



Evaluation of the CGIAR Research Program on Roots, Tubers and Bananas (RTB)

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Jillian Lenné (Team Leader)
Milla McLachlan
Selçuk Özgediz
KV Raman
Laurian Unnevehr



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Acronyms

A4NH	Agriculture for Nutrition and Health CRP
ACIAR	Australian Center for International Agricultural Research
AfDB	Africa Development Bank
ARI	Advanced Research Institute
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
BBDT	Banana bunchy top disease
BMGF	Bill and Melinda Gates Foundation
BoT	Board of Trustees
BXW	Banana Xanthomonas Wilt
CapDev	Capacity development
CBSD	Cassava Brown Streak Disease
CCAFS	Climate Change, Agriculture and Food Security CRP
CCER	Center-Commissioned External Evaluation
CFP	Center Focal Point
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
CoA	Cluster of Activity
CRP	CGIAR Research Program
CRS	Catholic Relief Services
DDG	Deputy Director-General
DfID	Department for International Development
DG	Director-General
DH	Doubled Haploid
DIIVA	Diffusion and Impact of Improved Varieties in Africa
EAHB	East African Highland Bananas
ENDURE	Expanding Utilization through Research Project
EPMR	External Program and Management Review
FAO	Food and Agricultural Organization of the United Nations
FP	Flagship Project
G&M	Governance and Management

GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IARC	International Agricultural Research Center
ICAR	Indian Council of Agriculture Research
ICARDA	International Center for Agricultural Research in Dry Areas
IDO	Intermediate Development Outcome
IEA	Independent Evaluation Arrangement of CGIAR
IF	Impact Factor
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
IPG	International Public Goods
IPM	Integrated Pest Management
IRR	Internal Rate of Return to Investment
ISC	Independent Steering Committee
ISPC	Independent Science and Partnership Council
KM	Knowledge Management
L&F	Livestock and Fish CRP
M&E	Monitoring and Evaluation
MAB	Marker Assisted Breeding
MC	Management Committee
MGIS	Musa Germplasm Information System
MV	Modern Varieties
NARO	National Agricultural Research Organization
NARS	National Agricultural Research Systems
OFSP	Orange-Fleshed Sweetpotato
PA	Priority Assessment
PAC	Program Advisory Committee
PIM	Policies, Institutions and Markets CRP
PL	Product Line
PMCA	Participatory Market Chain Approach
PMU	Program Management Unit
PNAS	Proceedings of the National Academy of Sciences
RBM	Results-Based Management
RTB	Roots, Tubers and Bananas CRP
SIAC	Strengthening Impact Assessment in CGIAR

SLO	System Level Outcome
SPIA	Standing Panel on Impact Assessment
SRF	Strategy and Results Framework
SSA	Sub-Saharan Africa
ToC	Theory of Change

Executive Summary

Background and context

Root and tuber crops and bananas are an essential staple food for the poor in developing countries. With a mean production of 685 million tons on 55 million ha in 2006–2008, the RTB crops represent the second most important set of crops in developing countries after cereals. Some 400 million tons are consumed as fresh or processed food; the remainder is used as animal feed, planting material, or industrial raw material. Production and use of RTB crops tends to be concentrated in countries with lower per-capita incomes. RTB crops are excellent sources of cheap energy and some varieties are rich in vitamins and essential minerals. They are true food security crops and are mostly produced, processed, and traded locally, contributing to the sustainability of cropping and production systems and helping to reduce the risk of food shortages and nutritional shortfalls. RTB crops also play an important role in the livelihoods of women.

The CGIAR Research Program (CRP) on Roots, tubers and bananas (RTB) is led by the International Potato Center (CIP) and brings together the RTB crop-related work of CIP, Bioversity International (Bioversity), the International Center for Tropical Agriculture (CIAT), the International Institute of Tropical Agriculture (IITA) and the French agricultural research and international cooperation organization, CIRAD, as well as about 300 partners. The aim of RTB is to more fully realize the potential of RTB crops (banana/plantain, cassava, potato, sweetpotato, yams, and other tropical and Andean root and tuber crops—sometimes termed ‘vegetatively propagated staple crops’) for improving nutrition, income generation, and food security—especially among some of the world’s poorest and most vulnerable populations.

The CRP on RTB was initially approved for three years and began to operate in January 2012. In 2014 an extension phase 2015–2016 was approved. The original structure of RTB was made up of seven disciplinary-based Themes each with a mix of existing, expanded and new Product Lines (PL) as well as cross-cutting activities. A detailed priority assessment (PA) exercise was carried out in 2013–2014 and RTB began to reorganize its program structure into Flagship Projects (FP) and Clusters of Activities (CoA) in 2014. The FP program structure presented in the extension proposal was expanded and refined in the recently submitted pre-proposal for Phase II to be initiated in 2017. In 2016 RTB will begin to transition to this new structure. The program structure will be further revised in the preparation of the full proposal.

Purpose, scope and objectives of the evaluation

The primary purpose of the evaluation is to enhance the contribution that RTB is likely to make to reaching CGIAR goals, in particular food security for nutrition and health. The evaluation aims to inform decision-making and planning by program management, CRP sponsors, partners and other stakeholders with respect to program performance and the potential options for the future. It is also intended to serve the interests of the broader group of RTB partners and stakeholders.

The evaluation includes both summative and formative aspects. The summative part encompasses an assessment of research outcomes, primarily from pre-CRP research and outputs from current research and the period leading to RTB. The formative aspects focus on current research and

evolution of RTB over the past four years from the perspective of program design and governance and management (G&M) arrangements. The evaluation was also informed by the pre-proposal. Furthermore, the Evaluation looks at the extent to which current research is influenced by feedback from impacts derived from pre-CRP research. The evaluation also addresses four cross-cutting issues as part of programmatic performance: gender, capacity development, partnerships and communication and knowledge management (KM).

The Evaluation Team developed evaluation questions at two levels: overarching questions and questions in connection with the key evaluation criteria of relevance, quality of science, efficiency, effectiveness, impact and sustainability. Programmatic and organizational aspects of RTB were considered as distinct entities for defining the criteria-specific evaluation questions.

The evaluation addressed ten overarching questions related to CGIAR reform principles and RTB in the new CGIAR structure:

- How well does RTB operate as an integrated program - programmatic-level thinking, strategy, inter-center research activities and management?
- Has the implementation of RTB realized anticipated synergies and complementarities from centers working more closely together especially on the same crop, added value to research on RTB and improved its prospects of achieving its objectives and contributing more efficiently and effectively towards the program's IDOs and SLOs?
- Are the CGIAR reforms assisting RTB to deliver its objectives, achieve program IDOs and contribute to SLOs?
- Is RTB priority setting effective in terms of program coherence and focus of research on its intended objectives?
- To what extent shall the new RTB program structure based on discrete "business cases" of crop-specific activity clusters contribute to or impede the program's ability to achieve IDOs and SLOs?
- How is the long and continuing process of change in RTB to Flagship Projects affecting the management burden and transaction costs, and affecting relationships with partners?
- Is RTB designing and shaping future partnerships to articulate a sustainable research project portfolio?
- Are the impact pathways in the RTB structure sufficiently specified regarding target beneficiary groups and alternative research and industry providers, and are they clearly formulated and used in program monitoring and management?
- In the current complex funding environment, has RTB been able to manage multiple sources of funding to assure strategic coherence around highest priority areas of research?
- To what extent do the G&M structures and practices of RTB contribute to or impede the achievement of program coherence and effectiveness?

Questions for the evaluation of G&M focused on legitimacy, accountability, transparency, conflicts of interest and efficiency, and aspects of program management, including effectiveness, financial management, resource mobilization, monitoring and reporting, collaboration, and risk management.

Moreover, the evaluation explored the effects of CGIAR reform on the efficiency and likely success of the program.

Approach and methodology

The main impetus to bring research on root and tuber crops and bananas together in a single program was to capture synergies due to commonality of the crops and their value chains and potential efficiency gains. The Evaluation therefore focused on three main research areas where there is greatest potential for integration of research across crops. These areas were: the breeding pipeline; high quality planting material; and post-harvest management, value chains and marketing.

The Team based its findings, conclusions and recommendations on data collection and analysis from several sources:

- Case studies – PLs within Themes
- Review of essential documents of the program, its approval, planning and reporting.
- Documents for sample projects
- More than 300 interviews with RTB policy makers, managers, researchers, partners, donors and other stakeholders
- Field visits to Belgium, Colombia, France, Kenya, Nigeria, Peru, Philippines, Tanzania, Uganda and Vietnam
- Virtual attendance at one Independent Steering Committee (ISC) and one Management Committee (MC) meeting
- Survey among RTB researchers
- Bibliometric analysis of RTB publications
- In-depth analysis of 79 journal articles
- H-index analysis of 106 RTB researchers
- Impact narratives prepared by CIP, CIAT, IITA and Bioversity

As the evaluation took place when RTB had been operational for less than four years, many research results and impacts were attributed, at least in part, to pre-CRP research done at the partner centers.

Main findings and conclusions

Overall, the Evaluation Team concludes that in spite of the complexities and challenges of successfully implementing a multi-crop and multi-partner CRP, RTB has made notable progress in the past four years and is already delivering results, in spite of budget cuts. RTB is well-directed and reaching a reasonable number of its near-term milestones and is working towards achieving its goals, particularly those concerning productivity and nutritional improvement for some of its crops. RTB is successfully delivering added value across centers and crops in several areas mainly through strategically important complementary projects that are funded from Windows 1 and 2 (W1/W2). The momentum achieved through this initial progress needs to be further developed into fully integrated research programs on cross-center crops. RTB strongly warrants being continued as CRP beyond the extension period.

Generally, RTB is a coherent program with a strong global comparative advantage based in its stewardship and access to extensive well-characterized global germplasm collections of major RTB crops; scientific capacity in human resources and research infrastructure; strategic locations in production environments for next users; and broad range of often long-term partnerships with public, private, and development organizations. RTB should continue to assess its role and priorities in the light of the growing strengths of some National Agricultural Research Systems (NARS) and increasing involvement and interest of the private sector in RTB crops, particularly for basic seed production and processing.

The quality of RTB science is sound, overall, and novel approaches are being used to generate IPGs but greater efforts are needed to improve the quality of research publications. The incorporation of skills and expertise from noted Advanced Research Institutes (ARI) has enhanced the quality of the outputs produced. The program's effectiveness can be further improved through closer collaboration among breeders; strengthening CRP expertise in seed systems; improved integration of crop improvement and management (agronomy and soil fertility management) technologies; and enhanced focus of post-harvest research on the crop-specific aspects of value chain improvements that can deliver added value. Links with some CRPs are well-developed e.g. with Livestock and Fish (L&F) and Humidtropics CRPs, for developing cassava peel-based feed but others are a work in progress. NARS are appreciative of their enhanced roles and greater equity in RTB.

RTB has been successful in building new program G&M arrangements that largely meet the challenges of integrating five crops, four centers and CIRAD. The management of RTB is well-regarded throughout the CRP and CGIAR. Good progress has also been made in implementing a gender strategy.

Overall, RTB is a strong program that is addressing appropriate research issues for meeting the challenges to increasing food and nutrition security, poverty reduction and gender and social equity. A speedy move to using the outcomes of the PA for more strategic allocation of the budget across crops and further programmatic integration will further enhance its strength.

Relevance

RTB's research is strategically relevant to addressing the CGIAR's objectives. Lessons learnt from implementing the old program structure have been useful in informing the design of the new structure based on inter-disciplinary and integrated FPs and CoAs. Although the new structure will potentially improve coherence and should be more effective in the delivery of RTB's outputs and outcomes, RTB needs to further review and revise the CoAs for improved congruence with the FP problem definition and the PA.

RTB's revised impact pathways should better facilitate it to reach CGIAR goals, the System Level Outcomes (SLOs), measured through Intermediate Development Outcomes (IDO) at sub-level, thus addressing one of the core principles of CGIAR reform¹. Furthermore, the complementary projects have been important in facilitating programmatic integration across CGIAR core skills, adding value

¹ Confirmation of the potential of the new program structure to more effectively contribute to the sub-IDOs awaits the implementation of the Phase II.

and capturing synergies and complementarities across centers and across crops. However, RTB needs to make further efforts to enhance integration beyond individual time-bound projects. In particular, further value would be gained by fully integrating the IITA and CIAT cassava breeding programs and all RTB research on banana and plantain by IITA and Bioversity.

The strategic use of W1/W2 funds through sound and productive complementary projects has enhanced the relevance of RTB research and strengthened partnerships for more effective generation of priority research outputs, in spite of cuts to this funding. The Evaluation Team encourages RTB to move rapidly towards greater strategic allocation of these funds based on program priorities and highlights the need for CGIAR to put more effort into raising W1/W2 funds for such projects. RTB should build on the PA already completed, and use results for setting program priorities and in program planning, including fundraising. In doing so, RTB should also plan for continuous improvements in the data and estimates that support PA.

RTB has a strong global comparative advantage as a main supplier of RTB research outputs relevant and useful for small holders in Sub-Saharan Africa (SSA), Asia and Latin America. This comparative advantage has been strengthened by selected partnerships with ARIs with complementary skills and strong partnerships with NARS whose research has been developed by RTB centers. However, RTB needs to carefully consider alternative research suppliers in future assessment of its comparative advantage. The roles and responsibilities of each member of such partnerships will change over time and RTB should continue to focus on the generation of IPGs and hand-over areas of research to capable partners, enabling it to move on to other priority research.

Quality of science

The quality of science is generally good both from the centers themselves and through partnerships with noted ARIs. The current RTB breeding programs are using both sound and novel approaches but should continue to improve through the use of techniques such as gene editing, genetic modification, marker assisted breeding (MAB) and genomic selection and utilizing new knowledge generated from genomics research. Attracting young skilled scientists trained in these techniques will strengthen the quality of science while training the next generation of plant breeders will help to ensure continuity and sustainability.

Research on quality planting material is producing useful outputs for the development of economically sustainable seed systems for major RTB crops and has provided opportunities for developing cross-center and cross-crop partnerships and cross-crop learning. The incorporation of skills and expertise from ARIs has enhanced the quality of the outputs produced. The addition of CIRAD as a collaborating center has brought new intellectual energy to post-harvest work, generating high quality efforts and publications. The complementary projects are bringing together lessons from different countries and contexts to better inform technology development and potential market interventions thus contributing to research quality. The nutrition research is well-designed and results have the potential to provide a model for efforts in other crops or regions. Continued attention to generating knowledge that provides global public goods for RTB will be necessary.

RTB has published some excellent research papers in high impact journals. At the same time, the percentage of publications in non-IF journals is disturbingly high – 39 percent. While it is recognized that most RTB crops are at a disadvantage in terms of the range of journals willing to publish on these crops and the need to target African journals to promote research findings to the most appropriate stakeholders, RTB should endeavour to produce higher quality science in order to publish in higher quality journals for greater international impact. Furthermore, in future, the MC and ISC should play a more active role in monitoring the quality of science produced by RTB.

Program effectiveness

RTB has made notable progress towards outcomes in important research areas of its program: the breeding pipeline; quality seed systems; resilient cropping systems; and post-harvest, value chains, marketing and nutrition. Furthermore, the new program structure with its focus on outcomes and plausible Theories of Change at FP level is likely to enhance program effectiveness in achieving outcomes and contributing to sub-DOs, DOs and the SDOs. The multi-center and multi-crop complementary projects have fostered a strong willingness and commitment among scientists to work together towards greater research integration for program effectiveness. RTB must now capitalize on this progress and momentum as it moves forward.

At the same time, the Evaluation Team has identified a number of areas where RTB could improve its effectiveness. These include the need for improved understanding of both the capabilities of NARS for breeding RTB crops and of end-user needs for specific products to better direct the focus – hence effectiveness - of RTB breeding efforts. Furthermore, the team has also recommended a number of ways in which RTB's breeders could work more effectively together through a community of practice.

RTB has also laid a solid foundation for future research on developing systems for quality seed, making notable progress both in improving access and supply of planting material to seed producers and small holders. The effectiveness of this important research could be further improved by recruiting an RTB seed systems expert who would lead priority research on assessing demand for clean high quality planting material; on understanding the incentives for small holders to purchase quality planting material; as well as mechanisms for strengthening the supply chain with links to marketing and processing.

Some important aspects of crop management research have not been well-supported which compromises the ability to integrate crop improvement and management technologies to effectively realize improved yields on-farm. In future, RTB needs to consider rebalancing the RTB portfolio towards agronomic and soil fertility research to address this gap.

Moreover, in future RTB should focus post-harvest research on the crop-specific aspects of value chain improvements that can deliver added value, as these are most likely to generate global public goods. Lessons from the Theme 6 research on cassava should help to identify transferable strategies and options for other RTB crops. Collaboration with the Agriculture for nutrition and health CRP (A4NH) on nutrition research should also be strengthened.

Gender, capacity development, partnerships and knowledge management and communication

RTB has made substantial progress on increasing the gender responsiveness of research activities. The W1/W2 funding allocated for the development of the Gender strategy, capacity development on gender, and support for the integration of gender analysis in project design and implementation has been essential to achieve these gains. The recent RTB focus on gender capacity strengthening has delivered impressive results over a relatively short period. Much of the gender work has been in the form of case studies, and while some attempts were made to consolidate findings, the work is somewhat fragmented. It is anticipated that the collaborative analysis of the case studies in the GENNOVATE project will contribute significantly to strengthening capacity for rigorous consolidation of case study research, to continue to build the evidence base for the use of gender analysis and gender responsive project planning. It will be important to ensure that gender and social equity considerations continue to feature prominently in RTB research activities in future.

While RTB has made strong contributions to capacity development, particularly with regard to enhancing individuals' research capacity, training end-users, and implementing innovative learning strategies, the efforts remain largely project based, and heavily reliant on W3/bilateral funding. RTB's accountabilities for capacity development outcomes are not yet clearly defined. The initiatives need to be coordinated with others, including regional initiatives aimed at addressing high-level human resource constraints in agriculture. RTB could consider using a rapid assessment approach to identify and prioritize specific focus areas for capacity development in future.

Partnership is a major strength of RTB. It has capitalized on established center-based relationships with many institutions and broadened them where opportunity existed. Engaging partners in RTB research planning and implementation has contributed to stronger bonds and commitment in research. Similarly, partnership platforms and continent-wide projects have facilitated collaboration with all types of stakeholders. Partnerships with private tissue culture facilities in SSA have proven to be important for servicing the production of clean planting material for RTB projects. RTB partnerships with other CRPs vary from excellent to a work in progress but a solid foundation has been laid for enhanced collaboration in future.

RTB recognizes that a comprehensive and adequately resourced knowledge management and communication strategy is essential to support the shift in focus towards achieving greater impact through research and the proposed future focus on the use of ICT-smart communication strategies, and scaling RTB's knowledge management experiences through advancing networks, portals and other innovative methods is appropriate. However, it will be important to allocate adequate resources to develop and implement the needed strategy for communication and knowledge management.

Impact and sustainability

Impact studies on RTB crops show clear evidence of global impact in cassava and potato, and to a lesser extent in sweetpotato. Cassava modern varieties (MV) appear to have had major impacts in SSA and in East Asia. New RTB research efforts are focusing on whether these impacts can be carried forward to more marginal production environments in SSA and the importance of processing and

taste characteristics as constraints to adoption. Potato and sweetpotato programs have had significant global impact and positive economic returns as well, although the extent of adoption is more limited. Some of the most notable documented impacts are in China for both of these crops. Impact studies of orange-fleshed sweetpotato (OFSP) in SSA show preliminary promise for nutritional benefits, and these studies may provide lessons and models for biofortification efforts in cassava and banana.

There has been limited documented impact in bananas and yams, although IITA studies show the potential for increased productivity. Strategically directed studies of barriers to adoption for these crops are needed, which could then inform research planning for greater future impact. Impact assessment work is also uneven in both approach and quality across centers and regions.

Governance and management

RTB has made significant progress in establishing G&M structures and processes that create new ways of working to promote the inter-dependence of the members of the RTB alliance. The creation of the ISC has improved governance and works well with the Program Management Unit. However, currently, there is no overarching business framework that can help guide these relationships beyond common goals and mutual trust. There is therefore a need for RTB centers to develop and agree on an alliance compact that would bring clarity and greater understanding to critical partnership questions including the allocation of W1/W2 funds, handling of W3/bilateral projects, participation in RTB G&M, alignment of management processes, and handling of joint undertakings and appointments. The RTB leadership is well-appreciated by stakeholders and considered to be amongst the best across CRPs. However, RTB needs to bring clarity to the respective roles, relationships and accountabilities of FP leaders, CoA leaders and bilateral project leaders within the management structures of RTB and the centers.

Added value

RTB is successfully delivering added value across centers and crops in several areas, with collaborations and new science that did not exist prior to 2012. In this process it is capturing synergies and taking advantage of complementarities through novel research on problems common to crops and/or centers. Many examples are given in the report's Chapters on relevance, quality of science and effectiveness. Furthermore, there was general agreement among RTB researchers that the program is adding value by creating or enhancing synergies between the centers, becoming strategically better focused on development outcomes and improving the way that gender issues are integrated into research. However, there are still areas where synergies and complementarities from centers working more closely together especially on the same crop will add more value to RTB research. In particular, further value would be gained by fully integrating the IITA and CIAT cassava breeding programs and integrating and consolidating all RTB research on banana and plantain by IITA and Bioversity.

Going forward

The Evaluation Team's overall assessment is that RTB plays a unique and much needed role in research generating international public goods (IPG) on important root and tuber crops as well as

banana and plantain grown by small holders and consumed by the poor. Its potential to contribute to food security and nutrition as well as enhancing the role of women in RTB crop value chains has been established.

RTB has achieved a notable level of programmatic integration and captured synergies and taken advantage of complementarities which would not have been possible before the creation of RTB, in spite of budget cuts. However, a program-wide philosophy and commitment to programmatic integration is still not fully realized. Center-level thinking still predominates largely due to the fact that decisions on a considerable amount of RTB funds are made by the centers based on RTB priorities, centers have a stronger brand than RTB and researchers identify primarily with centers. Further effort is needed to enhance integration beyond individual time-bound projects.

These are several areas where improvements are needed for RTB to add value as a program and contribute more effectively to its objectives. Several of these are addressed in the recommendations below. It is important that RTB develops its research agenda and project portfolio by using and continuously building on its recent PA, allocating W1/W2 funds more strategically and managing different funding sources as one portfolio for enhancing strategic thinking. Program level partnerships can be strengthened; partnership with A4NH on nutrition issues and with the private sector particularly on seed systems and processing are but a few examples. Where national partners are strong and RTB has limited further opportunity for generating substantial IPGs, a strategy for handing over is needed to ensure long term local sustainability. This will enable RTB to concentrate on other important priorities. RTB needs to be pro-active in enhancing its visibility as a unique CRP amongst policy makers but also donors. This is important for expanding the currently narrow donor base and thus enhancing funding sustainability.

A strengthened alliance between center partners will enhance RTB's ability to contribute to its IDOs and ultimately to the CGIAR's goals for reduced poverty, improved food and nutritional security and improved natural resource systems and ecosystem services.

Recommendations

The Evaluation Team makes a total of 16 recommendations presented below by the main evaluation criteria.

Relevance

Recommendation 1: RTB needs to make further efforts to enhance integration beyond individual time-bound projects. In particular, further value would be gained by fully integrating the IITA and CIAT cassava breeding programs. There is also clear potential for integration and consolidation of all RTB research on banana and plantain by IITA and Bioversity. This would likely result in rationalization of staff positions, allow better targeting of scarce W1/W2 funds and improve the ability to approach donors as an integrated program.

Recommendation 2: The restructuring of the program into inter-disciplinary and integrated FPs adds coherence to RTB compared to the Theme-based structure. However in some cases the definition of clusters of activities lacks coherence and consistency with the FP problem definition e.g. the banana disease clusters, single yam cluster and complex clusters in FP4. RTB should review and revise the clusters for improved congruence with the FP problem definition.

Recommendation 3: During 2012-2015, with the exception of complementary and cross-cutting funds, RTB allocated W1/W2 funds to partner centers based on historical funding. RTB has now recognized the need to move towards more strategic allocation of these funds based on program priorities and performance. In the current environment of decreasing W1/W2 funds, RTB should ensure that W1/W2 funds are directed at the highest program priorities as informed by priority assessment and performance evaluation.

Recommendation 4: RTB should use priority assessment results for setting program priorities and in program planning, including fundraising. In doing so, RTB should also plan for continuous improvements in the data and estimates that support priority assessment.

Quality of Science

Recommendation 5: RTB has published some excellent research papers in appropriate journals with high impact. At the same time, the percentage of publications in non-IF journals is disturbingly high – 39 percent. While it is recognized that most RTB crops are at a disadvantage in terms of the range of journals willing to publish on these crops and the need to target African journals to promote research findings to the most appropriate stakeholders, RTB should endeavour to assure that its science quality is consistently high in order to target and publish in higher quality journals for greater international impact.

Recommendation 6: Although individual Centers are responsible for the performance of their scientists, RTB is responsible for the quality of science implemented and generated by the program. The MC in consultation with the FP leaders should play a more active role in monitoring the quality of science produced by RTB with oversight by the ISC. Reviving Commissioned External Evaluations at CRP-level would be of greatest value.

Recommendation 7: RTB needs to further modernize and strengthen its breeding programs. Within the current funding climate, highest priority should be given to:

- a) Adoption of the best breeding strategies for its crops that involve harmonizing breeding approaches within crops and transferring lessons across crops, where possible;
- b) A benchmark study of its utilization of genomic technologies with the most adopted ones by the private sector to identify opportunities for improvement in the deployment of techniques such as gene editing and MAB;
- c) Deployment of precise high-throughput phenotyping methods, novel breeding techniques and modelling for traits such as drought and temperature stress through engagement with best practice in ARIs;
- d) Attracting young scientists working in genomics-led breeding, bioinformatics or omics research for both accelerating breeding and increasing genetic gains; and
- e) Placing more emphasis on training the next generation of plant breeders so that breeding will continue after the termination of the short term bilateral project funding.

Effectiveness

Recommendation 8: RTB should better target client needs by delivering only two to three achievable product profiles for each mandate crop per country or region and placing even greater emphasis on farmer and consumer needs. RTB and NARS should decide together on the division of labour based on NARS capability in each target country. This will allow RTB to provide appropriate back-stopping to NARS in further development of the products into cultivar(s) for release to farmers.

Recommendation 9: RTB should develop a community of practice of researchers across all crop breeding undertakings for enhancing effectiveness through better synergy. It will allow the sharing of ideas on methods, data, results and user feed-back, thus leading to integrated data platforms, developing inter-center working groups on traits, enhancing the inter-disciplinarity between lab-genomics and field-breeding, establishing single RTB breeding programs for banana and cassava, and sharing experiences among those engaged in transgenic breeding.

Recommendation 10: The establishment of economically sustainable seed systems for RTB crops is of core importance for program effectiveness. Priority should be given to assessing demand for clean high quality planting material throughout the seed value chain; on understanding the incentives for small holders to purchase quality planting material; as well as mechanisms for strengthening the supply chain with links to marketing and processing. Due to the importance of seed systems research for impact, as RTB moves into scaling-up and scaling-out seed systems activities, it should recruit an expert in RTB seed systems rather than relying on short term inputs from consultants and partners as was noted in Chapter 4.

Recommendation 11: Some aspects of crop management research, for example agronomy and soil fertility research in Theme 5, have not been well-supported. Narrowing the yield gap for farmers may require rebalancing the RTB portfolio towards agronomic and soil fertility research. In order to improve the realized yields in farmer's fields, RTB needs to better integrate research on crop improvement and crop management which have been implemented in different Themes to date and will be implemented in different FPs in the new program structure.

Recommendation 12: RTB should focus post-harvest research on the crop-specific aspects of value chain improvements that can deliver added value, as these are most likely to generate global public goods. Assessing lessons from the emerging cassava Theme 6 research results should help to identify transferable lessons and strategies for other RTB crops, providing a basis for scalability of lessons learned.

Gender, capacity development and partnerships

Recommendation 13: It is recommended that RTB management ensures that adequate resources are made available to develop and implement the needed strategy for communication and knowledge management. Flagship and cluster leaders as well as bilateral project leaders will need access to communication and knowledge management expertise, and be enabled to incorporate knowledge management 'experiments' into the design of new projects to achieve the ambitious intentions laid out in the pre-proposal. A strategy similar to the one proposed on capacity development (and drawing on lessons from the approach adopted to address gender issues) is recommended.

Impact and sustainability

Recommendation 14: Impact assessment is strategically important for demonstrating impact, justifying resources, and informing program planning. RTB needs a clear strategy of how priority and impact assessments will be linked over time, and how the results from *ex-post* assessments, complementing *ex-ante* assessment, will inform program planning. This may lead to changes in the design of *ex-post* assessments. In formulating an impact assessment plan, RTB should scale up activities and apply lessons from the SIAC projects they are currently engaged in. It should also ensure comparable quality of efforts across crops and regions.

Governance and management

Recommendation 15: RTB should bring clarity to the respective roles, relationships and accountabilities of FP leaders, cluster leaders and bilateral project leaders within the management structures of RTB and the centers.

Recommendation 16: RTB partners should develop and agree on an alliance compact building on the progress already made in inter-center collaboration. Such an alliance would bring clarity and greater understanding to critical partnership questions such as: allocation and use of W1/W2 funds, handling of W3/bilateral projects, participation in RTB governance and management, alignment of management processes, handling of joint appointments, handling joint undertakings and codes of conduct in program participation.

1. Introduction

1.1. Purpose and audience

The principal purpose of this evaluation is to enhance the contribution that the CGIAR Research Program (CRP) on Roots, tubers and bananas (RTB) is likely to make to reaching CGIAR goals, in particular food security for nutrition and health. The evaluation is aimed to inform decision-making and planning by program management, CRP sponsors, partners and other stakeholders with respect to program performance and the potential options for the future. It is also intended to serve the interests of the broader group of RTB partners and stakeholders.

In November 2013, the Fund Council of CGIAR agreed that all current CRPs should undergo some form of evaluation by the time preparation of the full proposal for the second call of CRPs begins. The RTB evaluation was conducted by a team of five, including the Team Leader (see Annex A for team biodata and Annex B for time frame and itinerary). The Evaluation Team shared its early preliminary findings with the RTB management prior submission of the CRP Phase II pre-proposal. The evaluation is being completed to provide input into the preparation of the full proposal and program selection in 2016.

The evaluation provides both accountability among the CRP, donors and partners, and learning for improving the likelihood of program relevance, effectiveness, efficiency, impacts and sustainable results. It will look at the extent to which RTB, within its mandate, is responding to the key aspirations underlying the CGIAR reform related to vision and focus, delivery orientation, synergy through efficient and effective partnerships and accountability.

1.2. The evolving CGIAR context

In the course of the CGIAR reform, initiated in 2008, CGIAR adopted a Strategy and Results Framework (SRF) in 2011 and, in parallel, the Fund Council approved 15 CRPs that started their operations in 2011-12. Since the start of RTB, and during the course of this evaluation, CGIAR approved extensions to all CRPs for 2015-16 and adopted a new SRF² that identifies CGIAR objectives at three levels: Intermediate Development Outcomes (IDO), sub-IDOs at the level of the CRPs and the CRP portfolio, and System Level Outcomes (SLO)³. The CRPs have been developing their impact pathways and Theories of Change (ToC) that link CRP activities and outputs to the IDOs that are, in turn, linked to the SLOs representing the CGIAR's high level goals. The CRPs have also been defining quantitative targets and measurable indicators for progress towards the IDOs and SLOs.

A new CRP cycle begins in 2017. In May 2015, CGIAR agreed on a new CRP portfolio and issued a call for CRP pre-proposals for the second funding cycle. In August 2015, RTB put forward a pre-proposal for the second phase for 2017-22, which was considered "satisfactory (generally of high standard) with

² CGIAR Strategy and Results Framework for 2016-2025. May 2015

<https://library.cgiar.org/bitstream/handle/10947/3865/CGIAR%20Strategy%20and%20Results%20Framework.pdf?sequence=1>

³ The three SLOs in are: Reduced poverty; Improved food and nutrition security for health; and Improved natural resource systems and ecosystems services.

adjustments” by the Independent Science and Partnership Council (ISPC) particularly with regard to FPs 5 and 6. It was invited to submit a full proposal.

CGIAR research is funded from four sources: Window 1 (W1) is the least restricted and allocation across CRPs is decided by the Fund Council; Window 2 (W2) is designated to specific CRPs and Window 3 (W3) to a specific CGIAR centers, mostly to a donor-specified project. Centers also receive bilateral donor grants for specific activities, and this funding is the most restricted. During the first phase of RTB, the W1/W2 funding decreased relative to other forms of funding and declined in real terms.

