Research Program on Roots, Tubers and Bananas

CGIAR

RTB Mid-year Report 2012

A. Key Messages

The RTB program began on January 1. It has made a successful start-up and brought the CG partners into a clearly structured new set of collaborative arrangements. This provides the basis for moving from the somewhat fragmented projects which were inherited from the old funding model to a more coherent impact-focused RTB program. There were six major challenges to get underway:

- Make operational the governance and management mechanisms to implement a joint research program across the four CG Centers and with partners (mostly achieved).
- Put in place an RTB communication strategy and engage donors and other stakeholders in generating a shared vision (initiated).
- Establish a clear scope of work to be delivered in collaborative manner across the four Centers, ensuring value added to existing Center work by RTB program (initiated).
- Set up a flexible system of contracts to accommodate additional funding within this new collaborative framework (achieved).
- Establish clear priorities for a more focused RTB program with improved outcomes and impacts (process underway).
- Engage and involve a broader range of partners in this program to ensure improved outcomes and impacts (pending).

We have made considerable progress with two of the challenges, made a good start on three more, and have the last pending. Because of the need to build programmatic coherence and establish priorities, we are only just getting to the important challenge of involving a broader range of partners. This is now being given enhanced importance. As we move into planning cycle for next year, we will endeavor to increase partner's share of budget for 2013.

Governance and management

The first challenge was to put in place a coherent management structure to link CG Center deliverables to the overall RTB scope of work (*product portfolio*). The RTB Steering Committee agreed terms of reference for an expanded Management Committee led by DDGs for Research (or their equivalents) in each Center. Each Center also identified an RTB focal point who plays a key role in agreeing and overseeing quantity, quality, and timeliness of deliverables (products and milestones) of the crop-theme combinations of their respective Centers. The Management Committee selected leaders for each of the seven RTB themes based on merit. Candidates were approved by the Steering Committee. Theme leaders are responsible for planning, overseeing delivery, and reporting on the part of the product portfolio which crosscuts two or more crops and Centers.

Communication strategy

We presented the RTB communication strategy for a peer assist from CG communication specialists at the Rome meeting in March. One of the key take-home messages was the need to focus first on internal communications to build a stronger collaborative platform amongst participating Centers.

The communication strategy with other stakeholders has centered on building on partner-organized events, including the Global Cassava Partnership symposium in Uganda and the 16th Triennial Symposium of the International Society for Tropical Root Crops meeting in Nigeria at the end of September, where a launch of the RTB in Sub-Saharan Africa (SSA) is planned. This includes a special plenary session of the RTB with an overview by the program director and presentations by theme.

Valerie Gwinner and Graham Thiele took part in the meeting: "Progress on Gender and Agricultural Research in CGIAR," held on June 15, and presented the RTB gender strategy and our gendered work with value chains, which was very well received by an important group of donors.

Scope of work

An RTB product portfolio organized by crops and themes was developed as part of the proposal. This included a schematic impact pathway and collaborating partners by milestone. However, at start-up in January 2012, this was out of date and contained many unfunded—although highly desirable—research products. The first four months of the year were dedicated to updating the RTB product portfolio, making products and milestones SMARTer, and aligning the products with the base funding which was made available for each crop through the Consortium Office. We continued to use Googledocs (CGX) for the product portfolio so that all scientists could see changes in real time and contribute into a single planning framework for all cassava and banana research, where mandates where shared, which hitherto had been planned by each Center separately. This meant a lot of cross-Center interaction, to agree a common set of products and genuinely shared milestones amongst the Centers involved. It was not a completely smooth process, and this mechanism needs to be improved to make it easier to agree joint work; but it was a big step forward. We will pay special attention to improving this process for the next planning cycle. The revised RTB portfolio is available at:

http://www.rtb.cgiar.org/resources/product-portfolio

This is an intermediate step to putting in place a coherent CRP program building on the set of projects which were inherited. Consequently, at present the portfolio has an excessively large number of products and milestones. We need to progressively reduce this to have a more focused and impactful agenda. The results of the priority-setting process and a shift to management for outcomes should help with this transition.

