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Root, Tuber and Banana Food System Innovations

Value Creation for Inclusive Outcomes

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Chapter 2
Innovation Models to Deliver Value at Scale: The RTB Program

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Abstract Collaborative programs that facilitate innovation to deliver value at scale require attention to effective program design, management, governance, and leadership. The CGIAR has experimented with different collaborative program design options over its 50-year history, most recently with the CGIAR Research Programs (CRPs) implemented from 2012 to 2021. This chapter examines the structure and processes of the CGIAR Research Program on Roots, Tubers and Bananas (RTB). It unpacks the constituent institutional innovations that underpinned the RTB program, their key design principles, how they evolved over the 10 years of the program, the innovations achieved, and the outcomes to which they contributed. Turbulence and transformations in the CGIAR system influenced the CRPs' emergence, design, and delivery. In this chapter, we discuss the RTB approach to collaborative governance and management as complex institutional innovations operating within this broader, dynamic system. This includes attention to opportunities, limitations, and other contextual factors influencing RTB's work. Institutional innovations include stakeholder consultations and priority setting, a portfolio organized by aggregated innovations, or clusters of activities, articulated flagship projects, incentive funding, a dynamic interactive communication ability, and programmatic embedding of strategic and integrated gender research. RTB's design, governance, and management innovations added value to the combined achievements of the participating centers in science and research for development outcomes, described in the following chapters.

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2.1 Introduction

For 10 years, the CGIAR Research Program on Roots, Tubers and Bananas (RTB) advanced a significant body of scientific knowledge and practice on the clonally propagated staple food crops: banana (principally cooking banana and plantain), cassava, potato, sweetpotato, and yam. Root, tuber, and banana (RT&B) crops have been historically neglected, even until recently (Krishna Bahadur et al. 2018; Almekinders et al. 2019; Scott 2020). RTB's vision was to tap the potential of these crops across the world to improve food security, nutrition, income, and the climate change resilience of smallholders, especially women and youth. RTB brought together the work on RT&B crops across four CGIAR centers (Bioversity, CIAT, CIP, and IITA) and French research partners represented by CIRAD. It sought to strengthen the agri-food system of these crops in partnership with numerous research and scaling organizations. RTB was part of an integrated portfolio of CGIAR Research Programs (CRPs) established in 2012. This chapter explains how RTB developed an integrated set of institutional innovations shaped by a historical context of change in the CGIAR system.

In this chapter, we first briefly address the historical context of the CGIAR and then present the institutional memory of RTB from its emergence in the "New CGIAR" in 2011 to its transition within the "One CGIAR" (2022–2030). RTB had two 5-year phases of program design and management (2012–2016 and 2017–2021). In both phases, the institutional innovation by RTB was critical in developing adaptive capacity and resilience in the context of emerging priorities and resource disruptions. The final sections of the chapter draw lessons of broader relevance for designing international agricultural research for development programs. Highlighted examples of strategic and integrated science outcomes of the RTB program will be covered in more detail in subsequent chapters of this book.

2.2 Context

International agricultural research plays an important role in advancing agricultural science to improve the lives of billions of people in the world, especially the food insecure who face exigencies of poverty and environmental and climate crises. Since the 1970s, coordinating agricultural research for development and its coordination has changed substantially (Dalrymple 2008; Feldman and Biggs 2012; Immonen and Cooksy 2019). Linear models that implicate top-down problem-solving, for example, from scientists to farmers, have shifted toward demand-driven solutions. The inequitable distribution of the benefits of new technologies, for example, seed that is high yielding but requires costly inputs that disadvantage resource-poor farmers, has led to greater recognition of the socio-technical complexity of knowledge plurality and the need for bridging cross-sectoral and disciplinary boundaries (Pigford et al. 2018).

There are advantages to co-produced knowledge and co-innovation with diverse stakeholders in the agricultural system (Pant and Hambly 2009). Approaches to improving innovation have included participatory design process, reflective practice in science management, regional hubs and innovation platforms, learning alliances for scaling, adaptive collaborative management that strengthens local capacity, and partnership projects to foster collective knowledge assets (Horton et al. 2009; Ekboir 2009; Pigford et al. 2018; Berthet et al. 2018). Recently, the COVID-19 pandemic has drawn attention to the role of science and trust in expert knowledge, informing not only research in human diseases but also agri-food systems, climate change, and biodiversity loss (Barrett et al. 2020). The current transition known as One CGIAR (Coffman et al. 2020) is both a response to system changes and a contributor to innovation that can unleash the creativity needed to respond to shocks such as COVID-19 that prioritize donor funding to health.[1]