1.3. Evaluation questions

The evaluation’s design and implementation was guided by the Terms of Reference⁴. In the context of the CGIAR reform, and based on initial document review and engagement with RTB and its stakeholders, the evaluation put special focus on the following questions:

- How well does RTB operate as an integrated program - programmatic-level thinking, strategy, inter-center research activities and management?
- Has the implementation of RTB realized anticipated synergies and complementarities from centers working more closely together especially on the same crop, added value to research on RTB and improved its prospects of achieving its objectives and contributing more efficiently and effectively towards the program’s IDOs and SLOs?
- Are the CGIAR reforms assisting RTB to deliver its objectives, achieve program IDOs and contribute to SLOs?
- Is RTB priority setting effective in terms of program coherence and focus of research on its intended objectives?
- To what extent shall the new RTB program structure based on discrete “business cases” of crop-specific activity clusters contribute to or impede the program’s ability to achieve IDOs and SLOs?
- How is the long and continuing process of change in RTB to Flagship Projects affecting the management burden and transaction costs, and affecting relationships with partners?
- Is RTB designing and shaping future partnerships to articulate a sustainable research project portfolio?
- Are the impact pathways in the RTB structure sufficiently specified regarding target beneficiary groups and alternative research and industry providers, and are they clearly formulated and used in program monitoring and management?
- In the current complex funding environment, has RTB been able to manage multiple sources of funding to assure strategic coherence around highest priority areas of research?
- To what extent do the G&M structures and practices of RTB contribute to or impede the achievement of program coherence and effectiveness?

For addressing the evaluation criteria, the Evaluation Team considered specific aspects under each criterion:

⁴<http://www.iaa.cgiar.org/sites/default/files/IEA%20Evaluation%20of%20RTB%20Final%20TOR-web.pdf>

- relevance: consistency of RTB objectives with partner and beneficiary demands and priorities as well as the CGIAR objectives; coherence of RTB as a program and its focus on priority areas where RTB has comparative advantage; strategic use of W1/W2 funding; synergies among partners for enhancing the relevance of research.
- quality of science: scientific leadership, research teams and partnerships; research design and approaches, management for science quality and quality of research outputs.
- effectiveness: the likelihood of program effectiveness as evidenced by the plausibility and use of ToCs, progress made towards milestones and objectives, use of monitoring and evaluation (M&E) to feed back to program implementation; strategies and evidence of out-scaling; incorporation of capacity development (CapDev) and gender to program implementation and strategic engagement of partners for delivery.
- impact and sustainability: the extent to which outcomes and impacts have been achieved and documented including their magnitude; efforts to document outcome and impact results across the portfolio; the likelihood of sustaining the benefits.

The questions regarding evaluation G&M addressed legitimacy and participation, accountability, fairness and equity, transparency, efficiency, effectiveness and independence. The following aspects of program management were addressed: management oversight, stakeholder participation, risk and conflict management, resource mobilization and monitoring and reporting. Efficiency was assessed primarily as it relates to RTB's organizational structures and processes, institutional and administrative arrangements and financial management. The evaluation assessed the performance of RTB G&M against the Consortium and Fund Council response to the 2014 CRP Governance and Management Review⁵.

1.4. Evaluation scope and methodology

The main impetus to bring research on root and tuber crops and bananas together in a single program was the aim to capture synergies due to commonality of the crops and their value chains and potential efficiency gains. The team therefore focused on three main areas where there is greatest potential for integration of research across crops for synergies and complementarity. These areas were:

- Pre-breeding and varietal development (breeding pipeline), end-user priorities and uptake/promotion of improved varieties for impact
- Multiplication and distribution of low-cost, high-quality, disease-free planting material
- Post-harvest management, value chains and marketing:

Managing diseases and pests and cropping systems management were included in the evaluation but in less detail.

⁵ http://www.iaa.cgiar.org/sites/default/files/Final%20report%20CRP%20G%26M%201%20April%202014_0.pdf

The evaluation methodology is described in detail in the Inception Report⁶. The evaluation used a combination of qualitative and quantitative methods. The key components are briefly explained below.

Case studies. For in-depth analysis of the evaluation questions and cross-cutting issues, the team selected 18 PLs out of 28 PLs for case studies. These PLs cover the three focus areas and cut across all the RTB Themes (see Table 2-1). The team paid particular attention to the integration of research across all relevant centers, including CIRAD where these partners are working on the same crops. It also looked at RTB partnerships for single center crops and the linkages between RTB and other CRPs.

Review of program documents. The main program documents included key RTB documents (the original and extension proposals, Annual Reports and Plan of Work and Budget); evaluative documents [reviews by the ISPC the Consortium Office (CO) and Fund Council (FC)], documents on bilateral and complementary projects⁷ for the PL case studies (template for project sample analysis is given in Annex G), selected publications, documents on G&M and reference documents related to CGIAR and evaluation.

Field visits. The criteria for selecting countries and sites for field visits included the extent to which research related to more than one crop/cropping system could be observed and the extent to which more than one participating organization has activities in the country. The selection included locations where the synergy opportunities within RTB could be observed and assessed. The countries visited are shown in the team's itinerary (Annex B).

Interviews. The Evaluation Team conducted both on-site and virtual interviews and engaged a representative group of stakeholders across relevant categories, and involving RTB researchers, partners and other stakeholders, international peers and donors. Interviews were conducted on the premise that interviewee responses would be integrated into the report without personal attribution. More than 300 persons were interviewed. List of persons interviewed is in Annex C.

Researcher survey. The survey was targeted at CIP, IITA, CIAT, Bioversity and CIRAD researchers who contribute any of their time to RTB research. The survey was sent to 190 persons and the total response rate was 56 percent. The survey questions covered aspects of relevance, management of science quality and effectiveness, cross-cutting issues (gender, partnerships and capacity strengthening) and value added by RTB. The survey was confidential, conducted on-line through Survey Monkey. The survey summary results are given in Annex C.

Bibliometrics. As part of the quality of science assessment, quantitative and descriptive analysis was conducted on scientific journal publications related to RTB, published between 2012 and 2014. The list of publications was provided by RTB. The parameters included volume, frequency of articles by journals, citation analysis, and assessment of articles with highest citations. These results were interpreted by the team members, for instance in judging the appropriateness of the journals considering the audiences that RTB wants to reach with its knowledge products.

⁶ <http://www.iea.cgiar.org/sites/default/files/RTB%20Inception%20report.pdf>

⁷ Lists of selected projects are given in the Inception Report in Annexes F and G.

Research publications and analysis. For analysis of research output quality (a dimension of the quality of science assessment), the team members conducted a qualitative assessment of a random sample of research articles. A total of 79 articles were assessed covering all disciplinary areas. The parameters included methodological rigor, comprehensiveness of research narrative, innovativeness and novelty, and appropriateness of publication venue. The template used in the sample publications assessment is given in Annex F.

H-index analysis. As one dimension of the assessment of scientific leadership, H-index analysis was conducted, including researchers with team leader or supervisory responsibilities. A total of 106 researchers from the four CGIAR centers were included. In the analysis the team looked at variance, taking into consideration that publications are not the only output from RTB research.

Analysis of impacts. The CGIAR centers participating in RTB were asked to prepare a narrative about outcomes and impacts since the most recent External Programme and Management Reviews (EPMRs) of those centers. The claims in the narrative were to be supported by documented evidence. The team member responsible for impact reviewed the narrative and evidence for credibility, magnitude of reported impacts and coverage of impact studies across research areas.

1.5. Limitations to this evaluation

The evaluation was conducted when several changes were taking place that affected RTB. During the evaluation RTB started transforming its structure from Themes to FPs and the unit of analysis therefore was changing. The changes had implications for data gathering at the portfolio level. The CRP submitted a pre-proposal for the Phase II funding and while the evaluation focused on the program as it initially was designed and evolved during Phase I including the extension period, it needed to be cognizant of new thinking and provide some preliminary guidance also for the new pre-proposal. CRP oversight also went through changes. CGIAR adopted a new SRF and in its guidance for the Phase II set directions for CRP G&M, for example, that the team needed to reflect in its assessment.

With more than half of the funding to RTB coming from bilateral sources, data and information at project level was difficult to obtain. It also made defining of CRP boundaries a challenge. Due to the lack of a comprehensive project portfolio⁸, assessment of all bilateral projects (grants) mapped to RTB was not possible. The Evaluation Team also observed other difficulties in getting comprehensive information across RTB activities, for instance regarding publications outputs that could be considered coming from RTB research rather than pre-RTB work. In the earlier years of RTB, publications were listed by center, but in 2014 only by crop. The team nevertheless considers that it has sufficiently covered the RTB portfolio and outputs in its analysis.

⁸ This refers to database that would contain all the projects (grants) that are mapped to the CRP. This is missing; RTB management doesn't know what grants are within the CRP.

2. RTB Background

2.1. RTB research context

Root and tuber crops and bananas are an essential staple food for the poor in developing countries. With a mean production of 685 million tons on 55 million ha in 2006–2008, the RTB crops represent the second most important set of crops in developing countries after cereals⁹. Production and use of RTB crops tends to be concentrated in countries with lower per-capita incomes. In sub-Saharan Africa (SSA), the region most dependent on RTB crops, they constitute nearly two-thirds of per-capita food production. Around 200 million poor families are involved in their cultivation and many others benefit as consumers. Some 400 million tons of RTB crops are consumed as fresh or processed food; the remainder is used as animal feed, planting material, or industrial raw material.

RTB crops are excellent sources of cheap energy and some varieties are rich in vitamins and essential minerals¹⁰. They are true food security crops and are mostly produced, processed, and traded locally, making them less vulnerable than grains to abrupt price changes in international markets. RTB crops generate income for poor small holders contributing to poverty reduction. RTB generally grow in marginal conditions with relatively few inputs¹¹. Many tolerate stresses such as drought, heat, and poor soil conditions. They play a key role in contributing to the sustainability of cropping and production systems, helping to reduce the risk of food shortages and nutritional shortfalls. RTB crops also play an important role in the livelihoods of women and vulnerable populations¹². Due to the perishability of RTB crops, attention to post-harvest losses and value chain development is a key part of improving productivity and enhancing livelihoods.

The RTB program has identified major research challenges to the development and delivery of outputs, outcomes and impacts. These include closing the yield gap through improved varieties, access to high quality planting material and improved management of nutrients and water; controlling pests and diseases; improved data and analysis of poverty targets; better alignment of research objectives to the needs of farmers and end-users, both women and men; addressing the impacts of climate change; and reducing post-harvest losses and facilitating market development.

2.2. Objectives and structure

RTB, which began in its current form in January 2012, holds its objective to be: “to more fully realize the potential of [mandate crops roots, tubers and bananas] for improving nutrition, income generation, and food security—especially among some of the world’s poorest and most vulnerable populations”¹³.

⁹ CRP Roots, tubers and bananas Proposal 2011.

¹⁰ Kenyon, L. et al. 2006. A synthesis/lesson-learning study of the research carried out on root and tuber crops commissioned through the DFID RNRRS research programs between 1995 and 2005. UK: DFID Crop Protection Programme.

¹¹ Lebot, V. 2009. Tropical Root and Tuber Crops: Cassava, Sweetpotato, Yams and Aroids. UK: CABI.

¹² FAO. 2010. <http://www.worldhunger.org/articles/Learn/world%20hunger%20facts%202002.htm>

¹³ “Roots, Tubers and Bananas.” Final Revised Proposal, 9 September 2011.

RTB is led by CIP with the Program Management Unit (PMU) based in Lima, Peru. It brings together the RTB crop-related work, and wide networks and partners, of CIP, Bioversity, CIAT and IITA, with CIRAD representing the French research partners. Combining expertise and capacity also with other partners and CRPs, RTB aims to capture significant synergies, increase the ability to advance research, share knowledge, and enhance uptake to increase research for development impacts for the foreseeable future.

The CRP’s mandate is thematically organized around its crops. The crops include banana, plantain, cassava, potato, sweetpotato, yams, and other tropical and Andean root and tuber crops—sometimes termed ‘vegetatively propagated staple crops’ (Figure 2-1). These crops have several factors in common, including similar breeding challenges for highly heterozygous crops, seed management with bulky planting materials, post-harvest issues associated with perishability and the frequency with which women are involved in their production and post-harvest use, this last factor being important to women’s participation in the value chains.

RTB is a multi-center initiative that aims to add value by exploiting cross-crop synergy: common workplans; collaborative genetic discovery and conservation; shared platforms for information systems, knowledge management (KM), conferences and training; and joint investment in experiment stations. Additionally, for banana and cassava where two or three CGIAR centers and CIRAD share the mandate for research, RTB provides a platform for joint research within a crop.

Figure 2-1: RTB crops by participating centers

CENTER	PRIMARY CROP EXPERTISE					OTHER ROOTS AND TUBERS	
	BANANA	CASSAVA	POTATO	SWEETPOTATO	YAM	AROIDS	ANDEAN
Bioversity	■						
CIAT	■	■					
CIP			■	■			■
CIRAD	■	■			■	■	■
IITA	■	■			■	■	

Source: See RTB Evaluation Inception Report 2015

Since its inception in 2012, RTB has been organized by seven Themes: (1) *in-* and *ex-situ* plant genetic resource management; (2) crop variety improvement; (3) crop protection; (4) farmer access to quality inputs (planting material); (5) decision tools and models for crop management; (6) post-harvest technologies, value chains and marketing; and (7) cross-cutting partnerships and capacity-building. Each Theme consists of a mix of existing research or Product lines (PLs) (from pre-CRP work), expanded research lines, and completely new research lines (fuelled by the new CRP arrangement). Each Theme contains a cross-cutting section (cross center, cross crop) where joint work is brought together. Theme

leaders appointed by RTB are responsible for the cross-cutting part of the portfolio (Table 2-1). Some PLs in some Themes were modified in 2014.

Table 2-1: Themes and Product Lines

THEME/Product Line
<i>Theme 1. Unlocking the value and use potential of genetic resources</i>
PL 1. Ex-situ and in-situ conservation methodologies optimized
PL 2. Increased coverage of gene pools
PL 3. Novel genotyping and phenotyping technologies applied
PL 4. Linking trait and genetic data
PL 5. Safe and innovative approaches for facilitating exchange of RTB genetic resources
<i>Theme 2. Accelerating the development and selection of varieties with higher, more stable yield and added value</i>
PL 1. Breeding tools, strategies, and approaches
PL 2. Trait capture and gene discovery
PL 3. Population development and pre-breeding
PL 4. Variety development
PL 5. Aligning research with farmers' and end-users' priorities
<i>Theme 3. Managing priority pests and diseases</i>
PL 1. Detection, surveillance, and mapping
PL 2. Ecology, biology, and epidemiology of pests and diseases
PL 3. Ecology and management of beneficial organisms
PL 4. Specific management strategies
<i>Theme 4. Making available low-cost, high-quality planting material for farmers</i>
PL 1. Policies, strategies, and decision support tools to improve effectiveness and pro-poor impact of seed systems
PL 2. Lower cost, more effective mass propagation methods
PL 3. Farmer-based quality seed production and management methods
<i>Theme 5. Developing tools for more productive, ecologically robust cropping systems</i>
PL 1. Ecological and physiological understanding of RTB crops and cropping systems
PL 2. Increasing productivity in RTB cropping systems through nutrient/water/light management practices
PL 3. Integrated decision and management tools for RTB crops
<i>Theme 6. Promoting post-harvest technologies, value chains, and market opportunities</i>
PL 1. Post-harvest approaches to improve food security
PL 2. Improving linkages to markets for environmentally friendly income generation activities
PL 3. Marketing strategies and policies to add value and promote RTB consumption
<i>Theme 7. Enhancing impact through partnerships</i>
PL 1. Information, capacities and partnerships for impact at scale
PL 2. Strategic research and support for gender transformation
PL 3. Assessing impact at scale

Source: CRP Roots, tubers and banana Proposal 2011 (Note: revisions of PLs were made in Themes 1, 4 & 7 in 2014 and 2015)

After carrying out an in-depth PA exercise in 2013/2014—which included stakeholder workshops and surveys, agro-ecological mapping, constraints analysis, and impact modelling—RTB has reorganized its program structure with FPs for discovery, delivery and impact at scale and CoAs. This structure is part of the recently submitted pre-proposal for Phase II to be initiated in 2017 and RTB will transition to this new structure in 2016 (see Table 2-2).

Table 2-2: Overview, coding and short titles of FP and CoAs

Flagship Projects:	DISCOVERY	DELIVERY			
	FP1: <u>Enhanced genetic resources</u>	FP2: <u>Productive varieties & quality seed</u>	FP3: <u>Resilient crops</u>	FP4: <u>Nutritious food & added value</u>	FP5: <u>Integrated livelihood systems</u>
Clusters of Activity:	DI1.1 (Breeding platform) DI1.2 (Next generation breeding) DI1.3 (Game changing traits) DI1.4 (In-situ conservation) DI1.5 (Adding value to genebanks)	CC2.1 (Quality seeds & access to improved varieties) BA2.2 (User preferred banana cultivars/hybrids) CA2.3 (Added value cassava varieties) PO2.4 (Potato quality seed) PO2.5 (Potato varieties for Asia) SW2.6 (User preferred sweetpotato varieties) YA2.7 (Quality seed yam)	CC3.1 (Pest/disease management) CC3.2 (Crop production systems) BA3.3 (Banana fungal diseases/Foc) BA3.4 (Banana viral diseases/BBTV) BA3.5 (Banana bacterial diseases/BXW) CA3.6 (Cassava biological constraints, Asia/Americas) CA3.7 (Cassava biological threats, Africa)	CC4.1 (Post-harvest innovation & nutrition improvement) CA4.2 (Cassava processing) CA4.3 (Biofortified cassava) SW4.4 (Nutritious sweetpotato)	CC5.1 (Sustainable intensification/diversification) CC5.2 (Institutional innovations) PB5.3 (East and Central Africa) PB5.4 (West Africa) PB5.5 (Central Mekong) PB5.6 (Tropical Americas and Caribbean)
	FP 6: Impact at scale CC6.1 (Knowledge, capacities, partnerships) CC6.2 (Strategic gender research) CC6.3 (Foresight, impact assessment)				

Source: CRP Roots, tubers and banana Pre-proposal for Phase II 2015

Note: prefix indicates crop where relevant: DI=discovery, CC=cross cutting, BA=banana, CA=cassava, PO=potato, SW=sweetpotato, YA=yam, PB=place based.

Crop management (agronomy and soil fertility) is only represented by one CoA (CC3.2). This is not in keeping with the statement in the pre-proposal: “A strong focus on conserving and rehabilitating the soil resource base will be essential to ensure total systems sustainability..”. This issue is discussed in more detail in Chapter 5.

The geographical scope of RTB’s portfolio includes research sites on three continents; its largest investment is in SSA. RTB also has a substantial investment in “global” research (e.g. technological innovation of plant breeding tools) as well as investments in Asia and Latin America and the Caribbean.

RTB engages in a large number of partnerships. Examples of CRP collaboration include: Climate Change, Agriculture and Food Security (CCAFS) ¹⁴ “to synergize expertise towards improving risk

¹⁴ Kroschel J. et al. 2012. “Management of critical pests and diseases through enhanced risk assessment and surveillance and understanding climate impacts through enhanced modeling.” CCAFS and RTB Workshop Report. CCAFS and RTB. Copenhagen, Denmark; Lima, Peru.

assessments of pests and diseases under current and changing climates”, Humidtropics on collaboration in joint action sites to expand the outreach of commodity research with NARS and other stakeholders as well as Results-Based Management (RBM) experimentation, A4NH on development and delivery of nutrient rich (Vitamin A) crop varieties and PIM (Policies, Institutions and Markets CRP) on foresight modeling. In 2013 RTB projects at the four centers subcontracted to 155 different partners a total of USD12 million.

2.3. Funding

In the original proposal, it was anticipated that about three-fourths of the USD183 million required for the first three years of operation would be financed through W1/W2. While the W1/W2 funding was much lower than anticipated (60 percent of expected), RTB was successful in surpassing its total funding target (actual funding reached close to USD200 million) because the partner centers were able to generate higher than anticipated funding from bilateral and W3 donors.

Actually, RTB was one of the few CRPs that received high W2 funding from the CGIAR Fund, reflecting the attractiveness of the RTB concept to the fund donors. As a consequence, due to the way W1 and W2 are linked, RTB has been allocated less W1 funding than CRPs that were not as successful in raising W2 funds. This is a policy decision made by the Consortium in order to protect the integrity of the entire CRP portfolio.

Since the beginning of the program 70 percent of RTB’s funding has come from only three sources: the CGIAR Fund, the Bill and Melinda Gates Foundation (BMGF) and USAID (Table 2-3; calculated from spreadsheet data provided by RTB and CIP). Although their contributions are smaller, Irish Aid, Nigeria and Belgium have been consistent supporters of RTB. Also, having raised their contributions in 2014, the International Fund for Agricultural Development (IFAD) and African Development Bank have become the 4th and 5th largest donors of the program.

Table 2-3: RTB funding (USD M) by the CGIAR Fund and donors (2012-2014)

	2012	2013	2014	Total (2012-14)	Share of Total, %
CGIAR Fund	22.3	29.4	31.1	82.8	41.6
BMGF	8.5	13.5	15.3	37.2	18.7
USAID	6.5	5.9	6.0	18.4	9.2
Irish Aid	1.0	2.2	2.4	5.6	2.8
IFAD	1.1	1.7	2.6	5.4	2.6
AfDB	1.3	0.9	2.6	4.8	2.4
Nigeria	1.0	2.1	1.4	4.5	2.2
Belgium	1.9	1.4	0.5	3.7	1.8
Other donors	11.0	12.1	13.1	36.2	18.2
Total	54.6	69.0	75.1	198.7	100.0

Overall, RTB funding has increased by 38 percent from 2012 to 2014 (from USD55 to 75 million), with similar rates of increase in W1/W2 and bilateral/W3.

Place of RTB funding in center expenditures. When one considers the relative share of RTB expenditures within each center's total expenditure, during 2012-14 CIP had the largest dependency rate on RTB, as close to 70 percent of its projects were mapped to RTB (Table 2-4; calculated from spreadsheet data provided by RTB and CIP). This is not surprising as potato and sweetpotato are exclusively mandated to CIP. When compared with the relative shares of center expenditures mapped to other CRPs, RTB ranks the highest in the cases of CIP, IITA and Bioversity, and 4th in the case of CIAT. This means that RTB occupies very high standing among all CRPs in three of the four partner CGIAR centers. The importance of RTB for IITA is likely to increase further as IITA plans to map a larger number of its projects into RTB in Phase II, especially from the terminating CRP Humidtropics.

The Evaluation Team conducted interviews with six key donors to ascertain their views on RTB. These included USAID, the Department for International Development (DFID), BMGF, GIZ, IFAD and the Australian Center for International Agricultural Research (ACIAR). The donor representatives varied widely in terms of their familiarity with RTB. Those closely or somewhat familiar had favourable opinions of the program and its leader. However some knew very little about RTB. In spite of RTB receiving high W2 funding from the CGIAR Fund, RTB still needs to make more effort in enhancing its visibility among the wider donor community.

Table 2-4: RTB as share of total center funding (USD M) (2012-2014)

	2012	2013	2014	Total (2012-2014)	RTB Ranking among CRPs
Bioversity	27.7	23.9	19.0	23.2	1
CIAT	7.1	7.9	8.3	7.8	4
CIP	60.9	71.1	69.6	67.4	1
IITA	23.4	23.0	25.5	24.1	1

The largest bilateral donor to RTB has developed its own RTB strategy covering all RTB's major crops with the exception of potato. Although the research strategies of RTB and the BMGF are closely aligned, RTB should seek to maintain sufficient independence from BMGF and other bilateral donors to continue to implement high priority projects that are part of its own research strategy.

3. Relevance

This section reviews the strategic relevance of RTB, the coherence of its research strategies, the consistency of program design with the reform principles of CGIAR, the targeting and impact pathways and the rationale for the six FPs. It also evaluates the use of W1/W2 in key areas of the program, PA and priority setting and the comparative advantage of RTB.

3.1. Coherence and program design

3.1.1. *Strategic relevance*

Widespread stakeholder consultations during the design of RTB Phase I and comprehensive expert consultation with more than 1680 stakeholders during the PA exercise showed strong support for a systems-based program on RTB crops¹³. Furthermore, nearly 90 percent of respondents in the researcher survey agreed that the RTB strategy had influence. The creation of RTB by bringing together all CGIAR research on root and tuber crops as well as bananas has therefore enhanced the strategic relevance of research on these important crops compared to the previous separate research in individual centers.

RTB's focus on food security and nutrition for the poor is of high strategic relevance. The energy output per ha/day of RTB crops is considerably higher than that of grains, providing one of the cheapest sources of dietary energy. In 2011, RTB crops provided around 15 percent of the daily per capita calorie intake for the 763 million people living in least developed countries¹⁵. RTB also gives priority to nutrition with the development of OFSP, vitamin A cassava and banana and Fe and Zn fortified potato in collaboration with A4NH.

RTB addresses its strategic relevance through breeding for higher nutritional and processing quality, user-preferred traits, and adaptation to stressful environments; improved access to quality planting material; better crop management practices; integrated gender research; and improved institutional arrangements to make use of the full potential of RTB crops to exit poverty. As human populations extend their environmental impacts, the different RTB systems will need to be evaluated for their potential to intensify production and increase productivity in an environmentally sustainable manner. Approaches are being devised that enable rural women and men smallholders to meet their food and income needs while at the same time safeguarding the long-term productivity of farming and natural environments in the face of climate change. These arguments are both compelling and relevant to CGIAR investment in RTB crops.

3.1.2. *Programmatic integration*

Integration of core competencies is one of the three main CGIAR reform principles and the Evaluation Team has considered it as an aspect of program relevance. For RTB, programmatic integration especially for crops common to more than one center will improve program coherence, better target impact and strategically improve the use of W1/W2 funds. Although RTB brought together the research programs of CIP, CIAT, IITA and Bioversity on five RTB crops: banana/plantain, cassava,

¹⁵ CRP Roots, tubers and banana Pre-proposal Phase II 2015.

potato, sweetpotato and yam, the initial level of programmatic integration was limited. A major initiative of complementary projects funded through the W1/W2 budget (see Section 3. 1. 4) has been instrumental in facilitating programmatic integration, adding value and capturing synergies and complementarities across centers and across crops. Some examples of programmatic integration both through complementary and other projects include:

- Germplasm sharing for cassava (NextGen project)
- Cassava breeding across centers (some projects)
- Metabolomics research across crops and centers
- Potato mini-tuber multiplication transferred to yam mini-tuber multiplication
- Seed systems framework development across centers and crops
- Degeneration modelling across centers and crops
- Surveillance and pest risk assessment across centers and crops
- Livestock feed research across centers
- PA exercise across all crops and centers
- Integrated methods for identifying cassava varieties and adoption studies across centers
- Food process modelling in cassava and potential for south-south transfers
- Multidisciplinary nutrition research on OFSP
- Gender integration research and
- Bioinformatic alliance to boost yields in roots, tubers and bananas¹⁶.

Although this accounts for only USD9.4 million (30 percent) of the W1/W2 funding (2014), it demonstrates that exciting integrative activities are possible providing funding is available. Nearly 60 percent of respondents in the researcher survey agreed that RTB purposefully uses W1/W2 funds to increase integration across discipline, crop and center. The ENDURE project funded through W3 in Uganda is the only other project to date to similarly address programmatic integration while RTB crop protection scientists in Kenya are working together outside of project bounds.

However, there are still areas where improved programmatic integration would add more value to RTB. Particularly, there is room for further programmatic integration on common crops in RTB, namely IITA and CIAT for cassava and IITA and Bioversity for banana/plantain. Currently, the collaboration between IITA and CIAT cassava breeders is limited to a small number of complementary and bilateral projects. Outside of these, they follow different philosophies and approaches (see section 5.3.2 for more detail) which appears to compromise overall RTB effectiveness for cassava breeding. Interviews with both IITA and CIAT cassava breeders indicated willingness to work more closely together. Achievement of programmatic integration of cassava breeding should pave the way for future integration of all cassava research in RTB. Furthermore, progress on targeted breeding of East African Highland Bananas (EAHB) by the National Agricultural Research Organization (NARO) is compromised by the existence of two overlapping breeding programs: the original program with IITA developing “NARITA” hybrids and a more recent program with Bioversity to develop “NABIOs”. Concerns have been raised by the IITA banana breeder while the leader of the NARO banana program has called for the merger of the two programs. In the interest of fostering programmatic integration in RTB and

¹⁶ <http://bti.cornell.edu/news/new-bioinformatics-alliance-between-cgiar-and-bti/>

partnerships with NARO, the two programs should be merged into one breeding effort where the roles and responsibilities of the key partners are well-defined and agreed and overlap is eliminated. It should also be reinforced by RTB that IITA has the responsibility for leading the banana breeding effort in this CRP. The above suggested programmatic integration would likely result in rationalization of staff positions and allow better targeting of scarce W1/W2 funds. The Evaluation Team noted that in WHEAT, the International Maize and Wheat Improvement Center (CIMMYT) and the International Center for Agricultural Research in Dry Areas (ICARDA) have successfully integrated their programs in WHEAT as have CIMMYT and IITA in MAIZE.

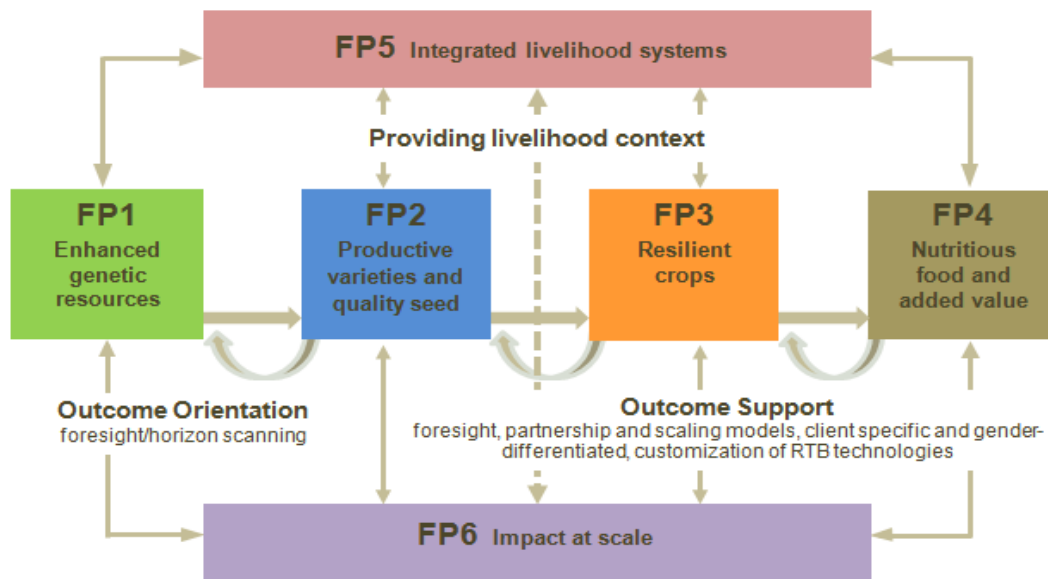
RTB has made notable progress towards achieving programmatic integration and has delivered added value across centers and crops in several areas, with collaborations and new science that did not exist prior to 2012. Much of this has been through complementary projects. The Evaluation Team considers that these projects are an important mechanism for enhancing RTB's programmatic integration and targeting and thereby relevance, and priority should be given to these projects for future allocation of W1/W2 funds. Despite this effort, a program-wide philosophy and commitment to programmatic integration is not yet fully realized and it should be promoted over and above the relatively small funding modality.

Recommendation 1: RTB needs to make further efforts to enhance integration beyond individual time-bound projects. In particular, further value would be gained by fully integrating the IITA and CIAT cassava breeding programs. There is also clear potential for integration and consolidation of all RTB research on banana and plantain by IITA and Bioversity. This would likely result in rationalization of staff positions, allow better targeting of scarce W1/W2 funds and improve the ability to approach donors as an integrated program.

3.1.3. Targeting and impact pathways

In 2012, the RTB research program was structured on seven disciplinary Themes and 29 PLs (Table 2-1 in Chapter 2). It offered a basis for planning and monitoring of research products, but did not provide a coherent basis for tracking research and development outcomes. Achieving outcomes required several Themes to come together, building on the entire stock of available technology. This disciplinary-based structure was therefore considered not conducive to developing a realistic impact pathway for the delivery of RTB's objectives. RTB was reorganized during 2014 - 2015 into FPs and CoAs (see Chapter 2). The FP structure was further developed in the pre-proposal for Phase II mainly through the refinement and regrouping of CoAs and the incorporation of a further Delivery FP on Integrated Livelihood Systems largely from the soon to be terminated Humidtropics CRP.

Figure 3-1: Proposed RTB program structure



This new inter-disciplinary FP/CoA structure with its focus on CoA-level outputs and FP- and CoA-level ToCs and impact pathways (the FPs and the linkages are shown in Figure 3-1), with the contributions of FPs to sub-IDOs and IDOs are shown in Table 3-1. The CRP level impact pathway is based on a balanced portfolio with a multidisciplinary, integrated research agenda. It describes how outputs from each FP contribute to outcomes and contribute to other FPs. The Evaluation Team considers that the set of interlinked and interactive FPs has better potential than the previous structure to facilitate RTB to contribute to CGIAR goals (SLOs) through sub-IDOs, thus addressing one of the core principles of CGIAR reform. Each FP has a ToC and impact pathway linked to sub-IDOs and IDOs. Of note, complementary funded projects will be an integral part of the CoAs and all CoAs in the future will be managed more along the lines of current complementary projects.