With the theme leaders in place, and with the approval of the Steering Committee, we organized an internal call for new strategic research with complementary (gap) funding of three types:

- Cross-cutting research of relevance to two or more crops and two or more Centers.
- Research within a crop that brings together two or more Centers and partners around synergistic opportunities which have not previously been addressed to any significant degree.
- New frontiers research which is truly novel involving two or more Centers.

We invited two types of profiles:

- Planning grant (max. $100,000 for one year) to scope out an idea which needs more work, and where workshops and preparatory work is needed.
- Full proposal, which could include planning or start-up workshop for up to three years (max. $500,000 per year for a total of $1,500,000).

We stipulated that this should contain a significant involvement of non-CG partners and address gender.

The RTB theme leaders organized the response to this call, which required very significant inter-Center collaboration. We finally agreed $2.75 million of funding for 11 proposals developed collaboratively (Table 1).

The RTB is committed to gender research and ensuring that gender equity is appropriately addressed at different points in the impact pathway. However, it turned out that the Center capacity for this work was quite limited, so we have implemented an action plan and made more resources available for gender focal points, availing an increase in window 2 funding from IDRC. We are contracting a part-time gender research coordinator, and revising our gender strategy with support from a consultant until the coordinator is in place; the strategy should be resubmitted by October.

Table 1. Novel cross-cutting collaborative research planned

Theme	Theme name	Title	Type
1 & 2	Conserving and accessing genetic resources	Enhancing global RTB productivity through more targeted use of global genetic diversity	Full proposal
2	Accelerating the development and selection of varieties with higher, more stable yield and added value	Multi-Center planning on banana/plantain improvement	Planning grant
3	Managing priority pests and diseases	Developing tools for describing, quantifying, and managing diseases causing degeneration of planting material in RTB	Full proposal
3	Managing priority pests and diseases	Towards the development of comprehensive strategy for combating Bemisia tabaci—a continuing menace to R&T crops	Planning grant
3	Managing priority pests and diseases	Building a collaborative, public-private R4D alliance to address BBTV in Sub-Saharan Africa	Planning grant
3	Managing priority pests and diseases	Management of critical pests and diseases of RTB through enhanced risk assessment and surveillance	Planning grant
4	Making available low-cost, high-quality planting material for farmers	Developing a proposal for modeling RTB-seed systems: Towards decision support systems for improving seed-related investments	Planning grant
5	Developing tools for more productive, ecologically robust cropping systems	Identifying and quantifying yield gaps in RTB crops to devise technologies for increased RTB production	Planning grant
7	Enhancing impact through partnerships	Reaching end user through capacity strengthening and learning: A needs assessment	Planning grant
7	Enhancing impact through partnerships	From rhetoric to reality on gender: Implementing the RTB gender strategy	Planning grant
7	Enhancing impact through partnerships	Partnerships and knowledge sharing for innovation in roots, tubers and banana research for development	Planning grant

Flexible system of contracts

We developed a two-part Partnership Performance Agreement (PPA) with grants and contract specialists in the Program Management Unit (PMU). The first part, or framework, contains all the flow-down conditions. We used the framework to disburse the base funds agreed initially, and this contract was signed by the lead Center on 24 May. The second part, or task order, contains additional scope of work and the budget linked to that, with the same flow-down conditions as in the framework. We used task orders to fund priority setting and support to theme leaders (signed 16 August) and the 11 complementary-funded projects (signed 29 August) for collaborative work in the four Centers.

Priority setting

We used funding from the PMU to initiate a priority-setting exercise for all crops and Centers. The purpose of priority setting is to identify the best bets for RTB research based upon likelihood of success in achieving research products and adoption. The results of priority will be used to identify a more focused product portfolio and concentrate resources into those which have the greatest probability of success, while also building the basis for future advances. The priority setting was initiated at the Global Cassava Partnership (GCPII) meeting in Kampala in June, where we conducted a survey with nearly 250 stakeholders.