2.3 CGIAR Collaborative Programs

Created in 1971, the CGIAR is the world's largest group of publicly funded, agricultural research for development organizations. Its creation involved vested geopolitical interests and other powerful forces, creating the context that was to shape the CRPs (Hardin and Collins 1974; Baum and Lejuene 1986; Harwood and Kassam 2003; Ozgediz 2012; McCalla 2014, 2017; Byerlee and Lynam 2020). Early international agricultural research programs, largely funded by the Rockefeller and Ford Foundations, generated positive social returns on investment from partnerships that developed high-yielding crop varieties. From the 1960s onward, growth in and modernization of smallholder agriculture were predicated on new Green Revolution technologies (high-yielding crop varieties, fertilizers, and pesticides), guaranteed commodity prices, subsidized inputs, research, extension, training services, and infrastructure (e.g., irrigation). The evolving mandates of the United Nations Food and Agriculture Organization (FAO), the United Nations Development Programme (UNDP), and the World Bank generated influential global agricultural policy analyses and assessments that led to the CGIAR's creation (Feldman and Biggs 2012). Increased multidisciplinary scientific exchange, civil society debate, and structural adjustment policies of the 1970s–1980s combined to reassess the priorities of the Green Revolution, which was argued to have typically benefited wealthier, larger-scale, and male farmers. This led to greater attention to equity, including gender and interventions directed toward less well-off smallholder farmers (Glaeser 1987; Feldman and Biggs 2012).

By the early 1990s, the CGIAR's first four decades were strained by the complexity of taking on issues from the global agenda set out in the World Commission on Sustainable Development (WCSD). This included adding new CGIAR centers,

[1] See also https://www.cultivation.hps.cam.ac.uk/CGIAR-histories.

which grew from 4 in 1971 to 12 in 1979. Limited funding led to competitive stress and coordination challenges. The CGIAR centers had, up to the 2009 reform era, two forms of funding: unrestricted (referred to as core funding provided jointly by the World Bank and other donors) and restricted funds (bilateral funding from specific donors for projects). The former supported centers' management costs, allowing operational flexibility when new cost items emerged. The latter covered donor-specified costs in projects and centers. Unrestricted/core funding declined relative to restricted and special project funding, from upwards of 80% in the first decades of the CGIAR (Operations Evaluation Department 2004) to about 30% of the system funds by its fourth decade (Ozgediz 2012). Consequently, some centers faced financial difficulties, as they competed for project funds and had little appetite for the unfunded transaction costs of system-wide initiatives (McCalla 2014, 2017). Added to this was a degree of protectionist behavior in the system that resisted further merging or a reduction in the number of centers.[2]

New priorities reflected in the WCSD led the CGIAR to give increasing attention to the environment, biodiversity, and sustainability. Against this backdrop, reform sought a strategy of unification respecting centers' autonomy with large, coordinated multicenter research programs to tackle these global issues (Fig. 2.1). This led to the creation from 1993 of system-wide and eco-regional and CGIAR initiatives involving attention to greater interdisciplinary farming systems research, farmer participatory research, location-specific research, and new centers focused on natural resource management and biodiversity (Greenland 1997). By 2002, a mechanism to invite collaborative proposals on large, system cross-cutting research programs emerged. These 5 Challenge Programs (CPs) aimed to improve CGIAR business processes while shifting the consultative group of centers toward a

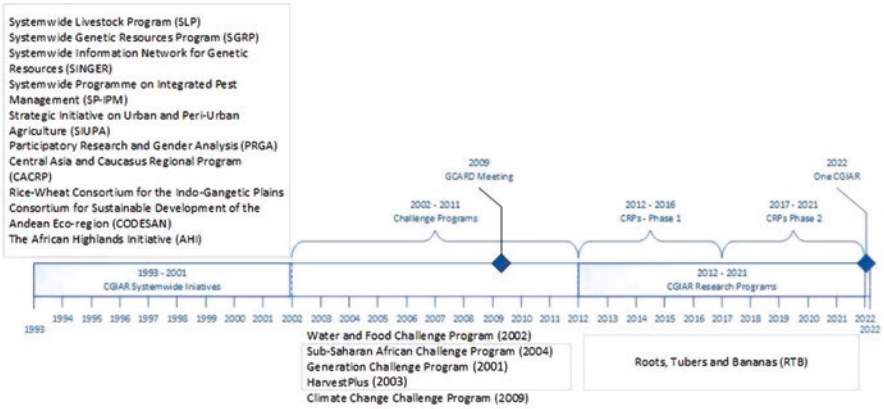

Fig. 2.1 Timeline for CGIAR collaborative programs with examples

[2] ILCA and ILRAD merged to become ILRI. INIBAP (banana and plantain) joined IPGRI (later Bioversity). ISNAR closed with some activities folded into IFPRI.

"consortium" model of setting system goals and regional priorities and enabling co-funding to reduce growing dependency on restricted funding (TAC/Science Council 2003).[3] One key element to engage partners in each CP was independent priority setting and management oversight bodies independent from the centers (Woolley et al. 2011).