Table 3-1 FP contributions to sub-IDs and IDs

IDs	Sub-IDs	FP contribution					
		1	2	3	4	5	6
Increased incomes and employment	Diversified enterprise opportunities		X		X	X	
	More efficient use of inputs				X		
Increased productivity	Reduced pre- and post-production losses, including those caused by climate change			X	X		
	Closed yield gaps through improved agronomic and animal husbandry practices		X	X		X	
	Enhanced genetic gain	X	X				
	Increased conservation and use of genetic resources	X	X				
Improved diets for poor and vulnerable people	Increased availability of diverse nutrient-rich foods		X				
	Optimized consumption of diverse nutrient-rich foods				X	X	
Enhanced benefits from ecosystem goods and services	Agricultural systems diversified and intensified in ways that protect soils and water					X	
	Enrichment of plant and animal biodiversity for multiple goods and services	X					
More sustainably managed agro-ecosystem	Increased resilience of agro-ecosystems and communities, especially those including smallholders			X			
Mitigation and adaptation achieved	Enhanced capacity to deal with climatic risks and extremes	X	X	X		X	
Equity and inclusion achieved	Gender-equitable control of productive assets and resources		X	X	X	X	X
	Improved capacity of women and young people to participate in decision-making					X	X
Enabling environment improved	Increased capacity of beneficiaries to adopt research outputs						X
	Conducive agricultural policy environment		X	X	X		
National partners and beneficiaries enabled	Enhanced institutional capacity of partner research organizations	X					X
	Enhanced individual capacity in partner research organizations through training and exchange	X	X				X
	Increased capacity for innovation in partner development organizations and in poor and vulnerable communities			X	X	X	X

Although the Evaluation Team considers that the change from disciplinary Themes to inter-disciplinary FPs has improved the structure of RTB and provided a platform with greater potential to contribute to outputs, outcomes and have impact, the definition of the CoAs in some cases lacks consistency and coherence with the PA exercise and FP problem definition (see Section 3.1.5 on Priority assessment). For example: in FP3, the complex of biotic and abiotic problems affecting banana in East Africa e.g. bacterial wilt, nematodes, weevils and poor soils is divided into three different CoAs apparently based on current bilateral projects on these topics and perhaps previous center projects. However this will compromise the research on this complex in East Africa. In addition, the Team agrees with a view presented by the yam scientists in IITA that adding value to yam through processing should be recognized as a CoA in the FP4 instead of being merged with activities on varieties and seed¹⁷. Similarly, a wide variety of activities are placed together under four CoAs in FP4 which compromises the complementary nature of the components.

Recommendation 2: The restructuring of the program into inter-disciplinary and integrated FPs adds coherence to RTB compared to the Theme-based structure. However in some cases the definition of clusters of activities lacks coherence and consistency with the FP problem definition e.g. the banana disease clusters, single yam cluster and complex clusters in FP4. RTB should review and revise the clusters for improved congruence with the FP problem definition.

3.1.4. Use of W1/W2 funding

For RTB, W1/W2 funding provides an opportunity to strengthen the strategically most relevant activities and functions of the program. Initially, W1/W2 funding was critical for maintaining the stability of the centers and the Consortium encouraged Lead Centers to allocate these funds to the participating centers on basis of their 2010 unrestricted funding levels. There were no restrictions on how the centers could use these funds. Cuts to RTB W1/W2 funding (in 2014 and 2015) were applied more to base funding than complementary funding for the participating centers.

About 40 percent of the total RTB funding in 2012-14 came from W1/W2 funds (see Chapter 2, Table 2-3). Due to the formula funding, RTB W1/W2 funds constitute about 70 percent of CIAT's and Bioversity's total RTB portfolio, implying that these two centers finance their RTB research mainly through W1/W2. CIP and IITA have significantly larger W3/bilateral funding of research mapped to RTB and receive relatively much less W1/W2 funding (33 and 30 percent, respectively). As IITA implements research on three RTB crops (cassava, banana/plantain and yam), in interviews IITA management has questioned its relatively small percentage of W1/W2 funding compared to other partner centers which work on only one crop. CIRAD received only USD 533,000 of W1/W2 funds in 2014.

¹⁷ See ITC Ghana Yam strategy for Rural Development and other similar studies in Nigeria, Benin and Cote d'Ivoire; the expanding yam processing sector in West Africa includes national and international companies producing starch, noodles, ice cream, beer, wine, gin, cosmetics etc.

Table 3-2: Use of Window 1&2 funds (USD M 2012-2014)

	2012	2013	2014	Total	%
Base Funding (centers)	20.2	22.0	19.2	61.4	74.2
Complementary Funding	0.6	4.7	9.4	14.8	17.9
PMU/Management	1.1	1.3	1.6	3.9	4.7
Costs					
Priority Assessment & other costs	0.4	1.4	0.9	2.7	3.2
Total	22.3	29.4	31.1	82.8	100.0

In 2012, RTB began to set aside part of W1/W2 funds to finance complementary projects on a competitive basis according to comprehensive program guidelines (Table 3-2; calculated from spreadsheet data provided by RTB and CIP). A small amount of funding was also made available for cross-cutting activities. The allocation to complementary projects increased to about 30 percent of W1/W2 in 2014. The Team observes that only a small part of W1/W2 funding has been purposefully used to enhance RTB's relevance although this has been increasing. In the researcher survey, the largest number of respondents (nearly 60 percent) agreed (response options 4, 5 and 6) that W1/W2 funds were used to "fill gaps in research funding". There was also reasonably high level of agreement among respondents that W1/W2 funds were used for enhancing RTB relevance.

The Evaluation Team understands the initial rationale behind allocations to centers based on historical funding levels but this should not be viewed as a permanent arrangement. First, continuing the practice essentially means business as usual (i.e. instead of CGIAR unrestricted funds centers receive CRP-allocated unrestricted funds). Second, allocating W1/W2 funding in the present manner implies that centers are in a better position to decide what is of highest priority for their own program than the RTB management. Currently, decisions on a considerable amount of the funds allocated or mapped to RTB are made by individual centers, based on agreed program priorities. RTB provides oversight on delivery and reporting.

RTB management has indicated that, following transition through a hybrid system in 2016, the allocation of funds to CoAs will follow the complementary funding system. Hence CoA priorities will guide all allocations of W1/W2 funds from 2017 onwards. The Team commends this move as it will provide RTB's governing bodies greater opportunity to influence the program's future directions. Feedback from donors interviewed suggests that lack of strategic use of W1/W2 funding could be a disincentive for donors to use these windows. The new hybrid system and the process to be used in allocating all W1/W2 funds as complementary funds should be incorporated in the *alliance compact* as recommended in Chapter 8.

In the Team's view, competitive use of W1/W2 funds through complementary projects has enhanced the relevance of RTB research and strengthened the alliance and its partnerships with stakeholders contributing to these projects (see Chapter 8).

Recommendation 3: During 2012-2015, RTB allocated W1/W2 funds to partner centers largely based on historical funding. RTB has now recognized the need to move towards more strategic allocation of these funds based on program priorities and performance. In the current environment of decreasing W1/W2 funds, RTB should ensure that W1/W2 funds are directed at the highest program priorities as informed by PA and performance evaluation.

3.1.5. Priority assessment and priority setting

The Fund Council and ISPC requested a quantitative priority setting exercise for RTB as a condition of implementation. The purpose was to assess economic, poverty, food security, gender, health and environmental impacts of investments in alternative potential research areas of the RTB program. With five crops, four centers, and different research approaches combined in RTB there was a need for a coordinated approach to *ex-ante* assessment and identification of high payoff research areas.

RTB has carried out a set of PA studies across five crops using a common methodology. Each study consisted of two parts. First, an expert survey was used to determine and rank the most important constraints to improved productivity that research might address. Second, economic surplus and internal rate of return to investment (IRR) was estimated for a set of research options to address important constraints, with both high and low adoption scenarios, as well as estimated poverty impacts. The PA studies have been through peer review and will be published.

This exercise was based on earlier work in CIP, and there were challenges with applying the framework to different crops. An important outcome of this effort was CapDev across the centers in carrying out this type of work. This activity was funded solely through W1/W2 funds for complementary projects (with co-funding from PIM and CCAFS CRPs). The Team assessed the results of the PA and subsequently considered how these could contribute to setting priorities for RTB.

An examination of the results highlights the high returns to research investment as well as the strong potential for poverty reduction. Investment in research and dissemination for all of the technologies considered has the potential to generate substantial economic surplus *and* poverty reduction¹⁸. For the low adoption scenario, which is arguably a lower bound estimate of returns, the IRR was greater than 20 percent for all technologies considered, and thus much greater than the social opportunity cost of capital, which the RTB studies assumed to be 10 percent. Thus, all of the research options considered would generate returns well above the social cost of capital. For the low adoption scenarios, the net present values of benefits from research are all positive, but vary widely from over USD8 billion to less than USD100,000. The number of people who would be lifted out of poverty by particular technologies would be as high as 2.7 million or as low as 21,000. With increasingly scarce resources available for research, these differences in potential impact should inform program planning.

The results from this extensive research were not available when the CoAs for the new program structure were originally defined although they have guided some of the subsequent revision of CoAs.

¹⁸ The IRR, NPV, and poverty reduction rankings may differ among technologies, but tended to be highly correlated in the RTB priority assessment results. Each of these estimates provides somewhat different information to inform program planning.

Of note, some of the technologies with the highest net present value benefits or greatest potential for poverty reduction are not reflected in the CoAs in the recent RTB pre-proposal for Phase II. This raises the question of whether increasingly scarce resources are being allocated to the areas with highest return and potential impact. According to RTB, the results have been used in some cases to demonstrate impact to donors, and sample high returns are referenced in the pre-proposal for 2017-22¹⁹. The results have been used to identify contributions to IDO's, for example by drawing on the PA studies to project adoption and poverty impacts.

The definition of the FPs/CoAs prior to the final results of the PA exercise being available represents a missed opportunity to maximize the relevance of the PA exercise for the new structure. Furthermore, on-going use of the PA results in program planning would require better tracking of the costs of research. Although one-time cost estimates for different research areas were made for the PA analysis, the centers do not keep track of expenditures and resources allocated to technologies as defined in the PA. These limitations reflect a lack of planning for the utilization and integration of the PA results into program management.

The ISPC requested this PA due to a concern about allocating program resources across five crops within one CRP. RTB has reported results as crop-specific, without an explicit attempt at comparison. In RTB's view, making conclusions across crops would require better data and consideration of the substitutions among these crops in production and consumption. Such improvements are an explicit goal of the PIM/IFPRI Global Futures project, which includes collaboration with RTB centers to incorporate these crops. Thus, collaborations under the Global Futures project could provide better information for future RTB PAs. It will be important to take advantage of these improvements as they become available.

The Team also assessed the PA's potential and use to inform future research and program planning. Based on past use of such analysis at CIP, the RTB view is that PA is not an explicit allocation tool, but rather a guide to future impact assessment. The Team would like to see the PA results used to inform proposed impact assessments *and* research planning. RTB is now undertaking a "congruence" study to see how well the FPs and CoAs match or not with the high priority areas identified through the PA. The purpose is to reveal if there are important gaps in the RTB program, and whether resource allocation is reasonably in line with expected research returns. The Team considers this an important first step towards use of the results in program planning.

PA analysis can demonstrate the expected scale and scope of benefits from research investments. Through identifying areas of high return, PA analysis can inform a strategy for bilateral fundraising, as well as the use of W1/W2 funds for complementary projects. RTB accomplished a unified set of PA studies with a common methodology across crops and centers in a relatively short time frame, which represents a significant achievement. The results show the considerable benefits from research investments in the five major RTB crops. However, RTB is yet to use the important new information to inform program management and planning. For this, the initial results will require further refinement to be fully usable.

¹⁹ Page 7, Table 3.

Recommendation 4: RTB should use priority assessment results for setting program priorities and in program planning, including fundraising. In doing so, RTB should also plan for continuous improvements in the data and estimates that support priority assessment.

3.1.6. Comparative advantage

RTB brought together four CGIAR centers (CIP, CIAT, IITA and Bioversity) and CIRAD to exploit several comparative advantages that also the Evaluation Team considers central to RTB: (1) scientific capacity in human resources and research infrastructure including many years of experience with five major RTB crops; (2) strategic locations in production environments for next users; (3) individual centers' capacity to act as conveners and facilitators across national boundaries, and as an "honest broker" to assemble a broad range of public, private, and development organizations together; and (4) stewardship and access to extensive well-characterized global germplasm collections of major RTB crops.

During 2012 to 2015, RTB has built on these comparative advantages by establishing a common umbrella to expand partnerships and capacity for cross-cutting synergistic work relating to (1) their status as crops of the poor and the implications for poverty reduction and nutrition; (2) predominant roles of women in value chains; (3) vegetative propagation as related broadly to seed systems and to breeding systems; and (4) commonalities in technical constraints in post-harvest management, including transportation, storage, and processing across RTB crops. The bottlenecks arising from perishability mean that processing efficiency, both technical and economic, is key to realizing the benefits of improved productivity and greater supply. Further effort is needed in identifying the specific product characteristics needed to meet consumer and processing demand for realizing improved value and higher farm incomes.

The Evaluation Team considers that, combined, RTB comprises a wide range of unparalleled multidisciplinary expertise that is available to partners working toward common goals. RTB therefore plays a pivotal role in integrative research generating IPGs, which would otherwise not be delivered by NARS, NGOs, universities, or private sector due to reasons of focus and capacity, relevance to other suppliers' agenda or attractiveness as investment targets. RTB has further enhanced its comparative advantage by developing partnerships with noted ARIs with additional skills. These include Cornell University for genomics; Royal Holloway for metabolomics; Food and Environment Research Agency for pest risk assessment methodologies; and Universities of Kansas and Florida for modelling skills to name just a few. These partnerships add further to RTB's comparative advantage in terms of scientific contribution and enhance the probability of impact.

However RTB needs to carefully consider alternative suppliers in future assessment of its comparative advantage, particularly in addressing national needs. For example, RTB is working with several strong NARS such as the NARO banana, cassava and sweet potato programs in Uganda, the National Root Crops Research Institute cassava program in Nigeria and the ARI-Ikiriguru sweet potato program in Tanzania, to name just a few, who are capable of implementing bilateral projects on their own. There are also good examples where RTB has built the capacity of private tissue culture companies and processors who can now work independently. The roles and responsibilities of each member of such

partnerships will change over time and RTB should remain vigilant of changes in the capability of its partners and make necessary role adjustments.

3.2. Conclusions

The Evaluation Team's analysis concludes that RTB's research is strategically relevant to addressing CGIAR grand challenges. Lessons learnt from implementing the old program structure have been instrumental in informing the design of the new structure based on inter-disciplinary and integrated FPs and CoAs. Although the new structure will potentially improve coherence and should be more effective in the delivery of RTB's outputs and outcomes, in some cases the definition of CoAs lacks coherence and consistency with the FP problem definition. RTB needs to further review and revise the CoAs for improved congruence with the FP problem definition and the PA during the development of the full proposal for Phase II.

The CRPs were built on three core principles: impact on the CGIAR's SLOs, integration across CGIAR core competencies, and appropriate partnerships at the different stages of research for development (the last is addressed in Chapter 6). The Evaluation Team concludes that RTB's new program structure should better facilitate RTB to reach CGIAR goals (SLOs), measured through sub-IDs, thus addressing one of the core principles of CGIAR reform. Furthermore, the complementary projects have been instrumental in facilitating programmatic integration across CGIAR core skills, adding value and capturing synergies and complementarities across centers and across crops. However a program-wide philosophy and commitment to programmatic integration is not yet fully realized. RTB needs to make further efforts to enhance integration beyond individual time-bound projects. In particular, further value would be gained by fully integrating the IITA and CIAT cassava breeding programs. There is also clear potential for integration and consolidation of all RTB research on banana and plantain by IITA and Bioversity.

The strategic use of W1/W2 funds through complementary projects has enhanced the relevance of RTB research and strengthened partnerships for more effective generation of priority research outputs. Needed skills have been contributed by ARIs. The Evaluation Team encourages RTB to move rapidly towards greater strategic allocation of these funds based on program priorities. In the current environment of decreasing W1/W2 funds, RTB should ensure that W1/W2 funds are directed at the highest program priorities as informed by PA, stakeholder demands, national priorities and comparative advantage.

PA can be useful for demonstrating the expected scale and scope of benefits from research investments. While any exercise will have limitations, the results can also be used to see which activities clearly have much higher returns, and thus would justify greater investment. A strategic vision for RTB's contributions towards the SRF requires a foundation in such *ex-ante* analysis of potential benefits. RTB should use PA for setting program priorities and in program planning, including fundraising. In doing so, RTB should also plan for continuous improvements in the data and estimates that support PA.

It is clear that RTB has a strong global comparative advantage as a main supplier of RTB research outputs relevant and useful for small holders in SSA, Asia and Latin America. This comparative

advantage has been strengthened by selected partnerships with ARIs with complementary skills and strong partnerships with NARS whose research has been developed by RTB centers. However RTB needs to carefully consider alternative research suppliers in future assessment of its comparative advantage. The roles and responsibilities of each member of such partnerships will change over time and RTB should continue to focus on the generation of IPGs and hand-over areas of research to capable partners.

4. Quality of science

4.1. Introduction

Chapter 4 reports the Evaluation Team's assessment of quality of science based on the RTB scientific staff, publications, processes, outputs and infrastructure. The methods used are described in Chapter 1. Results of the bibliometric analyses and document analysis related to prior studies on publication quality²⁰ as well as an assessment of randomly sampled publications are included. The Team's qualitative assessment of research processes and products, particularly other than scientific publications, focused on the three main areas of research of this evaluation (see Chapter 1), namely: the breeding pipeline, quality planting material and post-harvest management, value chains and marketing.

4.2. CRP-wise assessment of staff and publications output

4.2.1. Research staff in RTB

The Team assessed the quality of the human resource input to RTB research through its engagement with research leaders and teams and researcher feed-back, analysis of H-index of researchers with leadership role, and consideration of contribution of partners to RTB's scientific competence. On basis of the researcher survey (59 percent response rate) the Team concludes that RTB benefits from an experienced research staff cadre, with half of the respondents having worked in their respective centers for more than ten years. Furthermore, the Evaluation Team observed through interviews and field visits that the program also benefits from strong and committed leadership.

CIRAD has enhanced RTB's scientific capability for addressing issues in consumer preferences and processing efficiency bringing new dimensions to the post-harvest research. Novel science is applied to modelling processing efficiency and to evaluating environmental impacts of processing. Several gaps were noted among the current staff complement: currently there are no experienced RTB breeders for plantain in West Africa and potato in East Africa while the program has no in-house expertise on seed systems, relying on specialist inputs from ARIs and short-term consultancies. Some gaps in the current staff complement were also reflected in the researcher survey responses (Figure 4-1).

The H-index results for RTB (based on analysis of 105 research leaders) by participating centers are presented in Table 4-1. The overall average of 7.6 and median of 5 can be considered low for any area of research. However it is important to note spread and variability. For example, IITA and CIRAD had 47.4 percent and 41.6 percent of research leaders, respectively, in the medium-high and high categories, while CIP had 23.1 percent and CIAT and Bioversity only 12.5 percent and 5 percent, respectively, in these categories. CIRAD and CIP had a reasonable proportion of their research leaders in the high H-index (>20) category. The high percentage of indices in the low (0-5) category especially for Bioversity and CIAT represents a low level of scientific impact and visibility, which is a serious

²⁰ Elsevier (2014) CGIAR Research Output and Collaboration Study 2014. Consortium Board, Montpellier.

concern. As can be expected, the highest values (>18) were for senior, long-standing staff with representation from all centers.

Table 4-1: H-index average and frequency for RTB PL leaders, by center (%)

Center	N	0-5 (low)	6-10 (medium-low)	11-20 (medium- high)	21+ (high)
Bioversity	20	65.0	30.0	0.0	5.0
CIAT	16	75.0	12.5	12.5	0.0
CIP	26	53.8	23.1	15.4	7.7
CIRAD	24	37.5	20.8	33.3	8.3
IITA	19	42.1	10.5	42.1	5.3
Total	105				

4.2.2. Publication quality

The recent Elsevier study assessed the research output by CGIAR centers during 2003-2012. Although this period is largely prior to CRPs, the results provide information on center track-record. In this period, IITA was third (1050 publications) in the number of publications in agricultural and biological sciences but at 0.8 a little below the world average for the Field-weighted Citation Impact of 1. For environmental sciences, CIAT and IITA were average while for social science, CIAT was highest and Bioversity fourth highest although with only a small number of publications.

During 2012-2014, RTB published 402 journal articles in 219 venues²¹. The program also listed among its written outputs 72 book chapters, 70 books, 196 conference proceeding papers, 147 abstracts, 5 PhD theses, and 33 technical reports—for a total of 925 recorded publications. The science quality bibliometric assessment is on journal articles only. Table 4-2 lists the 22 journals in which the program published more than three articles between 2012 and 2014, along with the 2013-14 Thomson JCR Impact Factor (IF) of each journal (N/A means no IF).

Of these, 30 percent of papers were published in seven non-IF journals. Overall, 39 percent of all publications were published in non-IF journals compared to, for example, 13 percent reported in the evaluation of CRP WHEAT²². Among centers, Bioversity had the highest percentage of publications in non-IF journals with 57.7 percent followed by IITA – 41.2 percent, CIP – 34.7 percent and CIAT – 25.9 percent (data for 2012-13). Such journals have inferior peer review processes, lack visibility and should be avoided. There may be good reasons why it may be preferable to publish research relevant for

²¹ This is according to a list submitted to IEA by the PMU and edited to remove duplicate observations. The list was organized by each center from 2012-13 but by crop for 2014.

²² CGIAR-IEA (2015). Evaluation of CGIAR Research Program on WHEAT. Rome, Italy: Independent Evaluation Arrangement (IEA) of CGIAR iea.cgiar.org

Africa in African journals. However, overall too many papers have been targeted at 0 or very low IF journals.

The publications in the highest IF journals show notable collaboration and leadership by RTB partners. They are also more recent (mostly from 2014) and include Nature (1); Nature Biotechnology (1); Nature Communications (1); Trends in Biotechnology (1); and PNAS (4). Among the 12 most cited articles (ranging from 23 to 55 citations and one with 229), in none of the articles the lead author came from an RTB CGIAR center (IFPRI led in 4 and CIRAD one). It is difficult to judge the contribution of center scientists when they are in the middle of a long list of authors.

Table 4-2: Most frequent venues (and IF) for RTB publications, 2012-14

Journal	RTB articles	IF
Acta Horticulturae	23	N/A
African Journal of Biotechnology	13	0.573
Plant Pathology	10	2.969
Crop Science	9	1.478
American Journal of Potato Research	8	0.951
Plant Disease	8	2.742
Nematology	7	1.247
Virus Research	7	2.827
African Journal of Root and Tuber Crops	6	N/A
Euphytica	6	1.385
African Crop Science Journal	5	N/A
African Journal of Agricultural Research	5	N/A
Experimental and Applied Acarology	5	1.622
PLoS ONE	5	3.534
Archives of Virology	4	2.282
Crop Protection	4	1.539
Field Crops Research	4	2.608
Journal of Development and Agricultural Economics	4	N/A
Potato Journal	4	N/A
PNAS	4	9.809
R4D Review	4	N/A
Scientia Horticulturae	4	1.504

The Team members peer-reviewed 20 percent of the journal articles published in 2012-14 for different quality attributes and relevance to RTB. Most of the publications (about 80 percent) were judged to

be of good, even excellent, in terms of methodological rigor, relevant to RTB and demonstrating good level of collaboration. A weakness, particularly in publications related to breeding was insufficient reference to literature. Originality was assessed as good in publications on food and nutrition, gender, social sciences and processing, although the methods in social science were mostly conventional. Several publications in processing demonstrated novel science and strong collaboration with national research institutes, as well as important new expertise brought to the post-harvest area through CIRAD collaboration. In breeding related research, most papers demonstrated more routine approaches while those assessed as high quality involved collaboration with ARIs.

Almost none of the so-called social science articles were published in social science journals. That may be justified occasionally for reaching a wider multidisciplinary development audience, but taken as a whole it brings into question the quality of social science research. Most of the social science articles were very micro studies regarding adoption constraints, knowledge, and attitudes of farmers. Such studies are useful, but a strategy to aggregate the lessons might better inform technology development. In social science, relevance to RTB was judged to be an area of strength, with articles addressing issues important to these crops and to the technology research agenda. Collaborations across institutions and with local partners are very good, as demonstrated by co-authorship. Also in the crop management publications, good collaborations with NARS and ARIs were noted in the higher impact publications.

The Team's assessment confirmed the findings on journal quality. A large proportion of the articles were published in journals with low or no IF. These articles included also some on breeding that were judged to be methodologically of good quality and would have merited a better venue.

The Team notes that, with the exception of potato, root and tuber crops are orphans in comparison to major cereal crops. Papers on RTB crops can be at a disadvantage for publishing in some high IF journals due to editor preferences. Also as there are fewer RTB scientists globally compared to scientists working on crops such as rice, wheat and maize, there will inevitably be fewer citations of a smaller number of papers published. At the same time, RTB scientists should put more effort into striving for quality in science to give themselves more chance of publication in higher IF journals.

Recommendation 5: RTB has published some excellent research papers in appropriate journals with high impact. At the same time, the percentage of publications in non-IF journals is disturbingly high – 39 percent. While it is recognized that most RTB crops are at a disadvantage in terms of the range of journals willing to publish on these crops and the need to target African journals to promote research findings to the most appropriate stakeholders, RTB should endeavour to assure that its science quality is consistently high in order to target and publish in higher quality journals for greater international impact.

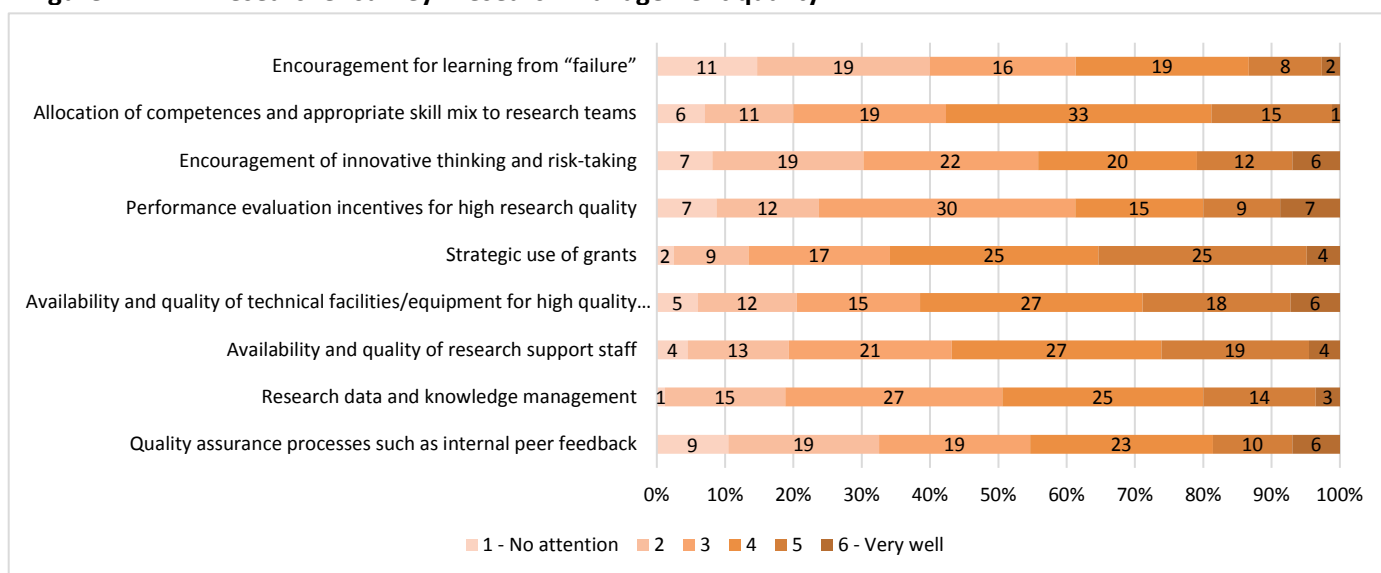
4.2.3. *Management for science quality*

The research survey revealed favourable perceptions of the strategic use of grants; the quality of infrastructure for high quality science; the quality of research support staff and teams in general; and data/KM work (Figure 4-1). However very few researchers responded with the *maximum* score – “very well managed.” The more negative perceptions are striking because they are related. The lowest-rated aspects for managing quality were “encouragement for learning from failure” —even though this is

widely viewed as a hallmark incentive for good research—and “performance incentives for good research”. There was no wide agreement that there is any encouragement for innovation and risk-taking. This suggests the need for an improved system of peer feedback, and perhaps also a new performance evaluation standard/norm from centers’ management. It should be noted that according to the survey too much time was spent on management, administration and reporting and too little on basic strategic research to develop IPGs which will potentially impact on the quality of science produced (Annex C). However it is clear that much of the increased management, administration and reporting burden on scientists is imposed by the CGIAR reform process and not directly by RTB management.

Center Commissioned External Reviews (CCERs) have proven useful to CGIAR centers in the past to

Figure 4-1: RTB researcher survey - research management quality



improve science quality. However, since RTB was initiated, none of the partner centers have implemented any CCER’s. CRP Commissioned External Evaluations (CCEE), that per the CGIAR’s Evaluation Policy are expected from CRPs, could be important in reviewing the quality of specific areas of RTB research to facilitate oversight on CRP performance. In discussion with partner centers, the ISC should consider reviving this review process to improve science quality in RTB. An independent evaluation of potential gains in science quality through greater programmatic integration should be given priority. Other initiatives could be gate-keeping of bilateral projects mapped to RTB. The Evaluation Team suggests that the MC together with the FP leaders who are responsible for oversight of the science in their respective FPs could play an active role in monitoring science quality. The ISC could also play an important role in facilitating and overseeing the development of an explicit RTB publications strategy. This could include incentives for publishing in higher impact journals and building staff capacity in preparing manuscripts that would be competitive in higher impact journals.

Recommendation 6: Although individual centers are responsible for the performance of their scientists, RTB is responsible for the quality of science implemented and generated by the program. The MC in consultation with the FP leaders should play a more active role in monitoring the quality of

science produced by RTB with oversight by the ISC. Reviving Commissioned External Evaluations at CRP-level would be of greatest value.

4.3. Breeding pipeline

The Evaluation Team considers efficiency (length of the breeding cycle) and quality of processes (design and incorporation of modern methods) and products (novelty and superiority of genetic materials) as main attributes of quality in plant breeding where publications are not the primary product. The main research areas considered are pre-breeding and varietal development within the breeding pipeline, and supporting activities. While the basic genomics related research is primarily conducted by scientists from CIAT, CIP, IITA, Bioversity, CIRAD and many partner ARIs, the applied breeding is strategically based in key locations in Peru, Ghana, Colombia, Kenya, Nigeria, Tanzania and Uganda.

4.3.1. Breeding processes and products

RTB is gradually modernizing its breeding programs through developing technologies suitable for the RTB crops and increasing use of genomic methods (where appropriate) for shortening the breeding pipeline and thereby increasing the efficiency of breeding. The Team's assessment of breeding processes for each crop and outputs generated is given below.

Banana: Until recently, the IITA breeding pipeline of banana was dominated by traditional breeding which led to the development of the NARITA EAHBs. This long program (about two decades) reflects the nature of working with a perennial crop whose life cycle and low fertility remain a major bottleneck for breeders to overcome. Genomic selection will assist in only some parts of this breeding cycle (recurrent selection at diploid 2x level). For plantain, marker-aided analysis and flow cytometry to determine genomes and ploidy have been used since 1997. Genetic engineering has been successful for both host plant resistance to *Xanthomonas* wilt in EAHBs and through a non-RTB project on vitamin A enrichment in Cavendish and Matoke bananas. The sequencing of the banana genome²³ and other omics research²⁴ is yet to be fully integrated into the breeding programs not only in CGIAR but also in CIRAD and other important institutes. Recently initiated and planned BMGF projects for breeding EAHBs and plantains will utilize these advanced tools.

Cassava: IITA is modernizing its cassava breeding through partnership with Cornell University by introducing MAB including the use of genomic selection²⁵. In RTB, 181 genetic markers have been identified in the cassava genome linked to important traits, including priority disease traits and quality traits such as pro-vitamin A. IITA has pro-actively engaged in using DNA markers for association genetics applied to genomic selection and introgressing a host plant resistance gene to Cassava Mosaic Virus Disease. Genetic engineering protocols aimed at traits that cannot be crossbred are available but so far lacking success in the field. CIAT and its partner the University of Icesi, Colombia have established excellent doubled haploid (DH) facilities to provide access to researchers from NaCRRI and

²³ D'Hont, A. et al. 2012. Nature 488, 213–217.