B. Baseline at Program Start-up

The RTB comprises diverse types of research with a predominance of more upstream commodity-based research as well as some more downstream work which provides models for scaling out by other partners. RTB work has very wide geographical scope and occurs across many different agroecologies and farming systems where RTB enter often as secondary crops and sometimes as primary ones. In addition, impact pathways are quite lengthy. This creates challenges for establishing a baseline against which to measure program progress. Because of this we are going to collect an array of different sorts of information to create a composite baseline along impact pathways:

1. Information from adoption studies of key development outcomes. For example, we will utilize information currently being generated by DIIVA as a baseline for varietal adoption.
2. Invest in yield gap analysis, which will require field-based activities to understand the drivers of yield gaps and the contribution of RTB-derived technology to closing them.
3. Database of key research outcomes—for example, numbers of releases with RTB attribution to be regularly updated. This will serve both as baseline and measure of impact of prior outcomes of RTB Center research.
4. Priority-setting exercise will gather and assemble data on beneficiaries, adoption domains, current adoption levels of key RTB technologies, and yields.
5. Mapping of partners using social network analysis to understand how RTB program reconfigures partnerships and moves towards managing for outcomes.
6. Mapping of production areas and identification of areas of high concentration of RTB crops and poor rural households.

C. Progress in Producing Outputs (Products)

Satisfactory progress was made in the first six months against the milestones of the RTB product portfolio as captured in the reports from the RTB Center focal points (see annexes). This relates mostly to the ongoing projects inherited from previous Center work. The idea is to identify and concentrate activities around emerging, high-priority flagship products.

Highlights in first half of 2012 by crop include:

CROSSCUTTING ALL CROPS:

- ***Overlays of maps identifying CRP-RTB target areas by crop ecology, crop production, and poverty/food security indicators*** are being developed. Initial data on crop area, production, and yield for RTB crops have been collected, as have GIS data on crop distribution and agroecology. For yield gap analysis, trial data for cassava are largely completed, some data for banana already are collected, and the organization of potato and sweetpotato data are being prepared. We are using CCAFS AgTrials system to organize this work.
- ***Initiation of the inter-Center grant preparation about RTB seed system modeling, to develop negotiation support systems and strategic guidelines for decision making by stakeholders involved in seed-related projects*.** Bioversity, CIAT, CIP, and IITA (i.e., the four CRP-RTB Centers) are working together to establish a common ground and framework to understand RTB seed systems, and develop a project proposal to validate such framework in the future.
- ***Methods and questionnaires to identify key production and constraints and research options developed for all RTB crops*** (cassava, potatoes, sweetpotatoes, bananas, plantains, and yam) and ready for expert consultation.

Bananas:

Genetic resource conservation use and improvement (Themes 1 and 2):

- ***Over 1,800 banana germplasm accessions held in collections were geo-referenced***. Field verification of accessions held in the International Transit Center is ongoing, with more than 100 accessions already validated. The Musa Genotyping Platform has become fully operational after two years of organizational efforts. These are elements of a broad initiative to integrate collections and in-situ diversity through a partner platform with a well-organized information system that will increase the access of diverse users to Musa genetic diversity.
- ***A genome-wide study of the main gene families involved in the carotenoid biosynthesis pathway in Musa was performed***, and a set of orthologs of enzymes responsible for the accumulation of pro-vitamin A carotenoids (pVACs) in Musa fruit were identified. The area of molecular characterization is continuing to expand and will span issues of disease resistance, abiotic stress tolerance, and nutritional and consumer-based traits.
- ***BXW-resistant varieties of banana through genetic transformation***. Results demonstrated that constitutive expression of the sweet pepper Hrap or Pflp gene in banana resulted in enhanced resistance to Xanthomonas wilt. Most of the transgenic lines in CFT are only for two cultivars. Thus, we started modifying additional farmers' preferred cultivars. We are transforming plantain cv. 'Gonja manjaya' and banana cv. 'Gros Michael' and 'Cavendish' at IITA/BecA hub Nairobi.
- ***Nematode-resistant plantains through genetic transformation***. Screen house trials provide evidence that the maize cystatin and peptide are capable of providing resistance in plantain to concomitant infection with multiple nematode species. More than 100 transgenic lines have been screened and 12 best transgenic lines showing > 67% resistance against nematodes will be further evaluated in a confined field trial in Uganda in November 2012 with approval of National Biosafety Authority.

