altilis</i> (breadfruit).	PDM
Stéphane Lebegin	Situation de la culture et de la recherche / développement de l'arbre à pain en Nouvelle-Calédonie.	DC
Adelino Lorens	Breadfruit varieties in Pohnpei, Micronesia: Traditional methods of production, use, and nutrient content.	BIS
Amon Maerere	Breadfruit production in Tanzania: Current status and potential.	PPC
Roy Masamdu	Systems approach to improve breadfruit exports in Fiji.	PPM
Indrani Medagoda	Diversity, ethnobotany, production, marketing and future of breadfruit in the Asian Region.	Regional Overview
Indrani Medagoda	Propagation studies and field evaluation of grafted breadfruit plants.	GECP
Mermedah Moustache	Breadfruit in the Seychelles.	PPC
Poasa Nauluvula	Breadfruit activities at Sigatoka and Legalega Research Stations.	PPC
Muriel Navarro	Breadfruit (<i>Artocarpus altilis</i>) of Vanuatu: Botanical diversity and traditional uses.	DC
Flora C. Nelson-Quartey	Formulation of a weaning food from two varieties of breadfruit – <i>Artocarpus altilis</i> and <i>Artocarpus incisus</i> .	PDM
Taiwo O. Omobuwajo	Breadfruit as a key component of sustainable livelihoods in Nigeria: The prospects, opportunities and challenges.	BIS
Taiwo O. Omobuwajo	Overview of the status of breadfruit in Africa	Regional Overview
Cenon Padolina	An Overview of the forest genetic resources conservation and management in the Pacific.	General
Alan Quartermain	Breadfruit in Papua New Guinea.	PPC
Alan Quartermain	Documentation of policies and strategies for underutilised species of crops.	General
Diane Ragone	Breadfruit: Diversity, conservation, and potential.	Keynote Address

Appendix II: List of Presenters and Title of Presentations (continued).

Presenter	Presentation Title	Theme*
Diane Ragone	In vitro propagation of breadfruit.	GECP
Takena Redfern	Research activities on breadfruit - Kiribati.	PPC
Laura Roberts-Nkrumah	An Overview of the Breadfruit (<i>Artocarpus altilis</i>) in the Caribbean	Regional Overview
Laura Roberts-Nkrumah	Colour and sensory characteristics of fried chips from three breadfruit (<i>Artocarpus altilis</i>) cultivars.	PDM
Judy Rouse-Miller	In vitro regeneration of <i>Artocarpus altilis</i> and <i>Artocarpus camansi</i> .	GECP
Clement Sankat	Post-harvest storage technology of the breadfruit.	PPC
Kyle Stice	A review of fresh breadfruit exports from Fiji.	PDM
Mary Taylor	Breadfruit in the Pacific.	Regional Overview
Valerie Tuia	In vitro culture of breadfruit: promoting germplasm sharing and exchange.	GECP
Philip Tuivavalagi	The past, present and future of the breadfruit industry in Samoa.	PDM
Jim Wiseman	Developing and applying descriptors for breadfruit germplasm.	DC

* BIS = Breadfruit in Society

DC = Diversity & Conservation;

GECP = Germplasm Exchange & Crop Improvement

PPC = Production & Production Constraints

PDM = Product Development & Marketing

Appendix III: Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis.

Strengths	Weaknesses
<p>Multipurpose tree Good nutritional value Food security Low cost of establishment and maintenance Wide distribution/ecological zones Beauty/ornamental trees Non-food uses Cultural importance Nutritious/versatile Not many pests and disease problems Food/income sources Marketing and post-harvest technology Delicious fruit Much information available (conservation, uses, varieties, propagation) High percentage of availability in-country High production of valuable food Few production problems once established, stays there until cut down Easy to grow Abundance (globally in ACP countries) High yielding Good for the environment High price on local markets Adaptability to wide range range of soil types Export potential and other value-added uses</p>	<p>Seasonality Highly perishable Lack of standardized descriptors Sharing of information Agronomy of breadfruit Backyard crop Short storage period/life (low shelf life) Limited knowledge base Bulky to market Research into non-food uses Few collections Lack of methods to preserve for a long period Not much promotion of its uses and development in the African and Caribbean region Post harvest handling Perishability Plant height/backyard production and difficulty in propagation Limited bearing season Not widely known Low production base Uses specific for each variety Difficulty in accessing information in technical papers and proceedings</p>
Opportunities	Threats
<p>Food security potential Lots of diversity Formation of breadfruit network Processing to increase marketability New research results Growing interest in health and indigenous foods R&D and commercialisation of products Export potential Explore traditional food with modern flavour Diversification of fruit for local market Germplasm distribution Planting campaign Medicinal (pharmaceutical) possibilities Poverty and hunger alleviation Cook book/ manual book production Tourism approach Product diversification (baby food and non-food) uses Documented germplasm availability in <i>ex situ</i> collection(s) Farming/cropping systems – agroforestry Import substitution</p>	<p>Genetic erosion Low priority in government policies Imported food consumption Loss of diversity Lack of interest of young generation Pest and disease: traditional and modern control methods Lack of interest by donors and funding agencies New species of fruit flies Loss of traditional knowledge Post harvest and perishability Other crops more marketable Negligence</p>