²⁴ Lee, S.J. et al. 2012. Structural modification of siRNA for efficient gene silencing. Biotechnol Adv. 31:491-503

²⁵ Ly, D. et al. 2012. Relatedness and Genotype × Environment Interaction Affect Prediction Accuracies in Genomic Selection: A Study in Cassava. Crop Science: 53: 1312-1325.

IITA in Uganda. CIAT has also recently hired a young tissue culture scientist to work on androgenesis. Early results are promising but further funding beyond current grant period is needed to demonstrate the applicability of this approach in cassava. CIAT has also used comparative genomics²⁶ for gaining insights into population structure and domestication/evolution of the crop. This knowledge should be used in the breeding program to tap available diversity in the cultigen pool.

Genomic selection approaches are being tested in the BMGF-funded NextGen project to shorten the cassava breeding cycle. IITA has now carried out three one-year genomic selections, shortening the cassava breeding cycle by one year compared to the typical four years. This required genotyping of over 2,000 lines each year, transplanting thousands of seedlings and maintaining and phenotyping more than 4000 field plots, an ambitious task. This example set by NextGen for high throughput genotyping, field trial design and management, international collaboration and trail blazing scientific research adds great value to RTB overall. Lessons learned from NextGen should apply across all RTB breeding programs.

Potato: CIP's potato breeding program has not fully utilized all the advances in MAB although they are being used elsewhere for association genetics plus pyramiding, "stacking" host plant resistance and for tuber traits²⁷. Genetic engineering has not yet been successfully used as the regulatory concerns for field-testing and commercialization continue to be a major challenge in the developing world. CIP through partnerships has, nonetheless, engaged in some genomic research regarding diversity, population structure, gene flow/biodiversity and association genetics, and participated in the Potato Genome Sequence Consortium which has provided genome sequence information vital for genetic improvement²⁸. Recurrent selection is used for faster potato breeding in CIP.

Sweetpotato: CIP has engaged in sequencing the genome of a diploid wild relative of sweetpotato²⁹. The challenge for using DNA aided-breeding in sweetpotato is the tetra-disomic inheritance of this hexaploid crop. CIP is also engaged in genetic engineering for resistance to sweetpotato weevil in collaboration with BeCA and NARO which involves horizontal gene transfer between *Agrobacterium* and natural genes of sweetpotato, indicating that transgene flow also occurs in the evolution of this crop. Such data are critical to regulators and hopefully would facilitate quicker approval of transgenic sweetpotato cultivars. Recently 21 sweetpotato accessions with heat tolerance have been identified. Marker associations have been identified for priority disease traits including Sweetpotato Feathery Mottle Virus and for quality traits such as pro vitamin A. CIP now uses an accelerated breeding scheme for sweetpotato that reduces the time from eight to four to five years from the crossing to cultivar release. The on-going breeding of OFSP is an icon of biofortification worldwide.

²⁶ Wang, W. et al. 2014. Cassava genome from a wild ancestor to cultivated varieties. *Nature Communications* 5, Article number: 5110.

²⁷ Ríos, R.O. 2015. DNA Sequencing, Other Omics and Synthetic Biology pp 125-140. In: *Plant Breeding in the Omics Era*, Ed. Ríos, R.O.

²⁸ The Potato Genome Sequencing Consortium, 2011. Genome sequence and analysis of the tuber crop potato *Nature* 475:189–195.

²⁹ Kyndt, T. et al. 2015. The genome of cultivated sweet potato contains *Agrobacterium* T-DNAs with expressed genes: An example of a naturally transgenic food crop. *PNAS* 112:5844–5849.

Yam: Yam still relies on crossbreeding due to the need for defining ploidy levels. The recent sequencing of the white yam genome will provide further insights including new knowledge of dioecy and should allow the design of a new approach for yam breeding³⁰. Furthermore, notable improvements have been made in breeding efficiency by IITA.

With some exceptions, centers have focused more on the developing single gene resistances to most biotic constraints in RTB crops, which may not be stable in the mid- to long-term. Notable exceptions are the deployment of four genes for late blight resistance in potato and multigenic resistance to the virus complex in sweetpotato. More attention is needed to exploiting the much-needed quantitative resistance to biotic constraints in partnership with ARIs and private sector.

Modernizing the breeding of RTB crops will depend both on the reliability of biotechnology methods and tools, suitable for these crops, for both accelerating breeding and increasing genetic gains, as well as a mind-set change in the RTB breeders for engaging in a "knowledge-led breeding-by-design" approach. Although RTB breeding programs have begun to use biotechnology-based methods, there has been limited success to date in using them for developing improved cultivars. Recruiting young skilled scientists for example as post-doctoral fellows should help to build greater capacity to effectively use biotechnological methods and tools in RTB breeding programs.

RTB can enhance breeding efficiency by reducing the breeding cycles of its crops and good progress has been made with cassava, potato and sweetpotato. RTB should work with NARS to promote and transfer the more efficient approaches. Furthermore, although RTB has been instrumental in building plant breeding capacity in the NARS through masters and PhD students in bilateral projects (see Chapter 6), in order to maintain continuity and sustainability of its breeding programs, RTB needs to develop a strategic approach to building the capacity of the next generation of RTB breeders. Finally, where RTB shares fields and greenhouses for phenotyping activities with NARS, efforts are needed to upgrade these facilities (e.g. in Tanzania) to support quality science.

4.3.2. Supporting technologies

Data and information management. Accessible datasets are valuable IPGs supporting critical breeding research for developing suitable cultivars. Outputs from the ITC are documented in the Musa Germplasm Information System (MGIS) but according to Bioversity are not yet integrated into the more widely accessible Genetic Research Information Network adopted by CIMMYT and tested by both CIAT and CIP. CGIAR is a joint facilitator of the recently initiated "DivSeek" (<http://www.divseek.org/>) to characterize all CGIAR crop diversity and develop a unified, coordinated and cohesive information management platform to provide easy access to genotypic and phenotypic data from all genebanks. This will provide RTB with the opportunity to integrate its genebank data into DivSeek where it will be more easily accessible.

There are a number of areas where data management within RTB could be strengthened to improve the quality of scientific outputs. Finalizing data sharing agreements between Bioversity (through ITC), IITA, CIRAD, and ICAR (Indian Council of Agriculture Research) would provide all with access to passport and molecular data for banana germplasm. Other examples include formalizing data sharing

³⁰ Bhattacharjee, R. et al. 2012. Genomics for transforming yam breeding. IITA publication.

on cassava between IITA and CIAT, and enhancing RTB breeders' input to the quality of data in databases. Recent initiatives to strengthen data management include RTB funding for joint database management and a bioinformatics position.

Genetic resources research. Gene-sequencing has been done of nearly 6,500 RTB crop accessions. Bioversity has made good progress in developing cryopreservation protocols for long-term storage of RTB crops (potato, sweetpotato, cassava and wild banana) through support from the Global Crop Diversity Trust but unfortunately this important work has now ceased.

RTB is unique among the CRPs in giving emphasis to *in situ* conservation of crops and wild relatives through a complementary project and a CoA in the proposed RTB Phase II. The research agenda of the current project is comprehensive but the quality of its scientific outputs would be greatly strengthened by incorporating studies on functional diversity (e.g. resistance/tolerance to pests and diseases). This crucial research has been lacking in most research on *in situ* conservation to date and should be a priority for RTB.

RTB has performed well in pre-breeding to identify useful germplasm. This was demonstrated many times during the evaluation e.g. *inter alia*, cassava mosaic disease resistance in Tanzania; high yielding EAHB tertiary hybrids in Uganda; OFSP lines with higher levels of vitamin A in Tanzania and Kenya; and late blight resistant potato bred clones in Peru just to name a few. Some significant and useful outputs have resulted from RTB research during the past few years, including many highlighted above and some cross- crop outputs, such as identification of 7000 metabolic features in RTB crops through profiling³¹.

Recommendation 7: RTB needs to further modernize and strengthen its breeding programs. Within the current funding climate, highest priority should be given to:

- a) adoption of the best breeding strategies for its crops that involve harmonizing breeding approaches within crops and transferring lessons across crops, where possible;
- b) a benchmark study of its utilization of genomic technologies with the most adopted ones by the private sector to identify opportunities for improvement in the deployment of techniques such as gene editing and MAB;
- c) deployment of precise high-throughput phenotyping methods, novel breeding techniques and modelling for traits such as drought and temperature stress through engagement with best practice in ARIs;
- d) attracting young scientists working in genomics-led breeding, bioinformatics or omics research for both accelerating breeding and increasing genetic gains; and
- e) placing more emphasis on training the next generation of plant breeders so that breeding will continue after the termination of the short term bilateral project funding.

4.4. Quality planting material

Theme 4 offers a unique opportunity to develop a more innovative cross-crop approach that brings both efficiencies and synergies to improving the quality of planting material used by poor farmers as lack of access to quality planting material is a major bottleneck for small holder farmers growing RTB crops. Furthermore, the lack of effective seed systems slows rapid and wide-scale adoption of

³¹ RTB Annual Report 2014.

improved cultivars. RTB crops face common challenges for seed systems improvement. These include the high volume of planting material required, low multiplication rates, transmission of pests and diseases, perishability of planting material, and, frequently, the lack of an organized seed system.

4.4.1. Outputs

Innovative targeted approaches: RTB has developed a vision of an economically sustainable seed system with farmers paying for higher quality planting materials and the suppliers of such seed being rewarded with profits. This vision is not only innovative but also challenging as three approaches need to be well-targeted and inter-linked and market mechanisms and control processes are needed to promote quality. Firstly, high quality basic seed is the foundation of any seed system of RTB crops: RTB is developing strong partnerships with private tissue culture, hydroponics and aeroponics companies for initial production of clean, high quality basic seed (tissue culture material and mini-tubers) of improved varieties of RTB crops in Kenya, Nigeria, Peru, Tanzania and Uganda^{32,33}. Secondly, the establishment of mass multiplication and marketing systems of planting material by and for farmers is essential for developing economically sustainable systems: RTB is fostering partnerships with NARS and farmer multipliers through several bilateral projects for mass multiplication of low-cost, clean, high quality planting material of sweetpotato through low cost net tunnels and cassava in several African countries for purchase by small holder farmers. Thirdly, the development of awareness of the value of quality seed is needed for maintaining economically viable seed systems: RTB is working with farmers to develop replacement regimes for planting material based on initial use of certified quality seed. Linked to this, RTB is also developing systems for Quality Declared seed, mini-tubers and vines.

High quality basic seed: The quality of strategic research is generally high both from the centers themselves and through partnerships with noted experts in ARIs especially in complementary projects. RTB has developed and implemented seed system interventions to clean-up and disseminate improved varieties, reduce yield loss due to seed degeneration, and help farmers recover from the devastation of crop diseases. RTB has both developed and adapted tissue culture protocols for propagation and multiplication of clean planting material of its five main RTB crops in major target countries suitable for use by private companies. It has developed and refined methods for hydroponics, aeroponics and the total immersion bioreactor for potato propagation and adapted these to boost yam propagation in West Africa³⁴. This spillover has added value to RTB through collaboration and new science that did not exist prior to 2012. In Latin America, CIAT has developed a thermotherapy chamber to rapidly and eco-efficiently clean and mass propagate cassava and plantain

³² Chiipanthenga, M. et al. 2012. Potential of aeroponics system in the production of quality potato (*Solanum tuberosum* L.) seed in developing countries. *African Journal of Biotechnology*. 11:3993-3999.

³³ Mateus Rodriguez, J.F. et al. 2014. Genotype by environment effects on potato mini-tuber seed production in an aeroponics system. *Agronomy*. 4:514-528.

³⁴ Balogun, M. et al. 2014. Status and prospects for improving yam seed systems using temporary immersion bioreactors. *African Journal of Biotechnology* 13:1614-1622.

planting material³⁵. These are excellent examples of the use of state of the art methods and innovative approaches and the generation of IPGs (both products and publications) is noteworthy.

Cross-crop seed systems framework: RTB has developed a seed systems framework that addresses the problem of farmers not having access to affordable high quality planting material. In the past progress has been limited. This is a significant quality output from an innovative cross-crop project initiated in 2013, which is likely to enhance the success of all future research on seed systems in RTB. A community of practice has been created across the four Centers with added seed systems skills from Wageningen University and Catholic Relief Service (CRS) which have enhanced the quality and usefulness of the framework. Twelve case studies, all in developing countries, were implemented to enable comparative analysis against the conceptual framework around farmer demand for seed, tools and techniques for seed production, and seed regulation and policies. A study on seed systems of an RTB crop (e.g. potato) in a developed country would have been useful for comparison. The framework will be used to systematically evaluate RTB seed systems, in order to improve their design and implementation, and to help scientists develop hypotheses for future research in this area. This project has been instrumental in facilitating programmatic integration and capturing synergies and complementarities across Centers and across crops. It has established a community of practice among participating CGIAR centers and their partners.

Models for degeneration of planting material: Improvement in the understanding of degeneration of planting material is also an important component of developing economically sustainable seed systems for RTB crops. RTB is producing simple models to predict degeneration due mainly to virus diseases under scenarios applicable to RTB farmers and producers of clean planting material. Skills from a number of universities including the University of Florida and Kansas State have strengthened the quality of the models produced. Impact network analysis has been applied to generate a better understanding of how the biophysical and socioeconomic aspects of seed degeneration management interact. The models will help to link the seed degeneration data with the research done for the framework and thereby improve the scientists' understanding of seed systems.

Mass-multiplication and marketing of clean seed/planting material: RTB is developing simple and practical, low-cost net tunnels for multiplication of virus-free sweetpotato vines in areas of high whitefly infestation; positive selection for potato for maintaining material free of bacterial wilt; and phytosanitisation for cassava viruses with farmer trainers, farmers and communities for producing, maintaining and marketing clean planting material of RTB crops especially in East Africa. Although this is not rocket science, the quality of research in these pilot projects has opened new possibilities in seed production research on RTB crops, contributing to the further development of economically sustainable systems.

³⁵ Alvarez, E. 2012. Thermotherapy chamber: A rapid and eco-efficient method for cleaning and massive propagation of cassava and plantain seed. Forum 2012 Africa - Brazil - LAC Agriculture Innovation Marketplace, Brasilia, Brazil (1-3 August, 2012).

4.5. Post-harvest, value chains and marketing and nutrition

The Evaluation Team considers that efficiency and quality of processes are the main attributes of quality in post-harvest, value chain and marketing and nutrition research. The main research areas considered are cassava processing, value chain and post-harvest research and nutrition research on OFSP.

4.5.1. Outputs

Cassava processing: RTB's research on cassava processing efficiency has a global scope, addressing processing bottlenecks and environmental impacts in all three major developing regions, and for a variety of cassava products for which there is growing demand. RTB is modelling processes based on careful observation of actual processing outcomes. Models are then used to simulate how changes in equipment, techniques, or organization may increase efficiency and reduce waste. This engineering approach is complemented by life cycle analysis to better understand the environmental footprint from cassava starch processing, in order to address concerns about water quality and energy use associated with growth in this industry. The linking of this research to more holistic studies of value chains associated with processing, will allow identification of constraints to supply and quality that may also be addressed. The Evaluation Team considers that this is appropriate and likely to generate IPGs as well as having potential for local impacts.

Value chain research: Value chain research encompasses many different approaches, and the work in RTB reflects this variety. CIP is well-known for developing and successfully applying a Participatory Market Chain Approach (PMCA) to potato value chains in Peru (see Chapter 7 for impact studies of this method). PMCA relies on engaging participants in the market chain to identify constraints and opportunities to add value, and then facilitating appropriate actions. The PMCA has now been adapted to have a stronger focus on gender. In the current RTB portfolio, this approach is being applied explicitly in western Uganda in a project for Reducing Post-Harvest Losses and Promoting Product Differentiation in the Cooking Banana Value Chain. However, the core approach of engaging value chain actors to identify and implement solutions to production and marketing constraints demonstrates research quality and is seen throughout the RTB post-harvest research.

Value chain research carried out by CIAT in SE Asia focuses on relieving supply constraints to meet growing industry demand, and works with private sector partners to transfer appropriate solutions. These projects, in twelve locations across five different countries, use a Farmer Participatory Research and Extension approach to test four different technologies. The on-farm research and training is complemented by value chain research in two of the countries. The value chain research focuses on developing agribusiness models that better link primary value-chain actors (farmers, traders, processors) and support actors (researchers, government agencies, industry bodies). The agribusiness model approach has identified the need for changes in fertilizer policy and marketing, as well as the potential to use processors for dissemination of new technologies.

The value chain research will be of benefit to RTB through the use of comparable research designs and structured efforts to compare experiences and distil general principles/ lessons across multiple regions and crops.

Post-harvest research: Post-harvest research with an empirical focus on a particular production system carries the danger that post-harvest projects become extension projects rather than research projects. The participatory or demonstration trial approach may focus on technology transfer and neglect to test interventions with sufficient rigor to provide reproducible results. For example, research carried out with national partners in Vietnam is testing new production technologies on farmers' fields and new ways to use byproducts from starch processing. This project extended a well-known feed technology, silage, to obtain greater feed value from cassava starch waste used in pig feeding. However, the feed trials were focused on a few large scale farmers and did not produce enough observations to test efficacy or scalability to small farms. Poor research design means that this aspect of the project might not deliver general lessons that can be applied elsewhere in RTB value chains. In another example, the project on cooking bananas in western Uganda does not seem to be testing the proposed interventions for improving quality and changing pricing schemes before carrying out extension activities. Both of these projects are bringing value chain actor engagement and new technologies to address identified needs, but both could use greater clarity about where and how either technologies or extension methods are being tested, and greater rigor to experiment design.

OFSP: Since the initiation of RTB, nutrition research on OFSP has become more strongly multidisciplinary, drawing on expertise in breeding, seed systems, nutrition, economics, and behaviour change communication, enhancing the quality of the outputs. Randomized control trials are used to test the effectiveness of alternative methods for nutrition education and technology dissemination. A well-rounded research design is used to address the twinned problem of promoting supply and demand simultaneously. One journal article emerging from this research, Hotz et al (2012)³⁶, is already one of the most cited RTB publications. It applies novel science to assess nutrition impacts and program effectiveness for OFSP, and provides a model for evaluation of similar biofortification efforts in other RTB crops.

4.6. Conclusions

Overall, the quality of science is generally high both from the centers themselves and through partnerships with noted experts in ARIs especially in complementary projects. There are good examples of the use of state of the art methods and approaches in crop improvement (use of bioinformatics, metabolomics, molecular genetics and characterization), virus diagnostics, pest risk assessment, integrated pest management (IPM), yield prediction and gap analysis, crop modelling, seed systems development, post-harvest and nutrition research which have generated IPGs. However, ways to improve the quality of RTB science are highlighted throughout this Chapter.

RTB breeding programs should continue to improve through the use of appropriate novel breeding methods and techniques such as gene editing, genetic modification, MAB and genomic selection and utilizing new knowledge generated from genomics research. Attracting young skilled scientists trained in these techniques will strengthen the quality of science implemented in RTB's breeding programs while training the next generation of plant breeders will help to ensure continuity and sustainability in the breeding of RTB crops. RTB should also continue to promote and support North-South and

³⁶ Hotz, C. et al. 2012. A large-scale intervention to introduce orange sweet potato in rural Mozambique increases vitamin A intakes among children and women. *British Journal of Nutrition* 108:163-176.

South-South partnerships that maximize access, implementation, and CapDev for discovery research and use of molecular technologies in developing countries. The proposed breeding platform in the 2017–2022 RTB Phase II proposal would enable all participants to track cultivar and trait pipelines, monitor genetic gains, support shared services, tools and information, and serve as a community of practice for breeders, geneticists, and molecular biologists.

The Evaluation Team considers that the research on planting material is of good quality and the outputs are relevant to the development of economically sustainable seed systems for major RTB crops. This research area has also provided useful opportunities for developing cross-center and cross-crop partnerships, and cross-crop learning and has built a common language for seed systems researchers. The incorporation of skills and expertise from noted ARIs has enhanced the quality of the outputs produced. This is laying a strong foundation for further research on improving seed systems for small holders growing RTB crops.

The addition of CIRAD as a collaborating center has brought new intellectual energy to post-harvest work, generating high quality efforts and publications. Research in this area uses a variety of approaches, generating important scientific contributions that are valuable additions to RTB knowledge. The complementary projects are bringing together lessons from different countries and contexts to better inform technology development and potential market interventions. The nutrition research is well-designed and results have the potential to provide a model for efforts in other crops or regions.

Continued attention to generating knowledge that provides global public goods for RTB will be necessary. Post-harvest research done in a wide range of ecological, geographical and social contexts must be locally relevant and also contribute to global knowledge. This can best be achieved through comparable research designs and structured efforts to compare experiences and distil general principles/ lessons across multiple regions and crops. The selective nature of the new FP on nutritious food and added-value in comparison to Theme 6 may not realize this. Multi-site projects/program with clear objectives on knowledge sharing are more likely to achieve this aim.

5. Program effectiveness

5.1. Introduction

The Evaluation Team assessed the likely effectiveness of RTB by examining progress towards near-term outcomes through review of selected complementary and bilateral projects, 2012-2014 annual report narratives, interviews with more than 300 program scientists, partners, donors, farmers and other stakeholders and visits to numerous sites in ten countries where RTB is actively involved in research. In the original RTB structure, a generic ToC demonstrated how the Themes and associated research products linked to seven RTB IDOs³⁷. The ToC highlighted probable causal linkages from research products to first level IDOs and mediated by next users translation of research outcomes into development outcomes for end-users and contribution to IDOs. Accountability in this RTB structure, however, was limited to the generation of research outputs with regard to their yearly milestones but without clear accountability linked to outcomes. The disciplinary-based structure of the initial RTB program was considered not conducive to developing a realistic ToC for the delivery of RTB's objectives. The restructuring of RTB (to be initiated in 2016) into inter-disciplinary FPs and CoAs with its focus on specific products and CoA-level ToCs and FP level impact pathways should be more effective in producing clearer outputs and outcomes that can be directly linked to sub-IDOs, IDOs and SLOs, as noted in Chapter 3. Respondents to the researcher survey considered RTB to be generally well regarded for developing strong impact pathways, ToCs and logic on how the research will make a difference; 72 of 92 respondents viewed influencing rural livelihoods through enhanced productivity as a primary impact pathway for RTB.

5.2. Overall assessment of progress towards milestones and outcomes

RTB has made good progress in some areas of research towards milestones and outcomes according to the defined indicators of progress for 2014³⁸. For knowledge, tools and data, 60 percent of indicators were achieved or more than achieved with only 10 percent being significantly underachieved. However for technologies and practices under development, 40 percent only were achieved or more than achieved while 60 percent were underachieved. All outcomes on the ground, namely those that CRPs report on annually to the Consortium, the targets for number of hectares under improved technologies and management practices and the number of farmers/others who have applied new technologies and management practices were met. Notable progress towards outcomes has been highlighted in a number of Themes¹ some of which are described in the next section. Furthermore, preliminary results show the potential for tripling of potato yields in Ethiopia through higher-yielding, blight resistant varieties, high-quality seed and improved agronomic practices (contributing to the IDO – Productivity); achieving a dramatic reduction in bacterial wilt of banana through improved management in the Democratic Republic of Congo (contributing to IDO – More sustainably managed ecosystems); and doubling Vitamin A intake in a cohort study population in

³⁷ See RTB Evaluation Inception Report 2015.

³⁸ RTB Performance Monitoring Report 2014 especially Annex 1.

Western Kenya with OFSP (contributing to IDO – Improved diets for poor and vulnerable people) demonstrated significant progress to achievement of development outcomes and IDOs.

5.3. Progress towards outputs and outcomes in specific research areas

This subsection not only evaluates the effectiveness of RTB research in the three main areas: the breeding pipeline, quality seed systems and post-harvest, value chains and marketing but also evaluates research on managing diseases and pests and crop management research under resilient cropping systems. Research effectiveness is discussed in regard to expected outcomes as defined by project documentation.

5.3.1. Breeding pipeline - progress

Several projects are demonstrating how pre-breeding and crop improvement activities are making progress towards outputs and research outcomes in the breeding pipeline aligned to RTB desired outcomes: increased access to and enhanced use RTB genetic resources and accelerated development of RTB cultivars for sustainable production gains and enhanced nutritional and market value. As advanced breeding clones are developed by NARS and farmers adopt improved cultivars in a reduced timeframe, on farm yield increases and yield stability should enable greater impact on food security in target countries.

Increased access to and enhanced use of RTB genetic resources: Improved understanding of the genetic structure of RTB crop diversity using high-throughput genotyping integrated with high quality phenotypic data for further association genetics is enabling more targeted use of RTB genetic resources. Vast amounts of genomic, metabolomics and phenotyping data have been amassed which is helping centers such as IITA to deploy genomic selection for resistance to cassava mosaic disease, cassava green mite and other traits in Nigeria and Uganda and CIP scientists for biofortification and adaptation to a long photoperiod and warm conditions for several diploid and tetraploid potato breeding clones. Results indicate predictive models can be implemented for genomic selection. The project is also enabling RTB to develop web platforms to manage the genomic and related data being generated and is promoting collaboration among RTB geneticists and bioinformaticians at various partner institutions to make that information accessible to breeders worldwide.

Currently IITA and Bioversity follow different procedures for distribution of banana and plantain germplasm, which affects the overall effectiveness of genetic resources use. IITA follows the approved phytosanitary regulations of the importing country while the Bioversity International Transit Center (ITC) in Belgium insists on further reconfirmation of health status before material is distributed which is not required by the recipient country. The Team considers that an agreement is urgently needed on common protocols for germplasm distribution related to recipient requirements to avoid wasting resources and time. Again, this emphasizes the value of one integrated banana program for RTB.

Accelerated development of RTB cultivars: Thousands of cassava clones have been genotyped and phenotyped through the NextGen project which aims to increase the rate of genetic improvement in cassava through the application of genomic selection to improve important traits. The project activities are on target and most milestones have been achieved. Delays with germplasm exchange activities between Latin America and SSA due to phytosanitary concerns are being tackled through

using Hawaii for third country quarantine. The gender research component is especially strong and will enhance the understanding of how cassava cultivars are perceived and used by women smallholders³⁹. This information is likely to feed back to the TOC on important end-user related assumptions.

CIAT is progressing with DH breeding for cassava to discover new methods to design heterotic systems in breeding to increase genetic gain for key traits by developing homozygous lines and ultimately, provide farmers with more rapid access to suitable cultivars. The collaborative approach with a global network of partners with expertise and interest in cassava, combined with expert consultants, is an excellent model for optimizing the likelihood of success. The outputs are progressing towards integration into RTB breeding programs followed by national cassava breeding programs in SSA, Asia and Latin America. It will also enhance sharing and conservation of germplasm adding value to breeding programs⁴⁰.

5.3.2. *Breeding pipeline – improving effectiveness*

RTB breeding and client needs: RTB relies heavily on strong partnerships with national breeding programs to further develop breeding lines and promote these to farmers. While RTB is benefiting from bioinformatics research, NARS will require considerable capacity building to utilize the data. Hence an analysis of the constraints and opportunities on how essential data in RTB databases can be applied in national breeding programs is needed. In addition, AGRA has provided critical support for SSA NARS crop breeding programs for a number of years. Concerns are now being raised by NARS and RTB breeders about future AGRA support for national RTB breeding programs in SSA due to changes in AGRA's priorities towards cereal crops. RTB needs to engage with AGRA to ensure continued support to avoid problems with the future of RTB breeding effectiveness at national level.

Finally a good knowledge of the capacity of NARS to further develop advanced materials (clones and seeds) is important to improving RTB's effectiveness. In some cases these materials have to be further bred with locally adapted materials (e.g. in Kenya CIP works with NARS to cross CIP advanced clones with locally adapted potato cultivars). This can be both expensive and time consuming. There is therefore a need to focus on developing two or three product profiles (advanced breeding lines) per region or country to ensure that delivery is more feasible. Furthermore, a number of RTB breeders emphasized that more informed understanding of consumer and market needs is crucial and that RTB should operate more like private breeding companies – seeking feedback from end-users to identify the appropriate product profiles.

Recommendation 8: RTB should better target client needs by delivering only two to three achievable product profiles for each mandate crop per country or region and placing even greater emphasis on farmer and consumer needs. RTB and NARS should decide together on the division of labour based on NARS capability in each target country. This will allow RTB to provide appropriate back-stopping to NARS in further development of the products into cultivar(s) for release to farmers.

³⁹ Rabbi, I.Y. et al. 2015. Tracking crop varieties using genotyping-by-sequencing markers: a case study using cassava (*Manihot esculenta* Crantz) BMC Genet. 16:115.

⁴⁰ Ceballos, H. et al. 2015. Conventional breeding, marker-assisted selection, genomic selection and inbreeding in clonally propagated crops: a case study for cassava Theor Appl Genet 128:1647–1667.

Collaboration among RTB breeders: Although RTB breeders collaborate through selected projects, there is no mechanism within RTB to a) routinely share ideas and information *across crops within a center*; b) *across crops across centers*; and c) *across centers for the same crop*. Hence there is insufficient opportunity to discuss approaches across crops and centers. For example, while molecular breeding, genetics and applied breeding of cassava are integrated into a holistic program in IITA, CIAT geneticists are not involved in applied field breeding and next generation genomics tools are not used as in the case of DNA markers for the waxy trait (also see Chapter 3 for Recommendation 1 for enhanced integration of cassava breeding). Building consensus between RTB breeders and geneticists on the best possible approaches for integrating MAB and other -omic technologies and sharing information to understand issues such as heterosis and the best methods to establish populations would greatly increase the effectiveness of cassava breeding across IITA and CIAT in RTB.

Research on mechanisms of drought tolerance in the ITC *Musa* germplasm collection has led to the development of model system applicable to other RTB crops. Breeding effectiveness could be enhanced if the KU Leuven research was connected to IITA's research on genome wide association studies on EAHB drought research in Tanzania but there is limited exchange of information. Creating opportunities for breeders, agronomists and physiologists at all RTB centers to validate the model for developing drought tolerant breeding materials and establishment of an inter-center working group on drought would further facilitate rapid development and adoption of promising drought tolerant lines of RTB crops.

Other opportunities include linking CIRAD's cassava post-harvest and quality research to IITA's breeding program; linking CIRAD's and IITA's yam breeding research; and linking Vitropic⁴¹ and IITA's banana research. Further efforts are also needed to facilitate sharing of information amongst CIAT, IITA and CIP researchers on transgenic cultivar development, especially in the methodologies used for contained field trials and regulatory dossier development as well as on biosafety and food safety issues.

During interviews, several breeders indicated willingness and a need to work more closely together. It is therefore essential to ensure that mechanisms are put in place in the future to build strong collaborative projects across crops and centers that will allow the evolution of a community of practice. From 2016 on, the CoA "Integrated breeding platform" should help to build and support such a community of practice.

Recommendation 9: RTB should develop a community of practice of researchers across all crop breeding undertakings for enhancing effectiveness through better synergy. It will allow the sharing of ideas on methods, data, results and user feed-back, thus leading to integrated data platforms, developing inter-center working groups on traits, enhancing the inter-disciplinarity between lab-genomics and field-breeding, establishing single RTB breeding programs for banana and cassava, and sharing experiences among those engaged in transgenic breeding.

Integrated programs could be led by the centers with highest investment in the specific crop or could be RTB positions. This applies not only to IITA and CIAT for cassava but also to IITA and

⁴¹ CIRAD's subsidiary for production of clean planting material.

Biodiversity for banana (see Chapter 3). In this way, the administrative burden should be reduced allowing scientists to concentrate on research.

5.3.3. *Quality planting material*

Lack of access to high quality planting material by small holder farmers and undeveloped seed systems to sustainably supply farmers at low cost are major constraints to RTB effectiveness. The ToC is that poor farmers especially women will benefit from improved access to and supply of lower cost, high quality planting material than currently possible through existing systems – a critical requirement for improving food security. During that past four years, RTB has made good progress in tackling both access and supply, laying a foundation for developing robust and economically sustainable seed systems for RTB crops in major target countries.

NARS and farmers have better options for production of quality seed: In developing a seed systems framework RTB has made significant progress in understanding the characteristics of better options for quality seed production (see assessment of the framework in Chapter 4). The greater involvement of social scientists especially for on-farm research in the future should facilitate better understanding of both gender and farmer demand. The project outputs position RTB to progress towards a community of practice to efficiently share and generate knowledge around better options for production of quality seed. However, more work is needed not only on developing improved options and incentives for farmers through RTB but also in learning from and linking with non-RTB on-farm multiplication efforts and existing semi-formal systems (e.g. sweetpotato^{42,43} and cassava⁴⁴) so that wider lessons are learned. These long-existing semi-formal systems also provide RTB with a base for improvement as well as cohorts of farmers who are prepared to purchase planting material.