Pest and disease management and farmer access to clean seed (Themes 3 and 4):

- ***Tools for more effective disease monitoring and detection***. A qPCR tool for a rapid diagnostic of *Ralstonia solanacearum*, developed and implemented in one country in Latin America, to certify disease-free seeds. Proof of concept of the tool was provided through the certification in Colombia of plantain seed as free of bacterial wilt. A molecular tool for Fusarium tropical race 4 (Foc TR4) is being made available first in Latin America to strengthen quarantine and detection. The mapping of TR4 distribution in Asia is near completion and will permit more focused surveillance. For BXW, the diagnostic tool which is being developed is envisaged to contribute to clean seed availability and quarantine.
- ***Understanding disease epidemiology and development of management tools***. Cultivar differences for resistance to Foc TR4 are the basis for projecting the impact of the spread of the disease as well as the basis for substitution in the case of disease presence. Resistance is being tested for important cultivar groups in Africa through testing in Asia where the disease is present. Studies on BXW have elucidated questions of systemicity; root colonization; and speed of movement of the pathogen, time to disease expression, and the influence of environmental factors. For BBTV, an aphid-vectored virus spreading through the Congo basin and beyond, studies are contributing to an understanding of the aphid presence and to the reinfection rate for local seed multiplication strategies. This type of research provides a strong basis for developing sustainable management options. Studies on the role of microbial communities in abiotic and biotic stress have also been initiated and a paper was published in *Applied and Environmental Microbiology* (78 (14): 4933–4911) characterizing microbial communities in different banana plant parts, in the rhizosphere and in the soil.

Production and marketing (Themes 5 and 6):

- ***Ongoing research on complex cropping systems with banana combined with annual food crops*** found focusing on East and Central Africa and with perennial crops focusing on Latin America and East Africa is adapting the framework of agroecological intensification for multiple system objectives. Simple criteria for managing the banana canopy for understory beans or coffee are in the final stages of validation through both formal experiments and farmer experimentation.
- ***A market and value chain focus for production system development*** is being strengthened during the past six months with a study on the lessons learned from group marketing of East African Highland bananas, a review of the role of gender in banana value chains, and simple practices to address postharvest quality of fresh market bananas which are an important source of income to smallholders in Africa, Asia, and Latin America.

Cassava:

Genetic resource conservation use and improvement (Themes 1 and 2):

- ***Next generation sequencing on reduced-representation libraries*** has been proposed as the most efficient genotyping method to rapidly discover SNP markers that can be used for germplasm characterization and conservation. Genotyping by sequencing has been conducted on 100 cassava landraces using the RAD-seq approach, with the identification of approximately 4,000 diagnostic SNPs.