Appendix IV: *Ex situ* collections of breadfruit.

Genebank	Country	No. Acc.	Notes
America Samoa Community College	American Samoa	4	Planted 1989. Local germplasm.
Etty Bay Exotics	Australia	5	Private collection. Some evaluation. Further introductions needed to spread crop.
Kamerunga Research Station	Australia	6	Closed
Sigatoka Research Station	Fiji	12	Established 2006 in conjunction with a marketing project. Needs characterization and further collecting. Should be duplicated at NTBG?
Naduruloulou Research Station	Fiji	5	Old trees. Not clear whether same varieties as Sigatoka.
Legalega Research Station	Fiji	10	Duplicate of material at Sigatoka.
SPC Regional Germplasm Centre	Fiji (regional org)	10	2 Samoan, 10 Fijian varieties in tissue culture. NTBG collection to be duplicated here in vitro and cryopreservation once protocols finalized.
Pohnlangas Pilot Farm	FSM	13	On-farm conservation seen as main strategy. This collection will concentrate on rare and threatened material. No duplication elsewhere yet.
Pohnpei Botanical Garden	FSM	30	Old trees, Pohnpei and Chuuk varieties, including 2 from South Pacific. Not labeled, no provenance data.
PGRRI, Bunso	Ghana	8	Need characterization, evaluation, new introductions.
Kosrae Agriculture Dept.	FSM	20	Old trees. Local and Pohnpei varieties. Not labeled, no provenance data.
University of the West Indies, Mona Campus	Jamaica (regional org)	10	Material from NTBG planted 1992-1993. Need human resources for maintenance, data collection, propagation.
Central Nursery, Bikenibeu	Kiribati	8	21 varieties introduced from NTBG in 1993. 5 of these remain.
Arrak Agricultural Research Station	Marshall Islands	6	Need safety duplication at NTBG?
Station de Recherches Fruitières de Pocquereux	New Caledonia	5	From NTBG, planted 2000.
NARI, Keravat	PNG	Few	New collections being made by EU funded atoll project. Will need characterization, evaluation, and duplication at NTBG.
Atele Research Station	Samoa	13	Still collecting. Characterization ongoing.
Grande Anse Research Station	Seychelles	Few	Old trees.
Fote Field Experiment Station	Solomon Islands	16	Collection threatened due to virtual abandonment of research station. Need rehabilitation and safety duplication at NTBG.
Tenaru Field Experiment Station	Solomon Islands	13	2 accessions duplicated at NTBG.

Appendix IV: *Ex situ* collections of breadfruit (continued).

Genebank	Country	No. Acc.	Notes
Newi Field Experiment Station	Solomon Islands	13	
HORDI	Sri Lanka	4	Need evaluation. Not a priority crop. Not duplicated.
Sokoine University of Agriculture	Tanzania	2	Need characterization, evaluation, new introductions.
University of the West Indies, St Augustine Campus	Trinidad & Tobago (regional org)	33	Some accessions from NTBG + local varieties from Trinidad, Jamaica and St Vincent. NTBG accessions sent in 1990, some of these were sent on to Mona campus.
NTBG, Maui, Hawaii (Kahanu Garden)	USA	200	Some accessions need replanting. Entire collection needs duplication and long-term tree management strategy.
NTBG, Kauai, Hawaii (McBryde Garden)	USA	35	27 accessions duplicates of NTBG Kahanu Garden collection
USDA, Hilo, Hawaii	USA	40	32 accessions duplicates of NTBG Kahanu Garden collection
Mark Greenwell, Hilo, Hawaii	USA	20+	From NTBG.
VARTC, Vanuatu	Vanuatu	69	36 established in 2005. Further collecting needed. Will need safety duplication at NTBG in due course.

Revised: 19 June 2007