Data from field studies is being used to strengthen a theoretical model for predicting yield under different management strategies and researchers are enhancing the model with management performance maps, which could be used to predict the effectiveness of strategies in specific regions and agro-ecologies. The project is also providing tools that will contribute to better options for replacement of seed. Both on-station and on-farm research is focused on management of bacterial wilt of potato in Kenya and Tanzania through replacement of farmer seed by certified seed each three years together with positive selection⁴⁵. Other projects are working with communities in Ghana on yam storage methods and seed selection and on management of Cassava Brown Streak Disease (CBSD) in Tanzania through 100 percent replacement which can reduce CBSD infection by almost 100

⁴² Gibson, R. et al. 2009. Review of sweet potato seed systems in East and Southern Africa. Integrated Crop Management Division Working Paper 2009-1, International Potato Center, Lima, Peru.

⁴³ Namanda, S. et al. 2013. The Triple S Method of producing sweet potato planting material for areas in Africa with long dry seasons. *Journal of Crop Improvement*. 27:67-84.

⁴⁴ Legg, J. et al. 2014. A global alliance declaring war on cassava viruses in Africa. *Food Security* 6:231–248.

⁴⁵ Schulte-Geldermann, E. et al. 2012. Improving seed health and seed performance by positive selection in three Kenyan potato varieties. *American Journal of Potato Research* 89:429-437.

percent⁴⁶. Practical recommendations for farmers and specialist seed producers for replacement of planting materials are being generated.

Seed systems sustainably provide farmers with higher quality seed at lower cost: RTB has made good progress in mentoring and partnering with private tissue culture, hydroponics and aeroponics companies for production of clean, high quality basic seed of improved varieties of RTB crops in Kenya (Genetics Technologies International Ltd. [GTIL]); Tanzania (Crop Biosciences); Uganda (Biocrops); Nigeria (Biocrops) and Ghana (Biochemical Products) for rapid and efficient propagation and multiplication of tissue culture and bioreactor plantlets and resulting seedlings as well as mini-tubers. Further development of these partnerships should reduce the cost of seed for mass multiplication by farmer seed producers. RTB provides technical backstopping and access to improved varieties and companies produce planting material for RTB bilateral projects which is mutually beneficial. In the future, RTB could further facilitate linkages between private tissue culture companies throughout SSA to foster sustainable production of basic seed to the benefit of RTB seed systems.

However, the economic viability of private tissue culture, hydroponics and aeroponics companies in SSA will depend on increased demand for their products. From the prices set to date, it was not clear whether full production costs were being taken account of. The supply of planting material to bilateral projects is important but is not a good gauge of demand. Some companies are not making a profit which is unlikely to attract more private sector investment. Increasing demand from farmers and farmer multipliers will be the key to the long-term viability of these companies. RTB has an important role to play in increasing small holder awareness of the benefits of clean, high quality planting material.

Paying for planting material of RTB crops has been the practice in East Africa for sweetpotato and banana and in Nigeria for cassava for several decades. The critical issues are the extent to which small holders are aware of the value of clean planting material of improved varieties and how much more they will be prepared to pay for it, at least until system growth leads to reduced cost. It is also a challenge to convince partners about the need to *sell* clean vines of improved varieties. Current and planned research should help to understand the robustness of demand for clean, high quality planting material but efforts should also be made to determine the costs of production and realistic prices which may not be as low as was initially perceived.

Quantification of the benefits to small holders ensuing from growing clean high quality planting material compared to farmer-sourced planting material is also essential for establishing sustainable seed systems. In order to demonstrate to farmers that there are advantages in growing clean, high quality material, such comparisons are needed to inform their decision to buy material or just save it for the next season.

RTB has made notable progress during that past four years in tackling both access to and supply of high quality planting material for developing robust seed systems for RTB crops in major target countries. To a large degree, RTB has relied on its breeders and crop protection researchers with

⁴⁶ Mtunda, K. et al. 2013. Community Phytosanitation: progress in Cassava Brown Streak Control through clean seed. Abstract, P. 272 in the 12th Triennial Symposium of International Society for Tropical Root Crops-Africa Branch (ISTRACAB), 30 - 5, October, Alisa Hotel, Accra, Ghana, 2013.

strategic project-based input from seed systems experts from Wageningen University and CRS. The Team considers that strengthening the in-house seed systems expertise in RTB is crucial for capitalizing on the progress made to date; realizing short term impacts; and laying a strong foundation for establishing economically sustainable seed systems for RTB crops. Ideally, the position would be a joint appointment for the four centers, with responsibility for seed systems research across all major RTB crops. Strengthening seed systems expertise in RTB is likely to make a major contribution to impact in the short to medium term.

Recommendation 10: The establishment of economically sustainable seed systems for RTB crops is of core importance for program effectiveness. Priority should be given to assessing demand for clean high quality planting material throughout the seed value chain; on understanding the incentives for small holders to purchase quality planting material; as well as mechanisms for strengthening the supply chain with links to marketing and processing. Due to the importance of seed systems research for impact, as RTB moves into scaling-up and scaling-out seed systems activities, it should recruit an expert in RTB seed systems rather than relying on short term inputs from consultants and partners as noted in Chapter 4.

5.3.4. Resilient cropping systems

Developing improved tools for pest risk assessment and decision making and sound IPM packages for serious pests and diseases as well as closing yield gaps through improved crop management practices are important outcomes for improving the resilience of RTB cropping systems.

NARS have better pest and disease modelling tools for risk assessment and decision making: The Insect Life Cycle Model Version 3.0 inputs life cycle tables into temperature-based models generating risk indices for climate change scenarios⁴⁷. This IPG is now used globally and has enabled the modelling of climate impacts on future insect pests and diseases risks and their distribution⁴⁸. The research produced cost efficient pre-emptive control methods for new, emerging or existing pests; facilitated access to resistant germplasm and IPM strategies; fostered innovations in IPM to address introductions of pests due to globalization and the impacts of climate change; and built capacity of NARS in 15 countries to identify and manage pests and to operate through regional networks. The participatory approach and the multi-disciplinary skills of RTB centers and partners provided opportunities for cross-crop and cross-disciplinary sharing of expertise and experience and also built trust and stimulated interest to seek more opportunities for future collaboration.

Linked to this, research in SE Asia monitored and mapped the occurrence and spread of economically important pests and diseases of cassava; developed appropriate management methods through quarantine, cultural and biological control as well as breeding strategies; and built the capacity of NARS pathologists, entomologists and cassava specialists, extension workers and farmers in the identification and management of cassava pests and diseases. Of note, the project established a regional network for monitoring and mitigation of cassava pests. These represent global public goods

⁴⁷ Tonnag, E.Z.H. et al. 2013. Insect Life Cycle Modelling User Guide. International Potato Center, Lima, Peru.

⁴⁸ Garret, K.A. et al. 2013. The effects of climate variability and the colour of weather time series on agricultural diseases and pests, and on decisions for their management. *Journal of Agricultural and Forest Meteorology* 170:216-227.

and major contributions with impact on regional productivity – high quality and effective research. The main strength of this project is the capacity built to identify emerging pests and manage them before they become major regions problems which leaves a foundation for sustainability of the outputs from the project.

NARS have better management practices for improved efficiency, productivity and sustainability:

Banana Xanthomonas Wilt (BXW) devastated banana in East and Central Africa during 2004-2007. A partnership between Bioversity, IITA and NARS built on a considerable base of research⁴⁹ in developing an appropriate integrated management package for small holder farmers. Gender analysis contributed to understanding of the differential perceptions of among women and men which informed the package structure. The promotion of this integrated BXW management program has been remarkably effective in pilot locations in controlling the disease. A strict government no-tolerance policy in Uganda penalizing farmers who do not comply with fines and imprisonment supported uptake. This initiative is currently being out-scaled to more affected areas through additional projects.

The Banana Bunchy Top Alliance⁵⁰ is a multi-national partnership platform to develop a cohesive strategy to control banana bunchy top disease (BBTD), a major threat to the food and income security of millions of people in SSA. Pilot sites are proving to be effective platforms to develop and distribute diagnostic tools; develop capacity for disease recognition and knowledge of control options; establish location-specific clean banana production and distribution systems; and train farmers and entrepreneurs in producing clean planting material and NARS in surveillance of the spread of BBTD. The pilot zone concept is being scaled up and scaled out in the eight target countries and other BBTD-affected countries.

NARS have better tools and models for yield gap analysis and crop management: Although the outputs from this research potentially feed into RTB's adaptive and applied research on resilient cropping systems, most of this research (80-90 percent) is supported by other CRPs e.g. Humidtropics, LWE and CCAFS. Currently outcomes are reported through these CRPs and not explicitly through RTB, although it is expected that there is a contribution to RTB. This gives the impression that limited research is being implemented on RTB crops that potentially will contribute to SLO3. These outputs need to be visibly and explicitly cross-referenced to RTB. Potential for joint research should be explored. Outputs from such research are likely to be used in the new Livelihood systems FP which will improve potential impact of RTB.

Useful remote sensing tools such as unmanned aerial vehicle platforms and acquisition multi-spectral systems as well as software (e.g. image stitching) have been developed as freely available IPGs. These are being applied to yield prediction and yield gap analysis of RTB crops; detection of biotic and abiotic stresses and precision agriculture. Additional tools are being developed for yield prediction and yield

⁴⁹ Published in a Special Issue of African Crop Science Vol. 14, 2006.

⁵⁰ <http://www.bbtvalliance.org/>

gap analysis using the SOLANUM model^{51, 52}. Notable progress has also been made in Uganda in developing tools and approaches for more productive, ecologically robust RTB systems. These have included: probing key system components such as drought stress and effects of nutrient deficiency on BXW; testing hypotheses in the field through nutrient omission, drought × K and plant density trials^{53, 54}; and on-farm testing of best-bets with emphasis on nutrient omission and plant density trials⁵⁵. Currently IITA is developing data sets from appropriate cassava nutrient management trials to develop a Nutrient Manager module in collaboration with International Plant Nutrition Institute which should be available for use by smart phone by 2016. Modules on land management, agronomy and IPM are planned to be part of the Decision Support System for cassava.

Although RTB aspires to “a strong focus on conserving and rehabilitating the soil resource base”⁵⁶, there have been difficulties in securing bilateral funding for field agronomy and soil management research especially for long-term cumulative fertilizer response trails. This is negatively affecting the ability of RTB to contribute to some of the sub-IDOs under SLO 3. Combining improved varieties with sound agronomy and soil fertility management will make a greater contribution to narrowing the yield gap for RTB crops than each component alone. It is therefore critical that in Phase II RTB addresses how to better integrate research to address yield gaps and better define the comparative contribution of varietal improvement and NRM research. It may be necessary to rebalance the RTB portfolio towards greater emphasis on ecologically robust systems.

Recommendation 11: Some aspects of crop management research, for example agronomy and soil fertility research in Theme 5, have not been well-supported. Narrowing the yield gap for farmers may require rebalancing the RTB portfolio towards agronomic and soil fertility research. In order to improve the realized yields in farmer’s fields, RTB needs to better integrate research on crop improvement and crop management which have been implemented in different Themes to date and will be implemented in different FPs in the new program structure.

5.3.5. *Post-harvest, value chains and nutrition*

The Evaluation Team observed program effectiveness, including outputs and partnerships for delivery, in several different areas. The research in this area initially focused on consumer demand for traits; development of livestock feed from wastes; and improving efficiency and reducing the environmental footprint from processing. The planned FP now includes efforts to enhance nutrition. The ToC focuses on improving value of RTB crops through enhancing quality or nutrition, improving efficiency in

⁵¹ Condori, B. et al. 2014. Managing Potato Biodiversity to Cope with Frost Risk in the High Andes: A Modelling Perspective. PLOS One 9:e81510.

⁵² Heidinger, H. et al. 2012. TRMM rainfall correction over the Andean Plateau using wavelength multi-resolution analysis. International Journal of Remote Sensing 33:4583-4602.

⁵³ Ndabamenye, T. et al. 2013. Ecological characteristics and cultivar influence optimal plant density of East African highland bananas (*Musa* spp., AAA-EA) in low input cropping systems. Sci. Horticulturae 150:299–311.

⁵⁴ Kissel, E. et al. 2015. Transpiration efficiency versus growth: Exploring the banana biodiversity for drought tolerance. Scientia Horticulturae 185:175–182.

⁵⁵ Taulya, G. 2013. East African highland bananas (*Musa* spp. AAA-EA) ‘worry’ more about potassium deficiency than drought stress. Field Crops Research 151:45–55.

⁵⁶ From RTB Pre-proposal Phase II pg. 3

processing, and utilizing waste or by-products. Projected outcomes include higher farm income and higher incomes in processing industries and allied activities, as well as more nutritious diets. The impact pathways are plausible but feasibility will vary with regional and crop-specific market conditions. Significant progress has been made towards research outcomes with impacts clearly expected in most cases.

Value chain actors have better options for adding value: Research to assess consumer and processor demand for cassava characteristics is underway in five SSA countries (Benin, Cameroon, Nigeria, Sierra Leone, and Tanzania). Understanding preferences for varietal characteristics will inform breeding work that selects for consumer preferences in addition to pest and disease resistance, and may overcome barriers to adoption of improved varieties. For example, in Cameroon, nine of 17 clones selected for cassava mosaic disease resistance were tested for performance in making gari, fufu, and flour were rejected by processors, demonstrating that new varieties do not always meet market demands, without specific attention to breeding for processing characteristics (see Recommendation 8). Studies across these five countries are illuminating the complexities of identifying the best and most important processing and consumption traits for breeding.

Studies are also ongoing to identify high provitamin A carotenoid *Musa* cultivars among those being fast-tracked in eastern Africa, and to increase intake of high-micronutrient *Musa*-based home processed dishes. Several high-pVAC plantain and banana cultivars that compare favourably with local varieties in terms of agronomic characteristics and sensory evaluation, were identified, tested, multiplied and ready for dissemination to farmers in East Africa during 2015. Furthermore, in Uganda, the post-harvest quality (NIRS) lab is contributing to identifying end-user traits such as Beta-carotene, iron, sugars and dry matter in sweetpotato breeding populations so that breeders can identify promising materials in early stages of breeding. In the field, ready to use colour charts for Beta-carotene are helping researchers to compare data obtained in the lab. Collaboration with SASHA II⁵⁷ helps the researchers to continually improve on their current research as sweetpotato research is more advanced than on banana.

The second major post-harvest research area is cassava processing efficiency and waste reduction i.e. more eco-efficient value chains. Research is on-going for starch processing in Asia and SSA, as well as gari processing in West and East Africa. Effective partnerships have been established with processors in Thailand, Vietnam, Tanzania, and Nigeria for collaborative research, problem identification, and extension. These value chain actors have identified a need for greater efficiency in drying, and reduced impacts from wastewater and unused by-products. Specific modelling efforts are underway to scale down cassava starch dryers in order to economically replace sun drying and to test whether use of biogas generated from processing wastes can reduce emissions and fuel costs. In Nigeria, RTB research is looking for ways to improve the efficiency of rasps for gari production. The need to reduce drying costs is a global concern, and this issue lends itself to South-south technology transfers, which may speed up the research and development process.

In South-East Asia, where demand for processed cassava is expanding rapidly, several projects employ some variant of participatory market chain approaches to engage value chain actors for identification

⁵⁷ http://sweetpotatoknowledge.org/projects-initiatives/sasha/Brochure_SASHA.pdf#

of constraints and opportunities, in addition to testing specific technical interventions. Similar projects that link improved production technology transfer to processing expansion are underway in Nigeria and Tanzania. Demonstration projects have indicated the technical feasibility of using waste products for either livestock feed or biogas generation. This research is integrated with pilot studies of processing efficiency improvements and enhanced utilization of by-products. Effective partnerships have been established with both the private sector and with national research systems for delivery to increase production and meet processing needs.

In both West and East Africa, the market for high quality cassava flour is growing, although demand is not yet consistently established. Research is undertaken in response to a perceived need to find more cost-effective technologies for processing and drying. In Nigeria, there is government-mandated replacement of wheat flour with cassava flour, which creates a market for high quality cassava flour, and there is demand among entrepreneurs for more cost effective technologies. In Tanzania, the value chain is more fragile, where cassava production and processing are not policy priorities. Even though the quality of the flash-dried flour is superior to the sun-dried product, the market is not yet ready to pay a premium price. In this case, processing efficiency is not the only constraint to market development. Post-harvest research to support high quality cassava flour processing needs to be more closely linked to value chain research and policy analysis, in order to better identify the impact pathway for new technologies. Involving socio-economists from the beginning of the project would help to better identify market opportunities, and to evaluate whether policies are supporting the best use of domestic resources.

Value chains improve gender equality: Gender is part of the post-harvest surveys and technology evaluations in the above projects. A workshop on “Gender and Value Chains-Sharing Lessons Learned” developed guidelines for mainstreaming gender in RTB value chains, and gender-responsive value chain development tools have been validated in the ENDURE project in Uganda. The consumer acceptance research in West Africa identifies traits and acceptability taking differences in product use by gender into account. In the SE Asia value chain research, gender has been incorporated into the needs assessment and the household surveys on impact. In five East African countries a gender-sensitive value chain analysis was undertaken as part of a collaborative study on banana beverage value chains. Research on gender norms related to marketing of seed and ware potatoes in Malawi demonstrated the importance of addressing underlying social structures in agricultural marketing interventions. RTB is encouraged to continue to integrate gender in value chain projects however mechanisms are need to assess its effectiveness and impact.

Increased availability of diverse, nutrient rich foods: Earlier initiatives demonstrated the efficacy and effectiveness of nutrition improvement through OFSP, and delivered proof of concept results on key bottlenecks in the sweetpotato value chain. Care is taken to measure the impact of OFSP adoption on Vit A intake and utilization in target vulnerable populations. Breeding and seed system improvement research continues under the bilateral SASHA II project. Recent emphasis is on multidisciplinary nutrition and food security research in SSA which is delivering promising outcomes. The bilateral projects Rooting out hunger in Southern Malawi, and the SUSTAIN project in Malawi, Rwanda, Mozambique and Kenya focus on developing models for sustainable scaling of biofortified crops. Scaling-up is supported through a concurrent focus on improving seed systems, behaviour change

communication and nutrition counselling, and strengthening markets for fresh roots and commercial products.

In the RTB pre-proposal for 2017-2022, FP4 for post-harvest and nutrition research is not as focused as the initial Theme 6 efforts. The combination of post-harvest activities with nutrition is not entirely coherent, as nutrition is a cross-cutting outcome, and not simply a post-harvest consideration. An improved, well-articulated ToC is needed. Furthermore, there are a large number of different kinds of research efforts under the post-harvest and nutrition research FP. Not all activities have a well-articulated ToC and some site-specific research may not yield global public goods. RTB should revise the focus of FP4 to specific technologies, policies, or process improvements for RTB crops that will provide the basis for scalability of lessons learned.

Recommendation 12: RTB should focus post-harvest research on the crop-specific aspects of value chain improvements that can deliver added value, as these are most likely to generate global public goods. Assessing lessons from the emerging cassava Theme 6 research results should help to identify transferable lessons and strategies for other RTB crops, providing a basis for scalability of lessons learned.

5.4. Monitoring and evaluation for increased effectiveness

The Evaluation Team assessed the extent to which M&E is used in RTB to provide feed-back on performance for enhancing the likely effectiveness of the program. The focus in RTB has been mainly on monitoring and reporting, rather than evaluation. One reason for this is that there is a specific requirement to produce an annual “monitoring report” to be submitted to the Consortium and there has been less attention to provide lessons for internal adjustment through M&E.

When significant amounts of the RTB funds are managed by the centers the M&E responsibility for the projects in the RTB portfolio rests primarily with them. The Team observed that the M&E systems vary from center to center and RTB does not have a harmonized system in place. As none of the RTB centers have had a CCER since the start of the CGIAR reform program (see Chapter 4), and nor has RTB commissioned any CCEEs, there has been no external assessment of performance either at center or RTB level. Funders of bilateral projects may conduct project reviews based on their own institutional requirements, but such reports were not available for the Evaluation Team.

With respect to monitoring, the existing system is based on PLs, products and achievement of milestones. While this meets the Consortium’s demand for the preparation of annual program monitoring reports, it has three major shortcomings: (1) the number of products monitored is too large (over 500) to allow meaningful analysis and follow-up; (2) according to scientists interviewed and surveyed, the demands on scientist time is excessive and increases transaction costs; and (3) the focus on monitoring is on products and is not linked to financial and management information. When the program monitoring system is not linked with (or is not a part of) a management information system, it is less useful as a decision-making tool, leading to duplication and confusion. In conclusion, it was not clear to the Evaluation Team to what extent RTB management or individual centers are using information from monitoring to adjust their research or the ToCs. Independent evaluations have not been conducted to inform program oversight. This is a matter that should be addressed in the future.

5.5. Conclusions

RTB has made notable progress towards outcomes in all important research areas of its program: the breeding pipeline; quality seed systems; and resilient cropping systems. Furthermore, as has been noted elsewhere in this report, the new program structure with its focus on outcomes and plausible ToCs at FP level is likely to enhance program effectiveness in achieving outcomes and contributing to the impact goals. The multi-center and multi-crop complementary projects have fostered a strong willingness and commitment among scientists to work together towards greater research integration for program effectiveness. RTB must now capitalize on this progress and momentum as it moves forward.

At the same time, the Evaluation Team has identified a number of areas where RTB could improve its effectiveness for enhanced achievement of outcomes for impact. These include the need for improved understanding of both the capabilities of NARS for breeding RTB crops and of end-user needs for specific products to better direct the focus – hence effectiveness - of RTB breeding efforts. Furthermore the Team has also recommended a number of ways in which RTB’s breeders could work more effectively together through a community of practice.

RTB has also laid a solid foundation for future research on developing systems for quality seed, making notable progress both in improving access and supply of planting material to seed producers and small holders. In the future, the effectiveness of this important research could be further improved by recruiting an RTB seed systems expert who would lead necessary research on assessing demand for clean high quality planting material; on understanding the incentives for small holders to purchase quality planting material; as well as mechanisms for strengthening the supply chain with links to marketing and processing.

Some important aspects of crop management research have not been well-supported in the current program, which compromises the ability to integrate crop improvement and management technologies to effectively realize improved yields on-farm. RTB may need to consider rebalancing the RTB portfolio towards agronomic and soil fertility research to address this gap.

RTB should focus post-harvest research on the crop-specific aspects of value chain improvements that can deliver added value, as these are most likely to generate global public goods. Significant progress has been made towards research outcomes with impacts clearly expected in most cases. However several weaknesses have also been highlighted. RTB should focus post-harvest research on the crop-specific aspects of value chain improvements that can deliver added value, as these are most likely to generate global public goods.

6. Cross-cutting activities: gender, capacity development, partnerships and communication

6.1. Introduction

This chapter considers four cross-cutting issues in RTB essential for its effectiveness: gender and equity, CapDev, partnerships and communication and KM. These issues are integral to RTB research for appropriate targeting of constraints and identifying activities which will result in progress towards outcomes. The assessment draws on review of relevant strategies and action plans, project analysis, field visits, stakeholder interviews and the researcher survey.

6.2. Gender and equity

6.2.1. Overview of gender expenditures and staffing

RTB has dedicated W1/W2 funding to gender activities, including for the development of the gender strategy and action plan, gender capacity building of RTB staff and partners, and integration of gender components into activities in four Themes. A few bilateral and complementary research programs also earmarked funds for gender research activities, for example for gender analysis related to OFSP vine multiplication in Bangladesh, and co-funding of the sex-differentiated preference study by the NextGen project. During 2013, 10 percent of total RTB expenditures (USD 6.9 million) were allocated to gender. In 2014, although the expenditure dropped to 6 percent (USD 4.5 million), the quality of gender research was not negatively affected.

RTB has strengthened its scientific capacity to address gender considerably— moving from one specialist in 2012, to nine in 2015. A full-time Gender Coordinator is based at CIP in Lima RTB, and each Center has an RTB Gender Focal Point (GFP). The job descriptions and time allocation of GFPs are not uniform across the centers, which means that gender support via complementary and bilateral projects, and time allocated to joint strategic activities (such as development of the gender action plan) can be variable. Yet, the demand for their input to research design and implementation has grown. Responses to the staff survey indicate that a high proportion of scientists felt that they had insufficient financial resources to implement gender activities (Annex C).

6.2.2. Gender strategy

The RTB gender strategy from 2013 is comprehensive. The first action plan is currently being revised. The overall objective is “to improve food security and reduce poverty while strengthening gender equality. For this to happen, all farmers, both men and women, must be able to benefit from science and technology interventions leading to positive development outcomes”⁵⁸. The strategy distinguishes between two types of outcomes - firstly, RTB research activities (across Themes) are responsive to the differential perspectives, preferences and roles of men and women (gender responsive), thus ensuring that as participants and end-users, women and men benefit. Secondly, it seeks to understand the factors contributing to existing differential access by women and men to

⁵⁸ RTB Gender Strategy 2013.

opportunities and benefits, and explore how these factors can be addressed (gender transformation). From a research design perspective, it uses a two-pronged approach, namely 'gender integration,' which focuses on integrating gender into research programs across Themes and FPs to enhance development outcomes; and 'gender strategic research,' focusing on understanding the roles and relationships of women and men which will create an enabling context for integrated gender research. Given the relatively low initial awareness of gender issues evidenced from stakeholder interviews, and limited capacity to implement the strategy, a step-wise approach was adopted, with an initial emphasis on integrating gender into high-potential PLs, and emphasizing CapDev, strengthening communication and knowledge sharing, building strong partnerships. The CGIAR Gender and Agriculture Research Network, strongly supported by the RTB, provides a forum for networking, and identification of synergies in gender research among CRPs. The gender strategy has proven its worth as a basis for initiating significant pieces of work - including the complementary projects on gender capacity strengthening and support to integrating gender into RTB projects.

6.2.3. *Examples of 'good practice'*

Primarily through the implementation of the Complementary Project "Integrating gender in RTB thematic research to enhance development outcomes" there are now documented examples of gender-integration research in several Themes:

- Key cassava traits preferred by men and women were identified in Nigeria and Cameroon while guidelines were developed to assist researchers in collecting gender-responsive PVS data on potato cultivars. In the NextGen project, the IITA Gender focal point worked with scientists to identify sex-differentiated trait preferences and to turn these preferences into standardized measurable units – this work is considered outstanding amongst CRPs. Gender has also been mainstreamed into the Mother and Baby Trial protocol through collaborative efforts between gender and biophysical scientists.
- Data collected on social and gender factors are now influencing management of pest and diseases in Asia and several African countries.
- A case study on gender and potato seed system in Malawi has been published; gender analysis on sweetpotato seeds systems was also conducted in Malawi and Bangladesh; and guidelines were developed on gender mainstreaming in seed production and multiplication.
- Responsive tools and applications were developed and tested in East Africa for post-harvest and value chain research.

Close working relationships between gender specialists and biophysical scientists on a number of the above activities served to demonstrate the importance of mainstreaming gender to achieve gender equitable outcomes and improve project performance and outcome for clients. Gender achievements in RTB have been noted by the CO.

As part of strategic gender research, RTB has played an active role in the GENNOVATE initiative, which will seek gender transformative outcomes through a nuanced understanding of factors that influence women's and men's ability to benefit from innovations, and explore ways to ensure equitable improvements in agricultural outcomes. Initial findings from GENNOVATE case studies indicate that gender norms are changing, enabling increased adoption of innovations and fostering women's economic empowerment.

6.2.4. *Gender tools and disaggregated data*

In response to requests from scientists, the gender team has worked on the development of a range of tools for gender analysis in different thematic areas, including PVS, pest and disease management, and value chain development. These tools are in different stages of readiness for testing and implementation. They were developed in a participatory manner, involving a range of RTB scientists and partners, which according to feedback from interviews contributed to buy-in, and should support the adaptation and wider dissemination of these tools. Guidelines on sex-disaggregated data collection and analysis were also prepared and progress is being made on ensuring that scientists use these approaches in research design and analyses. With guidelines available for adaptation in different contexts project teams should be able to implement gender sensitive research, and design gender responsive programs with less reliance on the gender research specialists. This would enable gender specialists to focus their attention on strategic areas where specialized gender integration skills are required.

6.2.5. *Assessment of progress on strategy implementation*

As a result of management support, effective advocacy and capacity strengthening activities, awareness of the RTB gender strategy is generally high throughout RTB, and GFPs indicated that there has been an increase in demand for professional input on gender in projects. Nevertheless, there is also concern that the commitment to gender on the part of biophysical scientists is still ‘fragile’. This is reflected in the staff survey in which only 17 percent of respondents clearly supported (agreed or strongly agreed with) with the statement that the strategy influenced the way RTB teams planned and carried out their work. A higher proportion of respondents (31 percent) clearly perceived that their own team uses the strategy, however. Opinions were strongly divided on whether or not gender is receiving ‘too much’ attention in RTB: nearly 30 percent of researchers *strongly* felt (6 on a six-scale) that “there is too much emphasis on gender”—but 14 percent *strongly* disagreed. This suggests that the RTB gender researchers need to work more closely with scientists to demonstrate the importance of its integration into RTB’s activities.

Some of the challenges in mainstreaming gender relate to incentive systems in centers. For example, work plans and performance appraisals do not consistently require evidence of attention to gender issues. In CIP, this problem has been addressed by ensuring that gender is incorporated in the work plan of the DDG-Research, and since work plans ‘cascade’ through the reporting line, this ensures that the work plans of scientists in the reporting line must indicate how gender will be addressed, and that it will be included in performance monitoring. Where this is not already done, similar strategies should also be implemented in other RTB centers.

Gender specialists have also recognized that the ‘sensitization’ process has to be reciprocal – social scientists, including gender specialists, need a sound understanding of the nature and context of biophysical research activities, while biophysical scientists need to develop a good understanding of how gender relates to every stage of project design and implementation, and the benefits to their work of paying attention to gender issues. The strategic and gender integrative research has contributed to building a culture of interdisciplinary work, and strengthened relationships between scientists in the different participating centers.

6.2.6. *Gender, CapDev and partnerships*

RTB has a gender CapDev plan from 2013 targeted to RTB researchers and stakeholders and has made good progress in building a training program throughout Asia, Africa and Latin America (80 scientists and partners trained in three regional workshops). The gender training program used adult learning approaches, for example, actively engaging participants in implementing gender-sensitive analytical approaches during their training. Several other Theme-specific gender training workshops were also conducted, including on PVS and nutrition. To strengthen overall capacity, and strengthen collaboration with international gender scientists, an RTB University Partnership Linkage fund initiative was launched. Through this initiative and engagement in individual projects, masters students from local and foreign universities participated in data collection and data analysis on several projects. CapDev was also included in engagements with national partners. For example, the Bioversity GFP worked with partners in four countries in East Africa to conduct gender sensitive value chain research and to analyze and use data for gender responsive value chain program design. Ongoing CapDev is needed to enhance partnerships with national universities, including strengthening qualitative and quantitative research skills to conduct gender research – among graduate students and young researchers.

The gender team has built strong partnerships and collaborative approaches both within RTB, among the RTB GFPs, with other CRPs, such as PIM, with academic institutions and other local and international partners. A joint workshop on gender and value chains with PIM resulted in a PIM-funded proposal on 'A Multi-center learning and scaling initiative for enhancing PIM value chain tools and improving smallholder participation with a gender lens. CIP, CIAT, ICRAF and Bioversity are involved.

According to the staff survey, the greatest achievements of RTB gender work were that research results are disaggregated by gender whenever appropriate that training is equitably targeted between men and women (50 percent and 45 percent, respectively agreed or strongly agreed). The 2013 and 2014 Performance Monitoring reports indicate that RTB came close to, met, or exceeded most of its targets on gender-specific indicators related to FPs and tools. With regard to training and CapDev, it exceeded its targets for women trainees in short-term programs, particularly during 2014, when an explicit focus was placed on training women on crop management (in Bangladesh). Male and female participation in long term training programs facilitated by RTB is about equal, with 62 men and 59 women newly enrolled in 2014.

6.2.7. Conclusions

It is evident that RTB has made substantial progress on increasing the gender responsiveness of research activities. The W1/W2 funding allocated for the development of the Gender strategy, CapDev on gender, and support for the integration of gender analysis in project design and implementation has been essential to achieve these gains. Much of the gender work has been in the form of case studies, and while some attempts were made to consolidate findings, the work is somewhat fragmented. It is anticipated that the collaborative analysis of the case studies in the GENNOVATE project will contribute significantly to strengthening capacity for rigorous consolidation of case study research, to continue to build the evidence base for the use of gender analysis and gender responsive project planning. The value of attending to gender and social equity considerations has been demonstrated during Phase I. It will be important to ensure that gender and social equity considerations continue to feature prominently in RTB research activities across the RTB portfolio during Phase II.

6.3. Capacity development

CapDev has been an integral part of the RTB strategy from the beginning. A focus on joint learning and capacity development becomes even more important as the focus in RTB shifts from outputs to outcomes. CapDev is thus intrinsic to RTB projects, FPs and CoAs and is included in their design.