- ***Establishment of efficient transformation system for local cassava cultivars***. Transgenic plant production is still difficult from farmer-preferred cultivars. To exploit the desirable traits of African farmer-preferred cassava cultivars, we have developed protocols for the regeneration of cassava plants through somatic embryogenesis. Primary somatic embryos have been induced using either axillary meristems or immature leaf lobes as explants in all nine cultivars tested. The friable embryogenic callus (FEC—a target tissue of transgene insertion) lines of four cultivars (Serere, Ebwanatereka, Kibandameno, and 60444) have been established and regenerated to produce complete plants.
- ***Testing of different genes for PPD tolerance in cassava***. To determine whether overexpression of GPX gene is capable of decreasing reactive oxygen species (ROS) produced in response to PPD, transgenic cassava plants expressing *Arabidopsis* GPX (*At*GPX) driven by a root-specific patatin promoter were generated. PCR, Southern blot, and real quantitative RT-PCR analysis indicated that the GPX gene had been integrated into the genome of transgenic plants and functionally expressed. Following PPD induction, root tubers from transgenic lines exhibited reduced black discoloration as compared to the wild type. Results indicate that overexpression of *At*GPX under the root specific patatin promoter might efficiently regulate ROS-mediated oxidative damage, thus delaying PPD onset in cassava roots.
- ***Transformation of cassava for CBSD resistance***. In collaboration with the Donald Danforth Plant Science Center (DDPSC), we are developing CBSD-resistant cassava for East African-preferred cultivars. We have signed an MoU and material transfer agreement with DDPSC and acquired plasmid constructs. The constructs have been validated and a transformation experiment has been performed. The Agro-infected calli are currently on selective regeneration medium.
- ***Good progress has been made this year in products which are developed collaboratively*** between Centers. For example:
  - CIAT and IITA have collaborated to establish a collection of 147 cassava germplasm accessions from six diversity clusters and 100 breeder's preferred lines The DNA of 80% of these cassava genotypes has been prepared and is ready to be sequenced.
  - CIAT and IITA are collaborating to produce partially inbred genetic stocks homozygous for resistance to white flies and CMD. Sources of these resistances were crossed and several F1 genotypes produced. A total of 419 seeds from these crosses was germinated and will be transplanted to the field in a crossing block to begin pollinations tentatively in early 2013. Self-pollinations will be made in the crossing block, or alternatively, crosses among selected genotypes will be produced with similar chances of reaching homozygosity for the two traits.

Potato:

Genetic resource conservation use and improvement (Themes 1 and 2):

- ***Network of long-term monitoring sites for the in-situ conservation of potato genetic diversity initiated: Chirapaq Ñan (= rainbow route).*** Five hotspots have been identified and baseline research and multistakeholder platforms involving indigenous communities, NGOs, government agents, and universities established at two hotspots. This novel initiative allows for in-depth learning about ongoing evolution and dynamic adaptation of potato genetic diversity in its center of origin within a context of accelerated socioeconomic and environmental change.

- ***Self-compatibility of potato plants derived from crossing self-incompatible diploid landrace accessions with a donor of the S-locus inhibitor gene Sli***. This is a first step toward testing the hypothesis that *Sli* will also be effective in overcoming interspecific reproductive barriers in *Solanum*. This could open the door to the introduction of novel sources of needed traits from previously isolated wild potato species into cultivated gene pools, as well as classical hybrid breeding schemes for potato resulting in uniform, heterotic progeny from botanical seed.
- **Eleven potato clones with extreme resistance to potato virus Y, 25 resistant to PVX, and 10 tolerant to drought identified** from a set of 65 clones of a new bred potato population. The clones have combined heat tolerance and late blight resistance (LBHT) with a 90-day growing period and high yield. These clones should adapt well to SSA and Asia, and are available in HS2 status. As late blight (LB) resistance is classically associated with long growing season, LBHT represents a new opportunity to introduce LB-resistant varieties into rotations with a limited window for potato production. The LBHT clones combining resistance to LB, potato virus-Y, and drought are suited for planting in warmer regions and will help ensure yields under unpredictable conditions with climate change.
- **CIP potato clones selected or currently being evaluated for variety release during 2012 in Asia.** In Bangladesh two CIP clones, one LB resistant and one early bulking, are under final testing for presentation for variety release by the Tissue Culture Research Center. Four promising early bulking, heat-tolerant clones are in field trials with the All India Coordinated project to release superior clones as varieties. Collaborative trials of CIP, PepsiCo, and CPRI have been established to validate processing quality before recommendation to the All-India variety release project.