6.3.1. Capacity development approach

The main aim of capacity development in RTB is to ‘enhance partner capacities, better reach potential end-users, and support strategic, innovative learning approaches and investment to achieve significant and measurable development impacts’⁵⁹. Each Theme identified specific capacity strengthening activities, mostly focused on building research capacity among partners, and to a more limited extent, end user capacity. Several Themes identified the need to develop knowledge products and improve research infrastructure. In support of the RTB strategic objectives, in the cross-cutting Theme 7, PL4 on Capacity strengthening set specific objectives related to research capacity, enhancing effectiveness of capacity strengthening efforts, and strengthening capacity for participatory research and approaches to enhance uptake of research.

The intention was to create an RTB community of practice on capacity strengthening and to support the development of quality learning materials, processes, (field guides and training manuals), reusable learning objects, protocols and analyses of RTB best practices. However currently centers have limited staff capacity to implement CapDev.

6.3.2. Progress in capacity development

Progress was considered with regard to three focus research areas related to three CapDev objectives articulated in the original RTB proposal, namely:

- a) enhanced partner research capacities
- b) reaching end users; and

⁵⁹ RTB Proposal 2011.

- c) implementing innovative CS strategies, including materials development.

Enhancing partner research capacity: Activities included developing the capacity of individual researchers and research teams within RTB and among local research partners, and to a lesser extent organizational capacity through research infrastructure development, research management systems and shared data-management systems.

CapDev of scientists from different disciplines through training, researcher exchange and networking (e.g. NextGen and MusaNet) serve to update technical skills, in areas such as cryopreservation and banana virus detection and clean seed principles and in gender issues (see 6.2).

Through fellowships and bilateral grants, degree students (many from countries where research is conducted) participate in data collection and analysis, and are given opportunity to develop topics further and use the data for their academic research.

Examples include:

- DH project at CIAT has provided good research opportunities for young researchers from Uganda and Colombia, including one completed PhD;
- NEXTGEN will support 8 PhD students from SSA - one was based at IITA;
- Complementary project on BBT Learning Alliance includes 3 PhD and 5 Masters students;
- Complementary Post-Harvest project included 2 post-docs (one with IITA in Tanzania, one with CIRAD in Thailand); and
- IFAD/EU funded project in Uganda includes three Masters candidates being support by project partners and respective universities.

Significant progress has been made in ensuring gender equity in staff and graduate-level training. More post-doctoral opportunities are needed to ensure that graduates are prepared for leadership positions in national and international research institutions.

High-quality research facilities also serve CapDev through collaboration between RTB centers and national institutions. The IITA Bioscience Centers in Nigeria and Tanzania are considered very important for CapDev within RTB. They have trained and mentored 80-100 students including 50 Masters and 10 Ph.D's in breeding trials, data collection and management. They could become Africa-wide training centers if they could link up with local and international partners. The BecA-ILRI hub in Nairobi also serves CapDev of RTB scientists. BecA has a strong focus on capacity building - through the Africa Biosciences Challenge Fund (ABCF) it provides 12-month fellowships for national center scientists. BecA also provides a wide range of training programs (e.g. on how to analyze and manage data; how to set up breeding platforms), Agricultural Research Connections Workshops and BecA Hub Networking events. These activities benefit both RTB scientists and partners.

Reaching end users: Participatory workshops and training sessions, including project inception workshops provide opportunities for joint learning between RTB scientists and local partners, including end users. During 2014, RTB put particular emphasis on training women, and reported participation by more than 22,000 women, in South East Asia and Africa in short term training on sweetpotato crop management practices. Other examples include: more than 200 farmers and 20 technicians trained in preventing and managing Moko disease in plantain in Latin America and the

Caribbean, contributing significantly to mitigating the impact of the disease by benefiting smallholder households that depend on the crop. In SSA, utilizing demonstration sites, 500 stakeholders (25 percent women) from INERA, the Food and Agriculture Organization of the United Nations (FAO), NGOs and farmers associations were trained in techniques to control BXW. Through ToT, 250 agronomists and 2000 lead farmers (20 percent female) were also trained; a good example being in enhancing on-farm capacity for producing clean seed in SSA (see Chapters 4 & 5). Hence RTB is strategically targeting capacity development especially for women end-users by responding to their needs.

Innovative CapDev strategies, materials development: Several innovative CapDev strategies were utilized. Examples include: participation in networks, such as the genetic resources networks, MusaNet and CLAYUCA provided ready access to up to date knowledge and methods. The Complementary project on gender mainstreaming provided resources to strengthen gender awareness, and developed and tested tools and strategies to mainstream gender into activities in four of the RTB Themes. Working together on tool development and testing, social scientists and biophysical scientists had the opportunity to develop a better understanding of each other's approaches and methods. A recent exchange visit by cassava scientists to Latin America was mentioned as a very effective way of learning and sharing experience across centers and regions. Extending knowledge sharing to interactions with the private sector has started (e.g. the Kampala meeting on end-user driven breeding on RTB) and greater efforts to engage with the private sector in this way may be fruitful. Other innovative capacity development initiatives, such as the Youth Agripreneurs initiative in Nigeria, show promise but need to be grounded in exposure to the realities of agri-food enterprise development.

A range of learning materials have been developed and disseminated. The Reaching Agents of Change (RAC) project successfully tested innovative approaches to strengthen organizational and individual capacity to advocate for increased investment in OFSP programs and projects and for policy change to combat vitamin A deficiency among young children and women of reproductive age (CIP). The project produced a seven-volume toolkit on Everything You Ever Wanted to Know about Sweetpotato; a training of trainers manual – published in English, Swahili, Portuguese and French; a five-volume toolkit on Engendered Orange-fleshed Sweetpotato Project Planning, Implementation, Monitoring and Evaluation– published in English and Portuguese; and three OFSP investment guide products to help advocate for increased investment in OFSP by country leaders in Africa. These were widely distributed and are available on the web.

In the researcher survey on RTB's CapDev, only a few agreed strongly that individual (1 percent) and inst/organizational (0 percent) CapDev are very well addressed. But majority of respondents agree more or less that CapDev is designed to enhance effectiveness (60 percent), and that it is well integrated into research (55 percent).

6.3.3. Conclusions

As the new CGIAR CapDev framework illustrates, CapDev is multi-dimensional. There are a wide range of needs and many objectives, and priorities vary widely from region to region, and between crops. While strong contributions have been made to capacity strengthening, particularly with regard to enhancing individuals' research capacity, training end-users, and implementing innovative learning

strategies, CapDev efforts remain largely project based, and heavily reliant on W3/bilateral funding. The accountabilities of Centers and CRPs for CapDev outcomes are not yet clearly defined. RTB's CapDev initiatives need to be coordinated with others, including regional initiatives aimed at addressing high-level human resource constraints in agriculture (such as the World Bank's WAAP). This will also help to ensure that RTB crops are included in forecasting studies and curriculum reform in tertiary education.

The recent RTB focus on gender capacity strengthening has delivered impressive results over a relatively short period. RTB could consider using a rapid assessment approach to identify and prioritize specific focus areas for capacity development. An approach similar to that used on gender (inviting proposals for Complementary funding) could then be used to provide financial support for robust needs assessment, strategy development and implementation in those areas. This could include providing support to build research into capacity development activities at all levels.

6.4. Partnerships

RTB has always placed strong emphasis on partnerships. In addition to embedding strengthening of partnership as an objective of each Theme, Theme 7 was devoted to enhancing impact through partnerships. This emphasis was informed by a recently completed comprehensive study on partnerships literature conducted by CIP⁶⁰ and involving key RTB staff. Respondents in the researcher survey considered partnerships most helpful in increasing the relevance, effectiveness and efficiency of their research.

6.4.1. Partnership strategy

RTB has seems to have employed a three-pronged strategy in the area of partnerships: learn about existing partnerships - "stocktaking"; strengthen the bonds between the centers making up the RTB alliance; and improve existing stakeholder partnerships and build new ones as guided by research priorities and funding opportunities.

Stocktaking: RTB commissioned the Institutional Learning and Change Initiative (ILAC)⁶¹ to conduct a study of existing collaborations as a baseline to monitor changes in collaboration profiles over time. Using social network analysis based on questionnaire survey among RTB scientists to diagnose networks of relationships, this study is important because it introduced to CGIAR a new approach to studying partnerships and complex networks. But in the case of RTB it revealed much less than expected about partnerships, partly because of challenges in data collection and the narrowness of the study's scope (covering only RTB scientists and not their collaborators).

Perhaps the most important finding from the study is that, of the 702 collaborations identified by the scientists, 19 percent were reported as "induced by RTB"⁶². During its first year RTB enabled particularly collaborations with other—mainly alliance—centers. By contrast, among the non-RTB induced collaborations, NARS (33 percent) and ARIs (25 percent) surpassed those with the centers.

⁶⁰ Horton, D. et al. 2009. Perspectives on Partnerships: A Literature Review. CIP.

⁶¹ Project hosted by Bioversity and closed in 2015.

⁶² Responses to the question: "Did your collaboration with this partner start as a result of the RTB program?".

Overall, RTB's partnerships were largely "traditional" but since RTB has made progress in establishing or strengthening links with non-traditional partners, such as the private sector.

The social network analysis revealed a network of weakly connected actors with few reciprocal connections, meaning that there were no central actors or nodes in the network. The disconnected nature of the network is partly explained by the way the alliance was formed: bringing under the RTB umbrella a large number of existing projects without a unifying strategy.

The data about the RTB network so early in its life will have little value without a comparable follow-up study. Apparently, ILAC has conducted a follow-up survey including RTB. It would be in RTB's interest to have the RTB portion of the survey data analyzed, especially for items that can provide a comparison with the 2012 data although additional funds would be needed.

Strengthening the RTB alliance: RTB used principles of equity and fairness in building the governance, management and coordination structures of the alliance (see Chapter 8). As far as possible, all centers were represented in all major G&M bodies and program leadership. A high quality PMU gained the confidence of all parties in short time because of its fair handedness and open communication. These were all steps in the right direction to building trust and strengthening interdependence and commitment. It will be important to ensure that the culture of collaboration that is being built at the central level extends to the work conducted at the regional level.

In addition, RTB took two important steps to strengthen the alliance: admission of a strategic partner and allocating funding for complementary projects. The inclusion of CIRAD in 2013 as a strategic partner brought new research skills and greater geographical coverage for RTB building on earlier cooperation among CIRAD and RTB scientists. In 2013, 57 scientists of CIRAD and its French partners were working on RTB crops. CIRAD has joined RTB's governance (ISC) and management committees (MC) as a member and takes part in program coordination as needed⁶³. During 2013-14 CIRAD received USD 533,000 from RTB (W1/W2 funds) for the complementary project it was managing and for administrative support for RTB.

Complementary projects supported by W1/W2 funds greatly strengthened the alliance. This helped to break the "silo" nature of center operations and improved collaboration and trust among the scientists by facilitating integration of research by centers working on the same crop (namely banana and plantain and cassava) and initiating research on problems common to all RTB crops (including pest risk assessment, seed systems and post-harvest problems). The value and outputs from these projects are considered in detail in Chapters 4 and 5. As a by-product, these projects forged new partnerships with ARIs. Thus, they facilitated programmatic integration, helped build trust across the RTB alliance and capture synergies and complementarities across centers and across crops.

Partnerships with key stakeholders: Each RTB center has had long-standing partnerships with their key stakeholders. RTB has benefited from this strong base and has brought added value to these partnerships in several ways: transforming bilateral partnerships on a single crop into broader partnerships across centers and crops; strengthening ties with stakeholders by engaging them in RTB

⁶³ In 2013 a CIRAD scientist served as leader of Theme 6 and another as Focal Point for CIRAD. Also, a CIRAD scientist led a complementary project.

planning exercises; bringing several existing stakeholders together in addressing a common problem (e.g. learning alliance for BBTB in SSA, Africa Yam Project, Stakeholder Forums for RTB).

RTB annual reports provide a (cumulative) list of partner institutions. The 2014 report lists close to 300 partner organizations, though active partnerships exist with only half. The 2013 data show that RTB has disbursed USD11.9 million of its USD69.0 million (17 percent) actual spending for the year to 155 partners with almost 90 percent from W3/bilateral funds. The partnership profiles described below are based on the Team's observations during site visits.

Partnerships with national institutions: The RTB centers' history of productive collaboration and excellent partnership development with national institutions was evident in site visits. Respondents in the researcher survey considered NARS to be their most important partners closely followed by universities in target countries. In Vietnam, partners were generally satisfied with their relationship and appeared to operate independently with support from CIAT and to a lesser extent from CIP. In Nigeria and Ghana, the national cassava and sweetpotato breeding programs, respectively, are well-integrated with RTB activities. There is also good collaboration on yam, including joint research in the Africa Yam Project⁶⁴. Bilateral projects such as Harvest Plus, SASHA, funding from AGRA, RAC, and Jump Start etc. help to support both CIP and partners. IITA, Bioversity and NARS work together to develop clean planting material through the BBTB Learning Alliance, which has significant capacity building component.

In Kenya, CIP's activities are well-integrated with NARS including KALRO and KEPHIS. RTB has enhanced these partnerships through joint projects and publications. In Tanzania, RTB has a very strong network of partners based on many years of collaboration with centers. IITA has a hosting agreement with Department for Rural Development (DRD) which facilitates strong working partnerships with all five regional RTB crop institutes throughout Tanzania. In Uganda, NARO's partnership with CIAT, IITA and CIP in Uganda has a 30-year history. NaCRRI, Namalonge appreciates the long-term partnerships with CIP and IITA as this has facilitated collaboration with many Advance Research Institute (ARI) partners, mobilised funds and produced useful information and publications. NARO now has many experienced researchers who lead on major areas of RTB research in Uganda (e.g., banana and cassava breeding.) and jointly publish (see Chapters 4 and 5). The partnership between Bioversity and NARO banana researchers in Uganda is less clear as some Bioversity researchers were recently former NARO scientists.

The IFAD FoodStart (FS) project in five Asian countries has collaborated with IFAD investment projects, and claims one major success story in extending a model for farmer business training through a project in the Philippines. While such training may be a useful tool for project implementation, this effort was not linked to production or nutrition research conducted under FS in the area. And, most of the expected impact from the farmer training will not be in RTB crops, as they were not the focus of resulting value chain efforts. This example suggests that some evaluation of lessons learned from such partnerships would be useful, in order to better utilize these opportunities.

⁶⁴ The Africa Yam Project funded by the BMGF (in 2014 for 5 years) will build capacity for yam breeding in IITA and the NARS. Many of the concepts in the AYP have spilled over from the NextGen cassava project.

Regional and sub-regional organizations: Sub-regional organizations such as the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) work with RTB centers directly rather than through RTB. ASARECA has been involved in various activities including: cassava breeding for virus resistance and seed systems, management of BXW, banana value chains, potato seed systems, and distribution of clean planting material of OFSP. ASARECA has formed a direct link with WHEAT through a MoA with CIMMYT, enabling development of joint-funding proposals on problems of importance to the region. Given the importance of RTB crops for the region, a similar arrangement with key regional and sub-regional organizations (such as IICA, FARA, CORAF, ASARECA) could make a difference in facilitating development of joint proposals and providing visibility to these crops in the donor community and the policy-makers in the region.

Partnerships with the private sector: Although respondents in the researcher survey did not consider the private sector to be amongst RTB's most important partners, there are several excellent examples of RTB's successful and mutually beneficial collaboration with private sector in mass propagation: tissue culture and mini-tuber companies in Africa for production of basic seed in Kenya (GTIL), Tanzania (Crop Biosciences), Uganda (Uganda) and Ghana (Biochemical Products) (Chapters 4 and 5). In addition, private cassava processing companies have been engaged across three developing regions to identify processing constraints, model processing efficiency, and test new approaches. Partners include Deriyuca (Colombia); Codipsa (Paraguay); VP Starch 2000, Banpong, TQS (Thailand); and Niji Luka, Nobex (Nigeria); as well as various small processors in Vietnam. Furthermore, Fresh Logistics, a food crop exporter, works in partnership with the ENDURE project to improve storage techniques for matoke bananas with potential to promote a major export crop from Uganda to Europe. In comparison to the ILAC study of 2012 which noted very limited engagement with the private sector, RTB's partnerships with the private sector have grown rapidly in the past 3-4 years, contributing to future sustainable outcomes.

Partnerships with ARIs: Respondents in the researcher survey rated ARIs as their second most important partners. Many of these partnerships have built the capacities of RTB and other partner researchers for further research after projects have been completed. Examples are given throughout Chapters 4 and 5. The Evaluation Team commends RTB for its successful efforts in attracting needed skills for research on RTB crops by establishing strategic partnerships with selected ARIs mostly through bilateral but also complementary projects.

CGIAR partnerships: Many respondents in the researcher survey agreed that "RTB provides good incentives for cooperating with other CGIAR partners" and that RTB has been effective in "enhancing synergies between Centers." At the same time, CGIAR centers were not listed among the respondents most important partners. But there are examples of cross-center partnerships that involve research on RTB crops but are not systematically linked to RTB. For example, CIP and IITA scientists collaborate with Water, Land and Ecosystems CRP and CCAFS on topics such as soil and water management, components of climate change and modelling. As these activities mapped to other CRPs, they are not explicitly linked to RTB. As was noted in Chapter 5, concerted efforts should be made in Phase II to document all of these partnerships as outputs from them should feed into the RTB livelihood systems FP.

RTB also has programmatic links with a number of CRPs although respondents in the researcher survey rated such links as the third least important partnership. The most visible links are with four CRPs: Humidtropics, A4NH, PIM and L&F. These partnerships vary in terms of their quality and strength. L&F is working with RTB to develop livestock feeds from processed cassava peels. This is a superb example of cross-center (IITA, ILRI and CIP) and cross-CRP collaboration (HT, RTB & L&F) with good potential for outcome and impact. In a similar vein, research on dual-purpose sweetpotato varieties for human nutrition and as animal feed is on-going in Kenya and Rwanda and is being extended to Uganda, Ethiopia and Burundi. In Uganda, this research on use of sweetpotato silage fosters collaboration between NARO, CIP and animal scientists from ILRI and Makerere University. It will also target young entrepreneurs to develop this as a business in collaboration with farmers and farmer organizations.

Some partnerships between RTB and Humidtropics are a “work in progress.” Collaboration has generally worked well through the innovation platforms where IITA scientists are involved in both CRPs; less so when other centers are involved. As a result, the process of developing joint work at the shared action sites has been long and difficult, but is now starting to function. As Humidtropics will close at the end of 2016, the inclusion of a systems FP in RTB should facilitate more opportunities for integration.

The relationship with A4NH is complex. RTB objectives include a clear focus on improving nutrition and food security, particularly of vulnerable populations. As the final link in the value chain, delivery of nutritious RTB foods to consumers, creating awareness of the nutrition and health benefits of those foods, and advocating for greater attention to these crops in national policies and strategies are included in RTB’s Theme 6. In this regard there is significant overlap with the aims and activities of A4NH. Research on biofortification and the promotion of diversified diets is in most instances mapped to A4NH. Research on OFSP has however been mapped to RTB from the inception of the CRPs, even with funding received from HarvestPlus (which is mapped to A4NH).

As biofortification extends to other RTB crops, notably banana and cassava, some confusion has arisen over where these activities should best be mapped. In Uganda, for example, Harvest Plus is funding research on access to and consumption of nutritious RTB foods (Vitamin A, Fe and Zn) with Bioversity and NARO. There is lack of clarity as to whether this project is being implemented under RTB or A4NH. This raises a concern regarding how the breeding for high nutrient content is best integrated with breeding for other desirable traits. Mapping to RTB is necessary to achieved desired integration in breeding programs.

Both RTB and A4NH need to seriously tackle this confusion and lack of clarity about the roles and responsibilities in nutrition research. Enhancing communication and establishing a community of practice, as planned for Phase II, between the scientists in RTB and A4NH involved in nutrition research would be a good starting point. Another good initiative would be to develop a common reporting system for scientists, as some need to report to both CRPs on their work.

PIM’s value chain research seeks to develop common tools, frameworks, and lessons from CGIAR research in this area. After initial difficulties in establishing collaborative equality, RTB’s post-harvest research now has strong linkages with this research. RTB social scientists participate in the PIM Value Chain working group. Results of PMCA and related gender tools developed at CIP have been shared through PIM. The value chain activities are beginning to morph into an improved inter-center

collaborative FP. RTB and PIM also collaborated in the PA exercise (see Chapter 3). There is little mention of the added value from working with RTB in PIM's documented outputs. The duplication of mapping tools in PIM and RTB should be assessed in future to determine how best to serve the needs of researchers for spatially explicit data.

Partnership platforms: RTB centers have a strong track record of establishing and/or coordinating partnership and learning networks of several kinds. These platforms also serve as incubators and facilitators of future partnerships with RTB. Examples include: ProMusa, a knowledge sharing platform on bananas with a lengthy and successful track record; The Global Cassava Partnership for the 21st Century (GCP21), partly sponsored by RTB and its associated networks (e.g., Pan-African Cassava Surveillance Network); Platform on shared databases and bioinformatics to support next-generation breeding of RTB crops, established with the Boyce Thompson Institute for Plant Research and Cornell University; the BBT Learning Alliance; and various stakeholder forums on RTB (such as International Society for Tropical Root Crops and various breeders associations).

6.4.2. Conclusions

Partnership is a major strength of RTB. As each center already had established healthy relationships with many institutions, RTB has capitalized on these associations and broadened them where opportunity existed. Engaging partners in RTB research planning and implementation has contributed to stronger bonds and commitment in research. Similarly, partnership platforms and continent-wide projects have facilitated collaboration with all types of stakeholders. Partnerships with private tissue culture facilities in Kenya, Tanzania and Uganda have proven to be important for servicing the production of clean planting material for RTB projects. RTB partnerships with other CRPs are still mostly a "work in progress" but the foundation has been laid for enhanced collaboration in Phase II.

6.5. Communication and KM

RTB planned to adopt a comprehensive approach to communication and knowledge sharing. The intent was to reach a wide range of stakeholders, from farmers and delivery agents, to local and international researchers, as well as policy makers. A media and communication strategy was developed in 2013, focusing largely on developing the RTB web portal and tools for promotion and advocacy for RTB crops and the RTB platform. The strategy identified key audiences and messages, and specific strategies related to capacity for communication, online presence, meetings and events, and publications and products. While the Evaluation Team considers that the strategy is appropriate and comprehensive, its implementation has been less certain as it rested almost exclusively with the RTB communications focal point. Interviews with communication specialists in different centers identified a lack of clarity on their roles with regard to CRPs. RTB's branding and publication guidelines, first published in 2013 and updated regularly should be more actively used to enhance RTBs visibility.

RTB continues to be actively involved in an informal community of interest/practice on communication and KM (<http://kmc4crps.wikispaces.com>).

Chapters 4 and 5 have also raised a number of communication and KM issues that affect science quality and program effectiveness. These are especially important in the breeding pipeline where there are needs for mechanisms for improving communication and data sharing.

6.5.1. *Examples of communication and knowledge sharing activities:*

RTB Communication and knowledge-sharing platforms:

- The RTB website includes access to news, working papers, links to CGIAR-partners and CIRAD (but no active links to a long list of other partners). While news items are up to date, other resources, such as publications and reports, are quite dated.
- A range of global and regional Research for Development networks and knowledge platforms are in operation including MusaNet and Promusa (for information sharing and stakeholder interaction) and the MGIS.
- RTB also participates in other platforms, such as CLAYUCA (cassava) and RedLatinPapa (potato). CIP launched the Sweetpotato for Profit and Health Initiative (SPHI), including an active Community of Practice (CoP) on sweetpotato breeding. The Sweetpotato Knowledge Portal (<http://sweetpotatoknowledge.org/about/>) funded under SASHA, Clone Selector program and a germplasm access database also support the CoP.
- RTBMaps⁶⁵ recognized by Computerworld 2014 for its effective use of big data analytics, brings together spatial information on RTB crop distributions, abiotic and biotic constraints, socio-economic conditions and other information relevant to these crops.
- A review of the use of innovation platforms as vehicles for disseminating sweetpotato technologies and practices provided important lessons for scaling-up new technologies through partnerships and capacity strengthening in SSA⁶⁶.

Other examples of knowledge sharing activities:

- In 2013, CIP published an interactive user-friendly catalog of Advanced Potato Clones and Varieties on line and in DVD in 7 languages. It represents a valuable tool for documenting intellectual assets and communicating the availability of elite bred clones.
- Through collaboration with FAO's regional office for plant protection, information packages were widely diffused to 900 farmers (30 percent of whom women) in the principal plantain-production zones of Colombia. The packages were also made available online through FAO, Musalit, and Agronet (Colombia) enabling stakeholders from Latin America and elsewhere to benefit from pertinent information.

RTB is committed to progressively implement the CGIAR Open Access and Data Management Policy. To increase impact of results, the various RTB databases will need to 'speak to each other.' The methodology for the implementation of the Open Access and data management policy at RTB would be developed during 2015-2016, and be fully implemented by the end of 2018.

Examples of knowledge sharing and communication activities, representing several Themes/PLs and participating centers, demonstrate that RTB researchers and partners have started to adopt innovative approaches to knowledge sharing. Interviews during field visits suggest that at project level, efforts are being made to work with communication specialists during the early stages of project

⁶⁵ <http://www.rtb.cgiar.org/RTBMaps/>

⁶⁶ Kimenye L. and McEwan M. (Eds) 2014. Scaling up, Dissemination and Adoption of Agricultural Technologies using Innovation Platforms, Lessons from Eastern and Central Africa.

design, so that there can be adequate planning and budgeting for communication activities. A strategic approach to communication and KM, drawing on experience gained during Phase I, will be needed to realize the potential of these activities to contribute significantly to achieving RTB's objectives.

6.5.2. Conclusion

The Evaluation Team agrees with RTB management (as stated in Phase II pre-proposal) that a comprehensive and adequately resourced KM and communication strategy is essential to support the shift in focus towards achieving greater impact through research. The proposed CoA on KM, CapDev and communication adopts a research-driven approach, focusing on the use of ICT-smart communication strategies, and scaling RTB's KM experiences through advancing networks, portals and other innovative methods.

Recommendation 13: It is recommended that RTB management ensures that adequate resources are made available to develop and implement the needed strategy for communication and knowledge management. Flagship and CoA leaders as well as bilateral project leaders will need access to communication and knowledge management expertise, and be enabled to incorporate knowledge management 'experiments' into the design of new projects to achieve the ambitious intentions laid out in the pre-proposal. A strategy similar to the one proposed on capacity development (and drawing on lessons from the approach adopted to address gender issues) is recommended.

7. Impact and sustainability

7.1. Introduction

The purpose of this chapter is to review the impact assessment evidence published since 2007, which reflects the impact of research prior to RTB, evaluate the current RTB impact assessment projects, and to provide recommendations for future efforts. For assessing the past impact of RTB centers, the Evaluation Team used impact narratives and evidence provided by each of the four RTB centers among other documented evidence of past impacts.

Impact assessment⁶⁷ is an on-going challenge for the entire CGIAR system. The episodic nature of most research funding creates a gap between funding availability and the timing of impact. Assessing impacts requires resources, including surveys to create a baseline, and follow up surveys to assess impact before and after the introduction of a new technology. Thus, it can be difficult to build into bilaterally funded research.

Impact assessment is particularly challenging for the RTB crops. As noted in the original RTB proposal, these crops often do not have good national production data and hence indicators of adoption and productivity are difficult to monitor. Furthermore, RTB faces the challenge of integrating impact assessment across four centers with varying histories and cultures of impact assessment. CIP has made a consistent effort to carry out *ex-ante* and *ex-post* assessments and to review and synthesize results⁶⁸. On basis of the impact narratives, it appears that at other centers, there have been multiple one-off studies at a very micro level that do not easily lend themselves to assessing impact at a larger scale.

The need to adequately understand and document impact has been recognized, and major new initiatives have been funded through bilateral projects under the Standing Panel on Impact Assessment (SPIA). The recently completed DIIVA (Diffusion and impact of improved varieties in Africa) study undertook a systematic look at adoption of improved varieties for 20 crops in SSA, including the major RTB crops cassava, yam, potato, banana, and sweetpotato⁶⁹. This assessment is being extended to other regions, and to testing better methods of variety identification. Under the Strengthening Impact Assessment in CGIAR (SIAC) initiative, new efforts are underway to establish the means for tracking impacts beyond varietal adoption, such as poverty reduction and improvements in natural

⁶⁷ Impact assessment refers to measuring the long term impact of CGIAR research on societal goals. These can be proxied by measures of technology adoption, productivity, incomes, poverty, food security, and gender equity. Ideally, impact assessment is part of a continuum of research prioritization and evaluation, beginning with quantitative priority setting, *ex-ante* evaluation of potential research endeavors, periodic review and refocusing, and finally impact assessment to determine whether research activities achieved their intended goals.

⁶⁸ For instance Fuglie, K. and G. Thiele, 2009. "Research Priority Assessment at the International Potato Center (CIP)" in *Prioritizing Agricultural Research for Development*, eds D.A. Raitzer and G.W. Norton, CAB International.

⁶⁹ Walker, T. et al. 2014. Measuring the Effectiveness of Crop Improvement Research in Sub-Saharan Africa from the Perspectives of Varietal Output, Adoption, and Change: 20 Crops, 30 Countries, and 1150 Cultivars in Farmers' Fields. Report of the Standing Panel on Impact Assessment (SPIA), CGIAR Independent Science and Partnership Council (ISPC) Secretariat: Rome, Italy.

resource management. These current research projects will lay the framework for more systematic assessment of various kinds of impacts in the future.

7.2. Results of impact assessment studies

Each Center had an EPMR during 2008 or 2009⁷⁰. With the limited availability of center studies on adoption and longer term impacts, these reviews focused on outcomes of research (eg. number of new cultivars). Three of the reviews commented on the weaknesses in impact assessment activities, and all noted that there was a need for improvement or enhanced integration of such activity into program planning. All of these reports point to the difficulties of measuring impacts rather than research outputs; sustaining investments in impact assessment; and integrating impact assessment into program planning (see section 3.1.5 regarding use of *ex-ante* impact assessments in RTB).

This section reviews the overall evidence regarding impact of RTB technologies, most of which pre-date the CRP. This section draws from the DIIVA study and from summaries provided by each of the RTB centers of studies published since 2008.

7.2.1. Results of DIIVA study on RTB crop adoption in SSA

The DIIVA report provides a comprehensive assessment of the adoption of MVs in SSA, including the RTB crops yam, cassava, potato, banana, and sweetpotato. The results, reflecting supporting studies carried out by IITA, CIP, and Bioversity, provide the single best indicator of past impact of RTB breeding programs in the SSA region.

Table 7-1 shows the DIIVA results for the five RTB crops in terms of adoption and the role of CGIAR center material. To put these RTB crop numbers in context, the study found that the overall adoption of MVs for the 20 crops studied was 35 percent in 2010, of which center varieties accounted for 66 percent. There is clearly wide variation in past success of breeding programs and varietal introductions among these RTB crops. The report notes that the CGIAR center contribution tends to be related to the area MV adoption. Crops with low rates of MV adoption tend to also have relatively new breeding programs.

⁷⁰ CGIAR Science Council (2008) Report of the 6th External Program and Management Review of the International Potato Center (CIP). Rome, Italy: Science Council Secretariat.

CGIAR Science Council (2008) Report of the 6th External Program and Management Review of the International Institute of Tropical Agriculture (IITA). Rome, Italy: Science Council Secretariat.

CGIAR Science Council (2008) Report of the 6th External Program and Management Review of the Centro Internacional de Agricultura Tropical (CIAT). Rome, Italy: Science Council Secretariat.

CGIAR Science Council (2009) Report of the Sixth External Program and Management Review of the Bioversity International. Rome, Italy: Science Council Secretariat.

Table 7-1: Adoption of RTP crops in SSA

Crop	% Area planted to MVs in 2010	Share IARC related varieties within MV (%)	percent Area planted to MVs in 1998	Study countries as % of SSA crop production
Cassava	39.7	82.5	21.0	90
Potato	34.4	90.8	49.2	61
Yam	30.2	15.1	NA	95
Sweetpotato	6.9	81.3	NA	54
Banana	6.2	34.9	NA	71

Source: Walker et al. (2014)

Improved varieties of bananas were adopted on only 6.2 percent of area. Bananas were studied only in Uganda, where it was found that the breeding focus on disease resistance did not take into account eating preferences across different uses. Elite clones were only introduced in 1991, so bananas had a relatively late start compared to other crops.

Adoption of improved varieties of yams is 30 percent of area (studies covered 8 countries) which appears high. The report notes that yam production tends to be very spatially concentrated and there has been relatively little investment in breeding. However, the results primarily reflect adoption in Ivory Coast, where the variety C18 was introduced in 1992 and accounts for a 75 percent MV adoption rate in that country.

Sweetpotatoes, with only 6.9 percent of area in 5 countries, are still mostly local landraces. There was no breeding program in SSA before 1990s, and now there are breeding programs in Uganda and Mozambique. There has been a recent infusion of new resources following interest in OFSP and its nutrition potential. The DIIVA studies showed that MV adoption was split between white and orange varieties.

According to the report, potato MV adoption on 34.4 percent of area across the region is disappointing in the context of strong market growth (based on 5 countries), as farmers could be expected to respond to expanded market demand by changing to higher yielding varieties. The breeding program in Malawi is only recently seeing success. MV adoption is high in Kenya and Ethiopia. The notable decline in MV area since 1988 is due to declines in Rwanda, where the civil war destroyed the breeding program and disrupted the seed system. Recovery has been slow.

Adoption of cassava MVs on 39.7 percent of area (in 17 countries) was considered surprisingly high, in light of low levels of research investment in this crop relative to its area. The report notes: “the performance of cassava crop improvement has been solid and steady with regard to adoption outcomes. The majority of the countries included in this study have substantially higher levels of uptake of improved varieties now compared to the late 1990s (Alene and Mwalughali, 2012a). A strategy that has emphasized high yield combined with disease resistance in a mostly sweet, rather than bitter, background seems to have yielded good dividends in many countries. Additionally, donors

have actively supported programs to propagate and widely distribute improved planting materials.” Widely adopted specific MVs were found that account for these trends in Nigeria, DR Congo, and Ghana. Cassava is reported to have made greater gains where adoption was low in 1998, but where adoption was already relatively high gains were slower. This indicates that with current cassava varieties future gains may be more difficult to achieve.

The DIIVA study also examined varietal turnover and age, to better assess whether breeding programs are providing new varieties to sustain productivity gains. Banana and sweetpotato varieties were, on average, the youngest among the 20 crops studied, at 10.2 and 10.3 years, respectively. This may reflect the relatively recent investment in breeding these crops, rather than rapid turnover of varieties. Cassava was one of the few crops with relatively large adopted area and relatively higher varietal age (14.1 years), reflecting successful breeding program results in Kenya and DR Congo as adopted varieties were appreciated for longer. Yams and potato had relatively old varietal age (18.4 and 19.4, respectively), showing declining breeding productivity for these crops. In three of the four countries where potatoes were studied, the average variety age has been increasing since 1998.

7.2.2. Recent studies carried out by RTB centers

The impact narrative from RTB centers show that impact assessment commitment and approaches vary widely among the RTB centers.

CIAT: at CIAT, a set of studies is under way to assess the adoption of cassava varieties in the nine main cassava-producing countries of Asia, and in Colombia. Preliminary findings shared by CIAT show that in seven East-Asian countries about half of the cassava area grown with MVs (80 percent of total cassava area) has CIAT related varieties. A more detailed study of CIAT’s contributions in Thailand and Vietnam found significant contributions to important new varietal releases in the 1990s, which now account for 60 percent and 75 percent of acreage, respectively⁷¹. Economic returns are also substantial and in the range of about USD 50 million annually in each country, with correspondingly high rates of return to the breeding investment.

Bioversity: Bioversity did not share any peer-reviewed impact assessment publications. Bioversity has carried out studies to document the impact of the MUSA network, in terms of how it provides a platform for sharing knowledge about new scientific developments for bananas. Findings from a 2014 survey of MUSA participants found that members value it for providing reliable, well-respected and updated information on banana production and research in one place⁷². Bioversity reports that a set of case studies is currently underway to better document MUSA’s impacts.

CIP: CIP has a longstanding program of impact assessment. In contrast to other RTB centers, CIP studies are notable for the scope of impacts assessed, as they examine impacts beyond varietal adoption. CIP studies are published in peer-reviewed outlets, and occasionally in high impact journals⁷³. Impacts through the early 2000’s are documented from varietal development, including

⁷¹ Robinson, J. and Srinivasan, C.S. 2013. Case-studies on the impact of germplasm collection, conservation, characterization and evaluation (GCCCE) in CGIAR.

⁷² Gotor E. et al. 2015. The effectiveness of knowledge sharing: The case of ProMusa. BioversityInternational series of Impact Assessment Briefs no. 15. Bioversity International.

⁷³ Earlier review studies of potato and sweetpotato research are summarised Fuglie and Thiele, 2009.

potato late blight resistance in all three developing regions; IPM in both crops, and clean seed multiplication, especially for sweetpotatoes in China. Global annual benefits from CIP research are estimated at USD170 million (1996 dollars) in the early 2000s, a substantial increase from the early 1990s, when they were less than USD20 million (1996 dollars) annually. A more recent review of MV potato adoption in 23 developing countries across all major regions shows that varieties derived from CIP materials account for 13 percent of area, or about 1 million ha worldwide; the rate of return to CIP breeding is over 20 percent⁷⁴.

CIP has carried out many studies within Peru and most recently found that adoption of CIP derived potato MVs is about 60 percent of area, and has contributed to the near tripling of national production during the past four decades⁷⁵. Other studies have examined the success of the variety Cooperation 88 in China. It is widely adopted in Yunnan with benefits estimated at USD350 million in 2010⁷⁶. This success will be studied in greater detail in a new project funded by SPIA (see below).

Recent CIP studies have measured the economic and environmental impacts of IPM, finding an average benefit of USD100/ha from adoption in LAC countries. The institutional requirements and barriers associated with IPM have also been addressed, including in a major survey of barriers across the globe⁷⁷.

Potato value chain research at CIP has been evaluated for its impact in fostering innovations, increased consumption, and higher farmer income, for example in Ecuador⁷⁸. Value chain research is also shown to have fostered growth in both total sales and income per producer in Peru⁷⁹.

Studies of OFSP adoption and impacts in east Africa are notable for their focus on nutritional outcomes, as such nutrition impact studies are still rare. A randomized control trial showed that OFSP introduction in Mozambique increased Vitamin A intake among women and children significantly through outreach education and provision of planting materials⁸⁰.

⁷⁴ Thiele, G. et al. 2008. Varietal change in potatoes in developing countries and the contribution of the International Potato Center: 1972-2007. Lima (Peru). International Potato Center (CIP). 46 p. Social Sciences Working Paper (CIP). no. 2008-6.

⁷⁵ Hareau, G. et al. 2009. Economic returns to improved crops in the center of origin: The case of potato varieties in Peru. In: International Society for Tropical Root Crops (ISTRIC). Tropical roots and tubers in a changing climate: A critical opportunity for the world. 15. Symposium of ISTRIC. Lima (Peru). 1-6 Nov 2009.

⁷⁶ Robinson and Srinivasan 2013

⁷⁷ Parsa, S. et al. 2014. Obstacles to integrated pest management adoption in developing countries. Proceedings of the National Academy of Sciences of The United States of America (PNAS) 111:3889-3894.

⁷⁸ Cavatassi, R. et al. 2011. Linking Smallholders to the New Agricultural Economy: The Case of the Plataformas de Concertación in Ecuador, *The Journal of Development Studies*, 47:10, 1545-1573.

⁷⁹ Ordinola, M. 2011. Innovaciones y desarrollo: El caso de la cadena de la papa en el Peru. *Revista Latinoamericana de la Papa*. (Colombia). 16:39-57.

⁸⁰ Hotz, C. et al. 2012. A large-scale intervention to introduce orange sweet potato in rural Mozambique increases vitamin A intakes among children and women. *British Journal of Nutrition*. 108:163-176.

IITA: IITA has carried out impact assessment and barriers to adoption research for cassava, bananas, and yams. These studies have been published in peer-reviewed outlets and sometimes in high impact journals.

Several studies of cassava adoption report high rates in particular regions (eg. 74 percent in Southeastern Nigeria), and thus show specific areas where MVs have had greater than average impact⁸¹. Studies show positive impacts of cassava MV adoption on household assets (poverty), income or household food security in Nigeria, DR Congo, and Malawi⁸². In terms of barriers to adoption, studies document the importance of processing technology for handling increased production and taking account of preferences for consumption attributes⁸³. While the latter are not impact studies per se, they show why impact may be difficult to achieve or less than expected.

IITA's yam studies have focused on barriers to adoption of new technologies. Access to improved seeds in Nigeria and Ghana is a barrier to adoption of MVs⁸⁴. Adoption of improved management practices in yams is held back by the increasing scarcity / cost of labor and poor access to markets⁸⁵. These studies illuminate some of the reasons for the finding of low MV adoption in yams in the DIIVA study.

IITA's banana studies have not addressed impact, which is not surprising given the low rate of adoption of MVs in this crop. IITA has documented the potential for yield increases shown in experimental plots, a finding which seems at odds with the low rate of adoption and raises questions for future study⁸⁶. Fertilizer prices and access to credit have been identified as barriers to fertilizer use⁸⁷.

Summary Comments Regarding Center Studies: As this review of recent studies by centers demonstrates, there is a great deal of micro-level research underway that measures different kinds of

⁸¹ Udensi, U. et al. 2011. Adoption of selected improved cassava varieties among smallholder farmers in South-Eastern Nigeria. *Journal of Food, Agriculture and Environment*, 9:329-335.

⁸² Udensi et al. 2011; Rusike, J. et al. 2011. Estimating impact of cassava research for development approach on productivity, uptake and food security in Malawi. *Food Policy*, 35: 98-111. Rusike, J. et al. 2014. Does cassava research-for-development program have impact at the farm level? Evidence from the Democratic Republic of Congo. *Food Policy*, 46: 193-204.

Udensi, U. et al. 2011. Adoption of selected improved cassava varieties among smallholder farmers in South-Eastern Nigeria. *Journal of Food, Agriculture and Environment*, 9:329-335.

⁸³ Abdoulaye, T. 2014. Awareness and adoption of improved cassava varieties and processing technologies in Nigeria. *Journal of Development and Agricultural Economics*, 6:67-75. Alene, A. D. et al. 2013. Economic impacts of cassava research and extension in Malawi and Zambia. *Journal of Development and Agricultural Economics*, 5: 457-469.

⁸⁴ Asumugha, G. N. et al. 2010. Empirical estimation of demand function and elasticities for seed yams in southern Nigeria. *African Journal of Root and Tuber Crops*, 8: 56-61.

⁸⁵ Mignouna, D. B. et al. (in press). Factors influencing the use of selected inputs in yam production in Nigeria and Ghana. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*. 116 (2).

⁸⁶ Wairegi, L. W. I. and van Asten, P. J. A. (2010). The agronomic and economic benefits of fertilizer and mulch use in highland banana systems in Uganda, *Agricultural Systems*, 103: 543-550.

⁸⁷ Van Asten, P. et al. 2010. Factors driving fertilizer adoption in banana (*Musa* spp.) systems in Uganda. *Acta Horticulturae*, 51: 465-478.

impacts or barriers to adoption. CIP and IITA have particularly active programs, with generally high quality research. Bioversity's efforts are more limited and are not published in peer-reviewed journals. Following a hiatus in this type of work at CIAT, the new multi-country adoption study should provide the basis for stronger impact assessment in the future.

Many of the studies reviewed in this section provide useful input into understanding the impacts of particular projects or technology transfers in specific subnational regions. But it can be difficult to assess regional or global impacts without periodic major assessments such as the DIIVA study, and thus to understand the broader impacts arising from RTB research. It is also unclear how or whether these studies are integrated into research planning.

7.3. Use of impact assessment in program planning

As noted above, impact assessment is part of a continuum of research prioritization and evaluation, beginning with quantitative priority setting, *ex-ante* evaluation of potential research endeavors, periodic review and refocusing, and finally impact assessment to whether research activities achieved their intended goals. Fuglie and Thiele (2009) document the history of using *ex-ante* and *ex-post* impact assessment as broad guidance to research program planning in CIP during the 1990s and early 2000s. For example, such assessments were partly responsible for motivating realignment away from low impact projects. However, they also note that commitment to priority setting declined as Centers have reduced flexibility in their use of funds (more bilateral projects and reduced W1/W2).

As noted in Chapter 3, there has been little explicit use of either *ex-ante* or *ex-post* impact assessment in program planning for RTB. The uneven coverage of the impact assessment studies undertaken for most of RTB crops does not provide sufficient guidance for overall program planning, although it may be providing some guidance of an informal nature within specific crop programs. For example, the identification of cassava processing characteristics as a constraint to adoption of improved varieties seems to have led to the complementary projects in Theme 6. Future impact assessment for RTB will be substantially enhanced by several studies undertaken in collaboration with SPIA, as discussed below, which provides the opportunity to more fully integrate impact assessment into program planning.

7.4. Future impact assessment

In the near future, SPIA (through SIAC) will develop new methods for regular collection of adoption data and some of them will address RTB crops. One approach is to collect adoption data through the World Bank's LSMS survey. This is being piloted for sweetpotatoes in Ethiopia and for cassava in Malawi, among others. A comparison of DNA fingerprinting with other means of varietal identification is being carried out for selected crops, including cassava in Ghana. Although not directly involved in all efforts, RTB was involved in Ghana and is supporting work in Nigeria. RTB should benefit from the lessons learned.

RTB is heavily engaged in several other SPIA-led studies, which provide the foundation for the current and proposed efforts in impact assessment. RTB is to be commended for dedicating complementary project funds towards the SPIA projects, showing commitment to greater engagement in impact assessment for the future.

RTB is engaging with SPIA through complementary funding impact assessment studies for potato/sweetpotato, cassava in Africa as well as Latin America and Asia and banana work in 2014-2015. This work includes: adoption of sweetpotato in Asia; development of methods and protocols for using DNA finger printing for varietal identification; and impacts of Cooperation 88, the widely adopted potato variety in southern China particularly to explore the reasons for its popularity, and whether widespread adoption arises from late blight resistance or from processing characteristics. The lessons from this latter success story can inform future breeding strategy and provide a model for future impact assessments. CIAT and IITA have complementary projects for impact assessment of cassava varieties jointly funded by RTB and BMGF. CIAT has claimed major impact in Thailand with cassava, and is adopting more robust identification methods to test the claim. The IITA cassava study is focused on robust adoption and reasons for adoption. One motivation for these studies is to provide better baseline data regarding adoption, filling an important gap for RTB crops. Any impact assessment in the future for specific technologies will rely on such improved baseline data.

Reductions in RTB W1/W2 funding have reduced the CRP's investment in the SPIA led projects. All of the above efforts rely heavily on bilateral funding. Ideally, investments in regular data collection to monitor adoption and to carry out panel household surveys regarding socio-economic impact should be a standard part of the RTB program. The current SPIA proposal to rotate assessments among crop-country combinations may be a reasonable alternative, but will still require a strategy to integrate results into overall impact assessment and program planning.

7.5. Conclusions and recommendations

Based on the studies reviewed above, there is clear evidence of global impact in cassava and potato, and to a lesser extent in sweetpotato. Cassava MVs appear to have had major impacts in SSA and in East Asia. In the DIIVA study concern was raised of whether these impacts can be carried forward to more marginal production environments in SSA, and studies by the Centers point to the importance of processing and taste characteristics as constraints to adoption. These latter constraints have been the focus on new research efforts under RTB, demonstrating some informal feedback from impact assessment into program planning.

Potato and sweetpotato programs have had significant global impact largely due to major impacts in China, and positive economic returns as well, although the extent of adoption in SSA, as noted in the DIIVA studies among others, seems to be lower than expected. Adoption of potato MVs has declined in SSA, and the average age of varieties planted is increasing. These observations raise the question of whether there is a clear future strategy for reversing these trends for potato in SSA. Impact studies of OFSP in SSA show preliminary promise for nutritional benefits, and these studies may provide lessons and models for biofortification efforts in cassava and banana.

There has been little or no documented impact in bananas and yams, although the IITA studies cited above show the potential for increased productivity. Clearly, strategically directed studies of barriers to adoption for these crops are needed, which could then inform research planning for greater future impact. The limited impact of new technologies for banana raises the question of how the network activities carried out in Bioversity can provide value to participants.

Impact assessment work is uneven in both approach and quality across centers and regions. The recent collaborations under the SPIA's SIAC demonstrate a way forward towards an integrated strategy for long term monitoring and impact assessment. In particular, the tools development in two areas (monitor varietal adoption and household level data collection), are key for future impact assessment, including impacts that go beyond variety adoption and that would demonstrate contributions to IDOs.

Recommendation 14: Impact assessment is strategically important for demonstrating impact, justifying resources, and informing program planning. RTB needs a clear strategy of how priority and impact assessments will be linked over time, and how the results from *ex-post* assessments, complementing *ex-ante* assessment, will inform program planning. This may lead to changes in the design of *ex-post* assessments. In formulating an impact assessment plan, RTB should scale up activities and apply lessons from the SIAC projects they are currently engaged in. It should also ensure comparable quality of efforts across crops and regions.

8. Governance and management

8.1. Features of RTB with implications on its G&M

While all CRPs operate under the CGIAR umbrella each CRP functions within its own set of programmatic, institutional, financial, and other circumstances that heavily influence the way the CRP is governed and managed. In RTB's case the following features need to be kept in mind in analyzing its G&M:

- *Narrow funding base:* Three donors funded 70 percent of RTB during 2012-14: CGIAR Fund (42 percent), BMGF (19 percent) and USAID (9 percent). Heavy dependence on a few bilateral donors has strategic and sustainability risks, especially if W1/W2 funding declines further.
- *W1/W2 funding cuts and delays in disbursements:* Funding cuts in 2014 (10 percent) and 2015 (19 percent) as well as significant delays in disbursements have put RTB into a major squeeze, resulting in staff reductions and delay or elimination of program deliverables.
- *Fund use:* RTB management has had direct influence only in the allocation of about 10 percent of total RTB funding, most of that (70 percent) devoted to complementary projects. The other 90 percent of funds include center-owned W3/bilateral and center historical W1/W2 funds. In the case of CIP, these are directly in line with RTB priorities.
- *RTB as an alliance:* RTB's organization has characteristics commonly seen in private and public sector alliances: independent centers agreeing to form a new entity (RTB) to pursue agreed objectives; contractual agreements defining the funding flows and responsibilities of the partners; independence of members of the alliance; sharing of benefits according to an agreed formula (such as historical funding); and agreement on program management⁸⁸.
- *Complexity:* In RTB's case, complexity is based in the integration of five crops and four/five centers. Overcoming this kind of complexity requires a flexible and adaptable organization and management style and a supportive culture.
- *Building trust:* Trust is a key condition for success in any partnership through nurturing a flexible and supportive culture.
- *Tracing accountabilities:* The RTB portfolio includes over 500 products with milestones. This makes reporting and monitoring quite onerous and limits attention to outcomes and accountability for the deliverables.

8.2. G&M structure

The CIP Board of Trustees (BoT) has the fiduciary responsibility for the program. A Steering Committee made up of the DGs of the four partner centers, chaired by the CIP DG, provided oversight during the first two years. An independent advisory group known as the Program Advisory Committee (PAC) was established early in the third year, which was less than a year later (as of Jan. 2015) transformed into an Independent Steering Committee (ISC) by merging the Steering Committee and PAC and

⁸⁸ Yoshino, Y.M. and U.S. Rangan. 1995. *Strategic Alliances: An Entrepreneurial Approach to Globalization*. Harvard Business School Press, Cambridge, MA.

nominating one of the independent members of PAC as ISC chair, following the recommendations of the IEA review of CRP governance. The program has been led by Graham Thiele, Program Director, supported by the PMU. MC made up of the DDGs of the four centers (and, later, a representative of CIRAD) served as the main decision-making body, assisted by Theme Leaders (on science issues) and Center Focal Points (CFPs, on center-level coordination).

8.2.1. Assessment of G&M structure

Roles of the CIP BoT and other governance bodies: The Evaluation Team's interaction with the ISC and center BoTs suggests that these bodies are supportive of the present governance arrangement. The Evaluation Team recognizes that (a) it is too early to reach a judgment about the role played by ISC, and (b) having multiple layers of approval can potentially slow down program implementation. Review of the CIP BoT's meeting minutes showed that the BoT carried out its fiduciary duties responsibly and acted diligently in matters related to RTB.

Role and potential effectiveness of the ISC: The shift from PAC and Steering Committee to ISC in 2015 provided the needed independent thinking in the governance of the program. Although it is too early to judge the effectiveness of ISC, the roles ascribed to it are appropriate and necessary. As the ISC is the RTB governance body with the least possibility of conflict of Interest in RTB matters, it will need to play a significant oversight role in pursuing critical strategic changes in the program, such as those recommended in this report. The ISC's success in carrying out its responsibilities in these critical areas will depend on both the quality of the support it receives from PMU, as well as ISC's ability to devote the time and effort needed. At present, ISC members are appointed on a 10 days-a-year basis, which should be reviewed as the Committee's future agenda becomes clear.

Balancing independence with inter-dependence: The ISC represents independence; the MC (and the previous SC) represents inter-dependence. Both are necessary for effective governance of an alliance. Until the creation of ISC, the goal of RTB in governance was to secure healthy inter-dependence necessary for building trust among the partners. The ISC now provides an institutional mechanism for check-and-balance within the program. If unchecked, inter-dependence and search for consensus can lead to choosing conservative solutions of the lowest common denominator type and increased resistance to change. On the other hand, ideas from an independent committee can be unrealistic under the conditions of an inter-dependent institutional setting. Bridging the two sides is a critical role for PMU as it can formulate change options that have a high chance of success during implementation.

8.3. Performance of key governance functions

The Evaluation Team assessed how effectively RTB's governance bodies have carried out essential program governance functions. These include overseeing strategy, priorities, program activities and their management, setting policies, providing financial oversight, and the effectiveness of their governance practices.

8.3.1. Overseeing strategy and priorities

Given the varying length of center projects mapped to RTB, it would be unrealistic to expect significant changes in RTB's project make-up (and consequently in its strategy and priorities) in three years. Change in strategy would be gradual, generated partly through new bilateral projects initiated since

2012 and hopefully will be more rapid after the PA. The complementary projects played an important role in directing W1/W2 funds to RTB priorities.

RTB faces three challenges with regard to strategy: (1) formulating a realistic strategy that takes into account priority needs in the target regions, continuing program activities and funding opportunities; (2) formulating an associated change plan that describes what changes are necessary to move towards the new program structure; and (3) having these reflected in the institutional strategies and operational plans of its alliance partners. As the centers are the primary management entities for implementing RTB-mapped projects, misalignment between the overall RTB strategy and the partner center strategies could pull the program in different directions. Sensibly, CIP has significantly aligned its latest strategic plan with the RTB Phase II program structure which has not happened for other alliance partners. There may be a need for the PMU and MC to identify what steps will be necessary to achieve greater alignment with the strategies of other centers on the RTB crops, including alternative use of W1/W2 funds to secure it (also see Section 3.1.4 on the use of W1/W2 funds).

It is positive that RTB's largest bilateral donor, BMGF, considers root and tuber crops as a priority research area. Frequent dialogue between the Program Director and BMGF on RTB priorities has been mutually beneficial in securing bilateral funding for addressing high priority research problems in RTB and for BMGF and facilitating important strategic changes in the program. A similar approach could be adopted in dialogue with other W3/bilateral donors. This will also contribute to further developing a role for RTB as a fund-raiser, especially for W2 and bilateral funds. At the same time, RTB needs to ensure that it retains independence over its own research priorities.

In future, the ISC should play a more significant role in monitoring and guiding the changes in the entire program (see Chapter 4). It should not accept automatically every project proposed by centers for inclusion in the RTB portfolio. The changes in the portfolio should follow an agreed plan that is based on the PA, as one important criterion. As the ISC is quite new, it may take some time for it to fully assume the strategy and priority-related responsibilities expected of a program governance unit. The ISC and the PMU have a good working relationship. While the Program Director and the MC should continue to show leadership in these fronts, this should be under ISC's guidance and support.

8.3.2. Setting policy and reinforcing values

RTB's first and strongest achievement on the policy front was the development of a gender strategy in 2013 following a consultative process covering 27 countries. The policy sought to generate gender responsive and gender transformative development outcomes for specific beneficiary groups and outlined the approaches that would be taken in each RTB Theme. (See Section 6.2)

The need for similar policies in three other areas was highlighted by the Steering Committee during its annual meetings but not much progress was made in these areas: partnerships, capacity development (see Chapter 6), and fund raising. Fund raising has been mainly handled by the participating centers for the parts of the RTB program managed by them. The individual initiatives taken by the PMU in reaching out to some donors need to be part of a systematic fund-raising strategy which remains an important policy vacuum in RTB.

Intellectual property, conflict of interest and management systems are additional areas where clarifying policies would be helpful, taking into account policy guidance available at the Consortium level.

Each center has its own management systems and practices. For financial management, common standards and practices have been adopted by the centers. However for human resource and research management, different systems are implemented among the centers within RTB. Such differences create challenges in managing cross-center projects and in tracing accountabilities and rewarding performance. There is a need for the governing bodies of RTB (including the center BoTs) to explore how these management systems could be harmonised to make them more compatible with the information needs of the CRPs.

Setting and reinforcing values is also an important function of governance. One of the achievements of RTB in this area has been developing new ways of doing business. Scientists in the collaborative teams of RTB (MC, CFPs, Theme Leaders) have begun to work collectively, resulting in increased trust and social capital. The Teams' engagement with RTB staff revealed that the progress made over the first three years is significant. The governing bodies of RTB should be mindful of protecting and furthering this cooperative spirit.

8.3.3. Oversight of program activities

The activities under the RTB program are overseen by multiple bodies: center BoTs in accordance with the PPA with CIP; individual donors for bilateral projects mapped to RTB in accordance with their own accountability standards; ISC as the governance unit entrusted with programmatic responsibility for implementation of RTB; CIP BoT in accordance with the PIA with the Consortium; and the Consortium as the regulatory institution responsible to the Fund Council for the implementation of RTB and other CRPs.

All of these oversight responsibilities are necessary given the legal and funding architecture of the program. However, their approval sequence (center to ISC/PMU to CIP BoT to Consortium to FC) presents a real processing challenge to the PMU. Delays in this chain have caused disruptions in program funding and implementation. Simplifying reporting requirements would benefit all parties. Also, individual bilateral donors should increasingly depend on RTB-generated monitoring information on projects to minimize requests for additional information.

The Evaluation Team reviewed the minutes of all CIP BoT and BoT committee meetings and is impressed with the care and attention given to RTB (not just the CIP mandate crops within RTB). The BoT's review covers not only programs but also financial and risk management. These reviews have been facilitated by reports from the Program Director. The establishment of ISC has not diminished the oversight responsibilities of the CIP BoT although ISC provides the CIP BoT with a more independent view on the health and challenges of RTB than the reports by MC.

8.3.4. Oversight of management

In hierarchical organizations "oversight of management" is quite straightforward, as the CEO representing "management," reports and is accountable to the single governing body. In the case of alliances like RTB, "management" means more than the Program Director, because the Program

Director does not have full supervisory authority over the staff managing or coordinating the components of the program (such as Theme Leaders, CFPs and project leaders).

The Program Director and PMU report regularly to the ISC at its quarterly meetings, and the ISC Chair interacts with the Program Director regularly between the meetings and brings key interim updates to the attention of ISC members.

Coordinators of RTB activities (such as Theme Leaders and CFPs) carry dual responsibility: to their center and to RTB. The activities of the Theme Leaders are closely reviewed by the Program Director while those of the CFPs are reviewed by their centers, with inputs from the PMU. The CFP and the MC member from that center serve as the key sources of information on RTB for their center management and BoT when necessary.

Oversight of RTB activities at the center management level is based on the center's internal research management system. Program Director and PMU have no direct link with these systems because of the disconnection between RTB's M&E system and the centers' HR and research management systems. Oversight of management is internal to each center. In the case of CIP, because of the proximity of the PMU, there is close interaction between CIP managers and RTB Program Director which enables sharing of information on project (and manager) performance. Discussion is needed amongst the alliance centers regarding how the RTB management can have some input into the performance appraisal systems of the centers, especially for center staff devoting part of their time to RTB managing or coordinating activities.

Bringing greater consistency to the oversight of research management across the centers would facilitate program oversight by the ISC in addition to enabling RTB management to provide (and receive) inputs in performance planning and appraisal at the scientist level. As this is an inter-center issue, the ISC should promote and monitor progress made by the alliance in this area.

8.3.5. Financial oversight

Prior to the establishment of ISC in 2015, the RTB draft budget for the following year was reviewed only by the CIP BoT before it was sent to the Consortium. The ISC now serves as an additional oversight body on the RTB budget. The current budget approval schedule allows the ISC five days to review and comment before the budget is submitted to the Consortium. The Evaluation Team does not feel that this tight schedule is realistic for the ISC to conduct a meaningful review. Oversight of RTB finances at the partner centers remains the responsibility of the center BoTs.

Financial oversight by the ISC is critical for the success of the program for at least three reasons. First, as changes in the RTB portfolio from year to year reflect parallel changes in strategy and priorities, the ISC needs to pay special attention to these portfolio changes (regardless of their funding source) and their implications for RTB priorities and alignment with the SRF. Second, the ISC needs to pay special attention to the allocation of W1/W2 funds in the proposed budgets to ensure that the allocations are in the best interest of the entire program. Third, recent instabilities in CGIAR funding have elevated the importance of risk analysis in budget preparation. The ISC should review and comment on the assumption and scenarios the budgets are based on.

8.3.6. Governance practices

Effective governance depends largely on how the governing bodies manage their own internal affairs. In the case of RTB the program faces three governing bodies: (1) CIP BoT; (2) ISC; and (3) the BoTs of the partner centers. During this evaluation, the Evaluation Team has not examined the governance practices of the partner center BoTs or of CIRAD. As for the CIP BoT, the review's focus was mainly on its role in RTB governance—not how it manages CIP affairs.

The review paid special attention to three governance practices: composition of the governing body, leadership, and managing the business aspects of governance.

Composition of ISC: The ISC's responsibilities are broader than those of PAC/Steering Committee and cover oversight of all aspects (including financial and management) of RTB. ISC currently includes members with the expertise needed to cover these aspects. Although it considers its composition balanced, some members mentioned that the private sector may not be sufficiently represented.

The transition from PAC/SC to ISC has created a vacuum in the links between some center BoTs and ISC. The CIP DG and another DG on rotating basis represent all four centers. Thus, while the CIP BoT is sufficiently informed about ISC's activities, BoTs without representation expressed disconnection from ISC. As synchrony among governing units is critical for the success of an alliance, the ISC should strengthen the means of addressing this need. This suggests the need for consultation and briefing between the BoT representatives and non-represented centers before and after ISC meetings. A center BoT should always be represented (at the least virtually) at ISC meeting when matters of direct interest to their center are discussed.

Leadership: Beyond effective management of ISC meetings, the chair is expected to set and implement "good governance" norms and processes, maintain healthy relationships with the Program Director, Lead Center BoT and DG as well as with the governing bodies of the alliance partners, and represent the program in external forums when necessary. The present incumbent has been elected to this position only recently. Effective discharge of the above-mentioned leadership responsibilities appears to require more than the 15 days-a-year currently allowed by RTB. This may compromise the ISC's function in effective decision making and oversight.

Management of ISC business: The Evaluation Team reviewed all SC and ISC meeting minutes, attended one virtual meeting as observer and examined the documentation for each meeting. Our overall impression is that attendance by members is high, the agendas are clear, information presented is relevant to the agenda, meetings are well-managed, and the records of meetings are accurate and well prepared. The ISC Chair and members and PMU are commended for the way ISC has conducted its business.

The ISC can benefit from conducting self-assessments of its performance on a regular basis, starting immediately. In addition to learning from its experience such assessments can help ISC to position itself to take advantage of the frequent changes taking place in RTB's external environment.

8.4. Organization and management

A complex organization like RTB cannot afford to have rigid boundaries between G&M. During the first two years of the program, the Steering Committee and the CIP BoT provided light oversight, leaving the steering of the program very much in the hands of PMU and MC. This reflects the Steering Committee's confidence in the management team of RTB. While the ISC continues to exhibit high confidence in RTB's management team in 2015, it has been following the developments in the program more closely than the previous PAC/Steering Committee.

8.4.1. Program organization

Implementation of the original RTB structure based on Themes, PLs and products soon identified considerable disadvantages including inability to focus on outcomes; problems with monitoring progress to inform the program direction; and inability to adequately deal with the information generated by over 500 products (see Chapter 3). Realization of the problems with the Theme-based and output-focused research agenda resulted in the development of a new FP-based structure and the beginning of a pilot of an RBM model in 2014/2015.

RTB is now in a better position to construct a research portfolio that addresses high-priority needs due to (a) learning from implementing the original program; (b) benefiting from the results of the PA study; and, (c) learning from the RBM pilots. At the same time, changes in the program design must be integrated well with the existing management processes (budgeting, performance management, M&E, etc.) and people⁸⁹. If there is not a satisfactory match, either the structure needs to be modified or new processes/people may be needed. This is a major challenge for implementing the new program structure. In addition, availability of funding and constraints imposed by funders can also impact on the ability of RTB to implement the new structure.

8.4.2. Results-Based Management pilots

RTB was one of several CRPs awarded a grant in 2014 by the Consortium to implement a pilot on RBM. The pilot proposed to develop impact pathways for selected projects through involvement of stakeholders and, in the process, identify output and outcome indicators (results) that could be used for monitoring the research process. RTB identified four CoAs for this pilot: quality seed potato for Africa; management of banana bacterial wilt (BXW); cassava processing; and next-generation breeding for RTB.