Pest and disease management and farmer access to clean seed (Themes 3 and 4):

- ***Qualitative model of potato seed system defined***. The proposed model presents and describes the factors that are related and influence the performance of potato seed systems based in a sound literature review. Paper with findings will be presented at the ISTRC symposium.

Sweetpotato:

Genetic resource conservation use and improvement (Themes 1 and 2):

- ***Selection of parents in genepool PJ and PZ on basis of their offspring performance in a hybrid population*** has been made to start the first reciprocal recurrent selection cycle for an orange-fleshed sweetpotato with wide adaptation and processing use showing hybrid vigor.
- ***Accelerated breeding initiated in sweetpotato on four platforms (Peru, Mozambique, Uganda, and Ghana) and by eight NARS programs (Uganda, Kenya, Rwanda, Malawi, Mozambique, Ghana, Burkina Faso, and India).*** It is estimated that in total about 32,000 sweetpotato genotypes were evaluated by the accelerated breeding scheme, which reduces the number of years and increases the number of locations per year when selecting clonally propagated crops with the objective to develop a variety in four to five years instead of seven to eight.

Yams:

Genetic resource conservation use and improvement (Themes 1 and 2):

- ***New accelerated scheme for yam breeding combined with participatory selection approaches*** has been implemented in Ghana and Nigeria, working closely with public sector NARs partners (CSIR and NRCRI) and private sector partners, including farmers and processors. At the same time, national yam-breeding strategies are under development in Ghana and Nigeria using broad stakeholder participation to rapidly release improved yam varieties.
- **Use of yam vine propagation to enable rapid multiplication of clear planting material from the** accelerated yam-breeding scheme. Extensive use of vine propagation from the F1 hybrid seedlings contributes to rapidly multiply disease-free planting material and produce yam minitubers to accelerate exchange among partner research organizations. Production of clean planting material will enable sharing of germplasm across West African countries that can meet phytosanitary requirements. Crosses between yam parents A x B produce F1 hybrid seedlings that are raised in the screen house using a new high-density propagation system. F1 hybrid seedlings are screened and virus-free seedlings are vine propagated to form the F1C1 breeding stage.

D. Progress in Producing Outcomes

It is premature to assess outcomes. We are putting in place processes and instruments which should make it possible to manage for outcomes and will give serious attention to this during planning for 2013, as guidelines from Consortium Office become available.

E. Risk Management

Perhaps the biggest risk has been that, because of uncertainties over contracts and the need to redistribute budgets, Centers have held back from implementation, so that when resources are eventually available they will not be able to appropriately use them in what remains of the year.

The overlapping of inherited RTB projects, and the new work associated with the complementary-funding projects, has created a serious task overload, particularly for some of the theme leaders whose time commitment may not have been adequately budgeted for. The resultant risk is that we will not be able to deliver on the products and milestones on time and with the quality expected.

Current mechanisms have resulted in funds being dispersed in many small packages with limited opportunities for identifying linkages and having larger flagship products. The priority-setting exercise should help, but it is only just getting underway and will only be available until well into 2013. During planning process for 2013 we will seek to consolidate where possible existing milestones and products to reduce dispersion.

F. Lessons Learned

Uncertainties about when and what funding would actually become available and the need to put in place the PPAs have made it difficult to involve partners as much as we would have preferred. Partnership opportunities are appearing and will be nurtured as we move ahead with the complementary-funded projects.

It has proved harder than anticipated to identify the partners to involve in governance or management in the RTB, although CIRAD, IRD, FERA, and Syngenta Foundation have expressed an interest in being considered. To provide some traction on this, we are conducting a survey of global partners who meet the following criteria:

- Global research engagement
- Significant expertise in the RTB scientific areas, in one or (ideally) more RTB crops
- Previous engagement with one or more of the CRP-RTB CGIAR partners
- Complementarity of their work with that of the CG Centers
- Willingness to commit human and/or financial resources to RTB
- Willingness to share research results.

This will provide the input for decision making by the RTB Steering Committee to broaden program governance.