None of the RBM pilots had been completed by the time of this evaluation. Therefore, the Evaluation Team is not in a position to assess their level of success. However, the initial lessons drawn from the experience have been noted in the reports from the initial workshops. Several of these relate to governance, management and financing of RTB under an RBM framework and include:

- RBM is a system where multiple elements must work effectively. The relevant financial and personnel resources; a workable management and accountability system; and information management systems must be in place to support RBM. Implementation of RBM is not cost-free and financial resources must be committed to support implementation.

⁸⁹ Steven Aronowitz, et. al. 2015. Getting organization design right," McKinsey Quarterly, June 2015.

- The RBM pilots conducted by RTB have shown that involvement of stakeholders at the earliest possible stage in a project facilitates understanding, commitment and trust—some of the ingredients of successful partnerships. However, in most cases, as the RBM pilots were targeted at well-established existing partnerships where some trust had initially been built, they are not a good gauge for judging RBM implementation with new partners.
- The heart of RBM concerns learning to use resources effectively to achieve targeted outputs, deliverables and/or outcomes in order to facilitate adaptive management and ensure sound accountability. Adopting an RBM approach may require behavioral changes in designing proposals and aligning M&E plans to activity-based budgets to ensure accountability in resource utilization, but not necessarily results in needed organizational change.

The Evaluation Team recognizes the resource-intensive nature of designing and implementing RBM for the entire program. As the pilots have shown, successful implementation requires considerable capacity building to enable the stakeholders to participate in the process effectively. It can also be very time-consuming and slow as was found in Kenya for the quality seed potato pilot. For this reason, RTB should continue to experiment with RBM on a project basis, while helping design the M&E and research management systems needed for effective RBM implementation. The difficulties to be faced in implementing RBM in CGIAR are well described in the IEA evaluation of FTA and include difficulties of attribution and monitoring of results at outcome level, relevance of RBM given long time lags from research to results, and risks related to quantitative comparisons for value-of-money⁹⁰. RTB should be mindful of these difficulties and proceed cautiously in moving towards program-wide implementation of RBM. Also, RTB should provide an explicit definition of how the concept applies to the overall research management environment of the alliance.

8.4.3. Program management 2012-15

RTB has five different chains of command that reflect the management structures of the alliance partners, one of which (CIRAD) is outside CGIAR. Successful management of CRPs requires strong commitment to the principle of inter-dependence by all parties implementing the program. This requires change in culture and mindsets and, as such, requires support at all levels of G&M. Building and fostering trust, both at the scientist and the organization level, is needed. RTB has made significant headway in this direction (see Section 6.4). The four groups in its management have played key roles in this achievement: PMU, MC, Theme Leaders and CFPs.

The PMU is led by the Program Director and employs five full- or part-time staff whose primary allegiance is to RTB. The unit provides leadership and day-to-day coordination to the program, serves as secretariat to all inter-center committees and to the ISC and maintains impartiality. The Team reviewed the records of all the committees PMU serves and concludes that the activities are well-documented. However, efforts are needed by the PMU to simplify processes and lessen the administrative demands on scientists, while satisfying the reporting requirements of CGIAR⁹¹ as currently RTB scientists are frustrated with the excessive levels of bureaucracy and transaction costs

⁹⁰ http://iea.cgiar.org/sites/default/files/FTA%20Evaluation%20-%20Volume%20I_0.pdf (p. 138)

⁹¹ For example, the current lead RTB banana breeder reports to two IITA Directors and one RTB Focal Point, each with different reporting requirements.

imposed by the CGIAR reform process. Respondents in the survey rated time allocation to management/admin/reporting as too much compared to time for strategic research that was perceived to be too limited. There is overwhelming doubt (63 percent) that “RTB has good potential to streamline administrative procedures.” To a large extent this is beyond RTB’s control. The Evaluation Team acknowledges that this problem is largely due to the demands of the CGIAR reform process.

The leadership shown by Graham Thiele is well-recognized across RTB. His interpersonal skills have contributed significantly to team, partnership and trust building within RTB for which he is commended.

The MC constitutes the decision hub of RTB and the first-level sounding board and consultative mechanism for the Program Director. Review of the records of MC meetings and the Evaluation Team’s observation of one MC meeting illustrate that (1) the group works well as a team, (2) the agendas cover all major issues facing the program, and (3) having a group composed of research managers with high status from the partner centers facilitates consensus building and implementation of decisions at each center.

The other two groups in the management structure of RTB are the Theme Leaders and CFPs. Theme Leaders have limited “management” responsibility, but focus on complementary projects and scientific matters. The annual Theme Leader reports present a good scientific overview of RTB activities in each disciplinary area. The CFPs serve as the principal operational link between the PMU and the center. They cover administrative and management issues and records are kept of their meetings. Given that CFPs play both a center and a program role, making these positions joint appointments (by the center and RTB) should be considered.

As has been suggested a number of times in this report, RTB could benefit in terms of building a stronger culture of cooperation through the development of communities of practice among scientists. This is also pertinent in non-science areas such as HR managers, finance officers, training specialists, etc. across alliance centers.

8.4.4. Program management going forward

The planned changes in RTB’s structure provides RTB an opportunity to examine its current governance, financing and management practices and introduce improvements to enhance the program’s effectiveness. Such examination should cover at least the following: consensus on the new research agenda, research management system, roles and responsibilities in program management, additional mechanisms to strengthen inter-dependence and trust in the alliance, and agreement on a new compact among the members of the alliance.

Research management system: The new research agenda is outcome and results oriented. Successful implementation of the program will require having in place compatible management and accountability systems. The objective should be to move to a system that provides both the M&E information required by the Consortium and the management information needed for effective G&M. The Team understands that this is being planned and should be operational in 2016.

Program management roles: RTB has prepared a set of business cases for the new FPs and CoAs. While there are “business cases,” these cover only the programmatic dimensions of the CoA but should also cover aspects of organization, staffing, management and finance. A key question is the role of a FP leader. As currently defined, the main responsibility of the FP leader is for scientific guidance and oversight. There is a lack of clarity as to who will manage the FP including the CoAs; who the COA will report to; who will monitor progress towards outputs and outcomes; and who will report to the MC.

Recommendation 15: RTB should bring clarity to the respective roles, relationships and accountabilities of FP leaders, cluster leaders and bilateral project leaders within the management structures of RTB and the centers.

Strengthening inter-dependence: Throughout this report the Evaluation Team has highlighted several mechanisms for further strengthening the alliance. These include committees (like MC, Theme Leaders, and CFPs), communities of practice, cross-cutting activities, joint appointments, partner participation in governance, and common management and M&E processes. Additional steps to generate changes in mindsets could include joint fund raising, joint conferences and training courses, offering incentives that reward cross-center activities, sharing of facilities, databases and services, etc.

Need for an Alliance Compact: RTB has made significant progress in establishing the building blocks of a strong partnership among the members of the alliance. However, all contractual relationships that constitute the backbone of the program are vertical: from the CGIAR Fund to the Consortium, to the Lead Center, to the partner center, to other partners. Yet, the alliance is expected to generate results that require strong inter-center collaboration and there is no overarching business framework that can help guide these horizontal relationships beyond common goals and mutual trust.

Recommendation 16: RTB partners should develop and agree on an alliance compact building on the progress already made in inter-center collaboration. Such an alliance would bring clarity and greater understanding to critical partnership questions such as: allocation of Window 1&2 funds, use of Window 1&2 funds, handling of Window 3 and bilateral projects, participation in RTB G&M, alignment of management processes, handling of joint appointments, handling joint undertakings, codes of conduct in program participation.

The evaluation envisages joint development of the alliance compact. This would not be another legalistic document, but a soft contract defining the principles and norms of the alliance agreed by the partners. At the time CIRAD joined the alliance the need for a collaboration agreement became clear and one was developed and agreed. The compact would be more comprehensive than the CIRAD agreement and would serve as an operational guide to the partnership.

8.4.5. Financial management

As noted in Chapter 2, W1/W2 funding for 2012-14 was only 60 percent of what had been projected at the start of RTB. RTB was able to reach its budget targets by expanded W3/bilateral funding which constituted 58 percent of its total funding for the period.

CGIAR fund disbursements and funding cuts: In addition to reduced levels of W1/W2 funding, instability in fund disbursements has been a most destabilizing factor for RTB since the start of the

program. To make matters worse, significant delays in disbursement W1/W2 funds have put RTB and the centers in a squeeze as funds needed to be spent before the end of the year. Clearly, not having the funds in hand has meant inability to make commitments to centers and partners, causing disruptions in results delivery. The cuts in W1/W2 funding in 2014 and 2015 (10 percent and 19 percent respectively) have compounded the difficulties leading to cancelling activities and reducing staff.

According to interviews, ISC members and the partner center BoTs regard funding uncertainties to pose the greatest challenge to the effectiveness of RTB. Clearly this is a system-wide issue applying to all CRPs and needs to be addressed at the system level⁹². Otherwise, demanding accountability for delivery from the programs becomes meaningless when the programs cannot clearly see the future funding picture in a timely manner in order to make adjustments. Similarly, centers are not able to see how they can meet their fixed costs for infrastructure and other center overheads. Rigid application of the CGIAR policy on payment of indirect costs by bilateral donors would help, but may not be sufficient to maintain the quality standard of an international center of excellence.

Use of funds and resource mobilization: Only 26 percent of the W1/W2 funds received during 2012-2014 was under the sole direction of RTB (used for complementary projects and other program costs); the rest was individual center-directed (See Section 3.1.4). W3/bilateral funds are secured and directly managed by individual centers, often in competition with other centers. Therefore, centers have a strong sense of ownership of these grants. While they are mapped to RTB, RTB management does not make decisions about them and there is no mechanism across the four CGIAR partner centers to share information on pipeline bilateral projects.

This situation makes it difficult for RTB to operate an integrated program and ensure strong links between the projects mapped to RTB and RTB's strategic objectives. The need for an RTB fund raising strategy has been flagged in several SC meetings and the current situation can be improved in several ways. First, W1/W2 funds should be allocated within the alliance aligned to RTB priorities rather than center historical allocations. Second, linkages between W1/W2 and W3/bilateral funds should be improved to help integrate funds for similar activities, as is already being done through the ENDURE project, in IITA, Nigeria for cassava breeding research and in Kenya for potato research. Third, RTB should initiate effective dialogue with W3/bilateral donors interested in RTB crops, as is already happening with BMGF for a good number of the bilateral projects. Fourth, RTB should endeavour to secure W3/bilateral funds directly as has been possible for the ENDURE project and a pending BMGF-funded project on cassava seed systems in Nigeria. Fifth, the partner centers of the RTB alliance should share project and funding plans in a timely manner to facilitate program-wide planning.

Going forward, there is need for RTB alliance partners to agree on the principles that should be observed in mobilizing resources and on their individual roles and responsibilities in this endeavour.

Auditing and risk management: The accounts of each center are audited separately (both internal and external) using CGIAR norms. The CIP BoT and its audit committee regularly (and carefully) review RTB finances as part of its fiduciary responsibility. Also, RTB and the CIP BoT regularly conduct a review

⁹² The evaluation of PIM also provides a discussion of this issue. See http://iea.cgiar.org/sites/default/files/PIM_Volume_percent201FINAL.pdf (p. 91)

of the program's financial risks. An inventory of financial risk factors is prepared (e.g., "sufficient funds are not raised to meet the financial plan"), showing the potential impact of the risk and measures that can be taken to mitigate each risk. This analysis yields an action plan based on the mitigation measures identified. The uncertainties in CGIAR funding observed in 2014 and 2015 and the impending re-organization of the CRP portfolio elevate the importance of carrying out such analyses by ISC and CIP on a regular basis.

The RTB accounts have been subjected to a review by the Consortium in 2015. Conducted by the IAU, the review was conducted concurrent with the IEA evaluation and completed in August. The Evaluation Team has not covered issues of compliance and controls as these are covered in detail by the internal audit. The Team has not detected a significant discrepancy between the findings of the audit and the observations made by the Team.

8.4.6. Human resource management

As each RTB center has a different HR management system, establishing a uniform standard in the handling of RTB-affiliated staff presents a challenge. The issues relate to variance in HR systems across centers and management of staff that divide their time between a center and RTB. In their case it is important that the RTB co-supervisor participate in the entire HR management process from planning to assessment. Center-wide HR processes should accommodate the special circumstances of staff spending part of their time on RTB. When a center manager is a member of an RTB management team, the Program Director should have an opportunity to provide feedback on his/her contributions to RTB and the supervising manager at the center should pay special attention to the performance feedback provided from RTB management.

In the future, RTB may require some scientists to work across centers through joint appointments and sharing of staff may be considered. Collaborative work with ARIs and NARS may also require innovative HR arrangements. The HR systems of the alliance should be open to facilitate such arrangements.

8.5. Conclusions

RTB has faced a difficult challenge in integrating research on five different crops conducted by four independent centers. Addressing this challenge required G&M structures and processes that create new ways of working to promote inter-dependence. RTB has been successful in building new program G&M arrangements that largely meet this challenge. In terms of commonly used performance criteria these arrangements exhibit the following characteristics:

Independence: The initial program governance mechanism (Steering Committee made up of the directors of the partner centers) that promoted inter-dependence has been transformed into ISC with majority independent members. Inter-dependence among the centers making up the alliance can be further strengthened.

Accountability: The lead center BoT carries out its fiduciary program governance responsibilities effectively. Multiple management and accountability systems are active during program implementation, partly a result of adherence to the principle of subsidiarity. Program monitoring is not connected with program management systems, limiting its use as an accountability mechanism.

Transparency: RTB's G&M operations are fully transparent. However, records of the participating center BoT meetings are not available to the public (except for IITA's highly limited summaries), which is a weakness for publicly-funded organizations. Also, center processes on the use of W1/W2 funds should be more transparent.

Legitimacy: In terms of its composition, the ISC brings together the perspectives from major RTB stakeholders. Several donors interviewed expressed favourable impression of the program and its leader. With the shift to FP-based program management and the RBM pilots, RTB has begun to increase the legitimacy of its project design and management systems.

Fairness: Since the beginning, the Program Director and PMU have strongly adhered to the principle of openness, fairness and equity among the partner centers. This largely accounts for the culture change that has begun to take place, improving the potential for the centers to work together effectively.

Efficiency: As a large proportion of RTB funds have been managed directly by the centers it is not possible to judge the efficiency of their operations without additional institutional reviews. Scientists perceive high transaction costs of managing RTB which is partly imposed by the CGIAR System and in part RTB's own program monitoring and reporting systems, although the RTB Program Director disagrees with this. As the initial years of RTB are largely a learning period, it is expected that the program would operate more efficiently as it eliminates/replaces inefficient practices.

Effectiveness: Instability in CGIAR funds and their disbursement patterns have been the most destabilizing factors for RTB and pose a great challenge to the effectiveness of the program and its sustainability. Effectiveness is likely to increase as the FPs and CoAs of the program are increasingly based on robust PA studies.

Leadership: The program has been led effectively by Graham Thiele. In terms of governance, the ISC is quite new, but has the potential to show strategic leadership to the program. The MC functions effectively in leading/coordinating operations.

9. Conclusions and way forward

9.1. Conclusions and added-value

In 2012, CGIAR approved the RTB CRP combining the research of CIP, CIAT, IITA and Bioversity on five major crops – banana/plantain, cassava, potato, sweetpotato and yam. CIRAD joined the partnership in 2013. The multi-crop, multi-partner nature of RTB makes it complex and challenging. This chapter presents the Evaluation Team’s synthesis of its findings regarding the overarching questions that were posed in Chapter 1 and addressed in more detail in the previous Chapters.

How well does RTB operate as an integrated program - programmatic-level thinking, strategy, inter-center research activities and management?

During the past four years, RTB has made notable progress in developing inter-center research activities. The complementary projects have been instrumental in facilitating programmatic integration across centers and crops. Although this accounts for only USD9.4 million (30 percent) of the W1/W2 funding (2014), it demonstrates that integrative activities are possible providing funding is available. However crop-specific and center-level thinking still predominates due to the dominance of bilateral funding and the manner in which W1/W2 funding is currently disbursed to the centers. There are a few examples of program-level philosophy and commitment outside of complementary projects such as the W3 funded ENDURE project in Uganda, and RTB centers working together in Kenya. A program-wide philosophy and commitment to programmatic integration is not yet fully realized.

Successful program management as well as the recent formation of the ISC for governance are important elements for moving towards enhanced levels of integration and progress has been made on these fronts. The planned FP and CoA program structure as well as greater investment in complementary projects in Phase II should also help to develop program-level strategic thinking. Although progress has been made, further efforts are needed to enhance integration beyond individual time-bound projects.

Has the implementation of RTB realized anticipated synergies and complementarities from centers working more closely together especially on the same crop, added value to research on RTB and improved its prospects of achieving its objectives and contributing more efficiently and effectively towards the program’s IDOs and SLOs?⁹³

RTB is successfully delivering added value across centers and crops in several areas, with collaborations and new science that did not exist prior to 2012. In this process it is capturing synergies and taking advantage of complementarities through novel research on problems common to crops and/or centers. The Team’s conclusion is illustrated in many examples given in Chapters 3, 4 and 5, and supported by the results of the researcher survey (see Figure 9-1). It appears that the program

⁹³ The question: *Are the CGIAR reforms assisting RTB to deliver its objectives, achieve program IDOs and contribute to SLOs?* has been merged with this question.

structure for Phase II positions RTB to contribute more effectively to the program's objectives and CGIAR goals. However, there are still areas where synergies and complementarities from centers working more closely together especially on the same crop will add more value to RTB research. In particular, although the IITA and CIAT cassava breeders are collaborating in individual projects, further value would be gained by fully integrating the two breeding programs. There is also clear potential for integration and consolidation of all RTB research on banana and plantain by IITA and Bioversity. This would likely result in rationalization of staff positions and saving scarce W1/W2 funds. It will be important to ensure that the synergies and complementarities and added value facilitated in the current program are maintained and strengthened in the future.

The creation of RTB is clearly supporting researchers to work more closely together towards outputs and outcomes. Combining the five crops into one program is a positive evolution which has enhanced the potential for integration across CGIAR core competencies to deliver program objectives. However interviews with a wide range of program researchers strongly confirmed the Evaluation Team's impression that the transaction costs from the long period of program planning exercises as well as proposal preparation and reporting are taking an increasing share of researchers' time. These transactions costs are particularly burdensome to RTB, as it coordinates efforts across four centers and one major external partner. Furthermore, the instability and uncertainty as well as the delayed disbursement of W1/W2 funds have been impediments to achieving the objectives of the CGIAR reform process. The CGIAR's new legal structures and processes have also created a stifling atmosphere. CGIAR should endeavour to reduce these burdens in future.

Is RTB priority setting effective in terms of program coherence and focus of research on its intended objectives?

A comprehensive PA exercise has been conducted by RTB. All of the areas of research identified by the PA have potential positive IRR but some have much higher returns than others (see Chapter 3). Neither the identified high return research activities nor the definition of program constraints seem to have directly informed the new program structure. A congruence exercise is in progress to compare the results of the PA to the priorities implied by the CoAs identified in the proposed new program. The ISC needs to carefully review the results of the congruence exercise and provide guidance for revisions for the future allocation of funds. Above all, RTB needs to determine how it will use on-going PA for future program planning. At the least, the PA outcomes/results should be used to support fundraising for high return research.

To what extent shall the new RTB program structure based on discrete "business cases" of crop-specific activity clusters contribute to or impede the program's ability to achieve IDOs and SLOs?

The old program structure was largely disciplinary-based but facilitated cross-crop disciplinary research through complementary projects and other cross-crop initiatives. The new RTB structure is more multidisciplinary. However 14 of 25 CoAs are crop-specific in contrast to the old program structure where none of the PLs were crop-specific. The cross-cutting CoAs in the new RTB structure will be crucial in facilitating cross-crop research. At the same time, some of the Themes in the old structure were multidisciplinary for example, Theme 4 on quality seed and Theme 6 on post-harvest and value chains. This report contains specific suggestions regarding how to better align research with

desired outcomes in three areas of research (see Chapters 3, 4 and 5). Of note, combining quality seed with varietal development in one FP is likely to contribute to the outcomes and impact of RTB's breeding efforts. Also, focusing on outcomes instead of outputs should give the program greater results orientation.

The identification of FPs was consultative, inclusive and strategic. In contrast, the process that led to the identification of CoAs of activities lacked strategic thinking and not all key RTB researchers participated. Of note, the Theme 5 leader was absent due to malaria. This may have contributed to crop management (agronomy and soil fertility) research being represented by one CoA only in the new program structure (at the same time acknowledging that other CoAs contribute outputs to this CoA). In addition, full results from the PA were not available at the time. There are also imbalances in the size, coverage and focus of the CoAs (see Chapter 3). As noted above, the congruence exercise should identify where revision of the program structure is needed to better reflect high priority research. Further clarity is needed on how the research outputs from projects within the CoAs will be aggregated up to FP level to contribute to outcomes and impact. In addition, RTB needs to define how the CiA leaders will report to the FP leaders, and the relationship between the FP leaders and program management.

How is the long and continuing process of change in RTB to Flagships and Clusters Projects affecting the management burden and transaction costs, and affecting relationships with partners?

As noted above in the response to Question 2, although overall the reform of RTB is likely to enable the program to respond more effectively to its objectives and contribute to its sub-IDOs, IDOs and the SLOs, there have been complaints from researchers about the long and continuing process of change in RTB. It is causing disruption to research activities and outputs through the significant transaction costs caused by too many meetings. The management burden is also significant. Furthermore the funding uncertainties and repetitive cuts to W1/W2 funds create disincentives amongst researchers to engage with RTB. CGIAR has not given the RTB time to settle down and get on with its research.

The change process has not had much impact on partners as they usually interact with RTB at project level. However there have been complaints from Ethiopian institutes about signing MoUs with multiple CRPs.

Is RTB designing and shaping future partnerships to articulate a sustainable research project portfolio?

Over the past four years, RTB has made excellent progress in designing and shaping future partnerships. The inclusion of CIRAD as a full partner brought in expertise in a number of areas such as crop quality and molecular breeding. RTB is increasingly engaging with the wider stakeholder community including the private sector for partnerships in basic seed production and processing. The sustainability of private companies in producing basic seed of RTB crops and developing quality processed products will depend on the growth in demand for the products and the profitability of these endeavours. To gauge sustainability, RTB will need to undertake research to better understand market development and impact pathways for this research. RTB has also developed strategic

partnerships with ARIs with complementary skills. In the future, RTB plans to work more closely with additional delivery partners such as development agencies.

RTB has also developed new ways of working with NARS which are much appreciated. The sustainability of partnerships with NARS has improved as they are now more equitably involved with project design, implementation and joint publications. In some countries, strong NARS are capable of implementing their own bilateral projects e.g. the NARO banana program in Uganda and the cassava breeding program in Nigeria. RTB needs to develop a strategy for handing over its activities to such reliable partners when the CGIAR effort is finished to avoid unnecessary duplication and competition with NARS. This will ensure that centers continue to focus on the highest priorities for producing IPGs.

Are the impact pathways in the RTB structure sufficiently specified regarding target beneficiary groups and alternative research and industry providers, and are they clearly formulated and used in program monitoring and management?

The old program structure was disciplinary-based and did not provide a coherent basis for tracking research and development outcomes. Achieving outcomes required the outputs from several Themes to be consolidated. This structure was considered not conducive to developing realistic impact pathways for delivery of RTB's objectives. Such a structure was also not useful for developing a robust M&E system. Furthermore, the old structure generically defined next-users of research outcomes and end-users of development outcomes. Consideration of risks and assumptions was limited. In the new structure, impact pathways are defined in detail for each FP and next users are also better identified. For example, in the Discovery FP these include RTB and NARS geneticists, breeders, genetic resources specialists and bioinformaticians while for Delivery FP – Nutritious food and post-harvest innovation the next users include NARS and private sector, food providers and health, education and agriculture stakeholder. Risks and assumptions are also defined. However efforts are still needed on developing an M&E system which links research progress to financial and management information. In addition, the demanding nature of RBM deserves a rethink as to how it will be incorporated into the program M&E system. Furthermore, an assessment of alternative research providers from research and industry would help RTB to make a stronger case for its comparative advantage.

The researcher survey revealed some scepticism that RTB is aligning research to better target beneficiary needs. Alignment should be enhanced in the new program structure where geographical and beneficiary targeting is driven by defined needs of beneficiaries in each FP. Selected IDOs with quantified targets for 2022 are also presented but their long term plausibility has not been assessed.

In the current complex funding environment, has RTB been able to manage multiple sources of funding to assure strategic coherence around highest priority areas of research?

Although it has been very difficult to manage multiple sources of funding in the complex funding environment, especially the on-going uncertainties regarding W1/W2 funds, RTB has been able to develop new proposals for priority areas of work e.g. DNA-based impact assessment and cassava seed systems among others. RTB has achieved strategic coherence around the highest priority areas of research e.g. in the breeding pipeline and multiplication and promotion of quality seed. But the lack of linkages between W1/W2 and W3/bilaterally – funded activities and the center autonomy over the

latter does not enhance strategic thinking. More strategic allocation of W1/W2 to the highest priority areas of research rather than historical allocations should help in future to improve coherence. In addition, CGIAR needs to put more effort into raising W1/W2 funds to support this critically important strategic research that is less attractive to bilateral donors. Full integration of IITA and CIAT cassava breeding and all IITA and Bioversity banana research should also build strategic coherence and improved targeting of W1/W2 funds. In future, RTB also needs to be able to raise funds for its research. The strategic alignment of BMGF projects to RTB priorities is helpful and other key bilateral donors should also consider this approach.

To what extent do the G&M structures and practices of RTB contribute to or impede the achievement of program coherence and effectiveness?

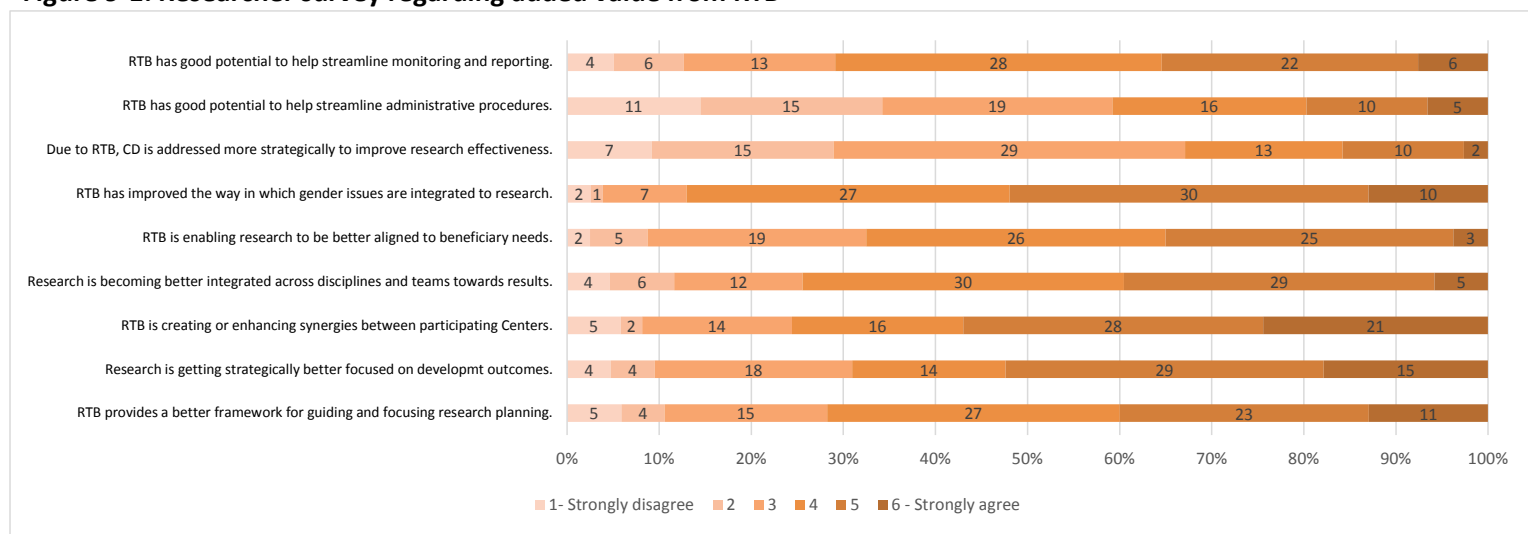
Management has made a significant contribution to the smooth implementation of the program. The PMU should be congratulated on establishing a transparent and fair CRP management system which is universally appreciated by all RTB researchers from all partner centers. The RTB leadership is also appreciated and considered to be amongst the best across CRPs. The focal points have been important support for RTB and have contributed to coherence and effectiveness. The creation of the ISC has improved governance. Overall RTB's management and governance structures have contributed to the level of program coherence and effectiveness thus far achieved.

Above all, creation of a strong alliance compact between the main RTB partners would bring clarity and greater understanding to critical issues such as: allocation and use of W1/W2 funds, handling of W3/bilateral projects, participation in RTB G&M, alignment of management processes, handling of joint appointments, handling joint undertakings, and codes of conduct in program participation. Such an alliance will also be mutually beneficial in the development of a fully owned Phase II proposal.

9.2. The way forward

The Evaluation Team's overall assessment is that RTB plays a unique and much needed role in research generating and sustaining IPGs on important root and tuber crops as well as banana and plantain grown by small holders and consumed by the poor. The partnership between four CGIAR centers and CIRAD is successfully delivering added value across centers and crops with collaborations and new science that did not exist prior to 2012. RTB's potential to contribute to food security and nutrition as well as enhancing the role of women in RTB crop value chains has been established.

Figure 9-1: Researcher survey regarding added value from RTB



The Evaluation Team’s assessment was also confirmed by the results of the researcher survey where there was general agreement that the program is adding value by creating or enhancing synergies between the centers, becoming strategically better focused on development outcomes and improving the way that gender issues are integrated into research (Figure 9-1).

In spite of the complexities and challenges of developing a workable partnership between four CGIAR centers and CIRAD and designing a program on five major crops, in the past four years RTB has achieved a notable level of programmatic integration and captured synergies and taken advantage of complementarities which would not have been possible before the creation of RTB. The integration of CIRAD as a partner holds exciting opportunities for collaborative research. However a program-wide philosophy and commitment to programmatic integration is still not fully realised. Center-level thinking still predominates largely due to the fact that decisions on 80-90 percent of RTB funds are made by the centers, centers have a stronger brand than RTB and researchers identify primarily with centers. Further effort is needed to enhance integration beyond individual time-bound projects.

The obvious next step to greater programmatic integration is to improve the integration of research on common crops across centers. As has been highlighted several times in this report, full integration of IITA’s and CIAT’s cassava breeding research and full integration of all IITA’s and Bioversity’s banana and plantain research through the development and implementation of common research protocols and approaches would enhance the effectiveness and efficiency of research efforts and sharing data sets would allow for greater integration of research results. It is also likely that overlaps and redundancies would be eliminated, staff positions could be rationalised through joint appointments, scarce W1/W2 funds better targeted and a more integrated approach could be made to donors. These actions should substantially enhance the sustainability of RTB’s research efforts.

Other important actions needed to improve the ability of RTB to contribute more effectively to its objectives are:

- CGIAR must endeavour to reduce further change and uncertainty on RTB in Phase II and allow RTB to raise funds for its research;
- RTB needs to determine how it will use on-going PA for future program planning including funding allocations and fundraising;
- RTB needs to work more closely with country-level regulators to facilitate the use of several proven GM crop technologies;
- RTB needs to enhance cross-crop collaboration on nutrition issues and engage more effectively with A4NH;
- RTB needs to enhance its engagement with the private sector for sustainability of research outcomes especially for RTB seed systems and crop processing;
- RTB needs to develop a strategy for handing over to reliable partners to ensure long term local sustainability when there is limited further opportunity for generating substantial IPGs; and
- RTB needs to manage different funding sources (W1/W2 and W3/bilateral funds) as one portfolio to enhance strategic thinking and allocate W1/W2 to the highest priority areas of research.

The creation of a strong alliance between RTB partners will help to address these important issues and enable RTB to contribute to its IDOs and ultimately to the CGIAR's goals for reduced poverty, improved food and nutritional security and improved natural resource systems and ecosystem services. At the same time, RTB needs to be pro-active in enhancing its visibility as a unique CRP amongst both donors and policy makers. Currently, the strong dependency of RTB on two bilateral donors carries some funding risks in the current uncertain funding environment.

The pre-proposal for Phase II of RTB was considered well-conceptualized with a clear, focused, logical and plausible ToC and impact pathway by the ISPC. Of note, there was full agreement between the ISPC and the Evaluation Team of the need for RTB move speedily to using the outcomes of the PA for more strategic allocation of the budget across crops and for further programmatic integration (one of the main CGIAR reform principles) in the development of the full proposal.