This formative period from 1981 to 2010 prepared the ground for what would be the future cross-cutting CRPs (Fig. 2.1). Nevertheless, despite the desire for integration, reflected in new system-wide initiatives, the CGIAR center-based model of collaborative international agricultural research for development not only survived but also grew, with scientific work by the centers having a high impact.[4]

Seeking further changes toward more coherent responses to the United Nations' Sustainable Development Goals (SDGs) reduced fragmentation of the centers, and to avoid duplication of efforts among them and to optimize available funding, CGIAR funders and centers came together for a major reform effort in 2009. In 2010, delegates of the Global Conference on Agricultural Research for Development (GCARD), in Montpellier, France, helped shape a *Road Map to Transform the Agricultural Research for Development (AR4D) System for Greater Global Impacts* (GCARD 2011). The conference finalized a new Strategic Research Framework (SRF) for the CGIAR integrating the work of all the centers in a results-oriented research for development system with an integrated programmatic structure (Consortium Board 2011).

2.4 Design and Evolution of CRPs

The proposed building blocks of the SRF were a set of (initially) 15 interdependent CGIAR Research Programs (CRPs). The CRPs were envisaged as multicenter, interdisciplinary, and collaborative results-oriented programs whose impact was expected to be greater than the sum of their parts, because of the gains from synergies and system-wide cooperation (Consortium Board 2011). Donors responded favorably to the SRF, creating pooled funding through the mechanism of the "CGIAR Trust Fund," designed primarily to finance centers' collaboration and AR4D synergies (Renkow and Byerlee 2010) (Table 2.1).

[3] The World Bank initially hosted the CGIAR Secretariat, and the FAO hosted the Technical Advisory Council (TAC) in Rome, which held science impact, shared research service platforms, and other accountability functions. Under the consortium, the System Office was a virtual entity, and later the Consortium Office was based in Montpellier. TAC was renamed the Science Council retaining its advisory and evaluative functions.

[4] The impact of the CGIAR is summarized in two reports: at its 31-year milestone (Operations Evaluation Department 2004) and at 40 years (Ozgediz 2012). For example, the latter report stated that every dollar invested in CGIAR research meant $9 worth of additional food was produced in developing countries.

The Fund was intended to pledge stable, long-term financing for collaboration and integration of activities across CGIAR centers. W2 gave funders the discretion to invest in particular CRPs or platforms. However, an internal stabilization mechanism allowed for compensating allocations through W1 when there was a reduction in W2 allocation for any CRP. This created more stable funding from year to year but somewhat frustrated the funders' intentions to support those research areas they deemed of the highest relevance.

Initially, with the enthusiasm for the new reform, funder investments in the CGIAR rose markedly, climbing above $1 billion in 2014. However, as difficulties appeared, funding fell to $800 million in 2019. With this promising start, pooled funding (W1&2) reached 35% of total CGIAR funding but then fell sharply through 2015–2017 to around 20% of the total (Fig. 2.2). The CRPs would face challenges responding to funding-related turbulence and the late confirmation of funding within each financial year.

Even midway through SRF Phase 1 in 2015, there was a growing feeling among donors that the portfolio was too complex, inhibiting the desired collaboration. A decision was taken to close the system's CRPs and reduce from the original 15 to 11 CRPs (CGIAR 2015a, 2016). Building on strong prior collaboration with RTB, much of the CRP on Integrated Systems for the Humid Tropics (CRP-Humidtropics 2016) that was led by IITA, including the work in innovation platforms and their budgets, was integrated into RTB. This incorporation made RTB the largest Phase 2 CRP in the system portfolio by 2017.

The CGIAR portfolio was redesigned in preparation for a Phase 2 beginning in 2017. This standardized the programmatic structures for each CRP, based on flagship projects (FPs), and established a clear framework for cross-CRP integration. The design process had two stages: (a) pre-proposals and (b) full proposals, each evaluated by the Independent Science and Partnership Council (ISPC). This significantly strengthened CRP and system-level consistency across the CGIAR portfolio compared to Phase 1, with common design principles and carefully crafted theories of change to which the FPs contributed (ISPC 2012). The new portfolio was

Table 2.1 CGIAR funding windows, 2012–2021

Funding window	Purpose
Window 1 (W1)	Portfolio investments: funding allocated to the entire CGIAR portfolio of approved system-wide investments, prioritized and allocated by funders collectively through the System Council – supporting CGIAR as a whole
Window 2 (W2)	Program investments: funding allocated by funders individually to any component (e.g., CRP, Platform) of the system-wide portfolio as prioritized, defined and approved by the funders collectively through the System Council
Window 3 (W3)	Project investments: funding allocated by funders individually to projects that are defined by the funders themselves (with partners) and that are aligned with system-wide investments

Source: CGIAR website

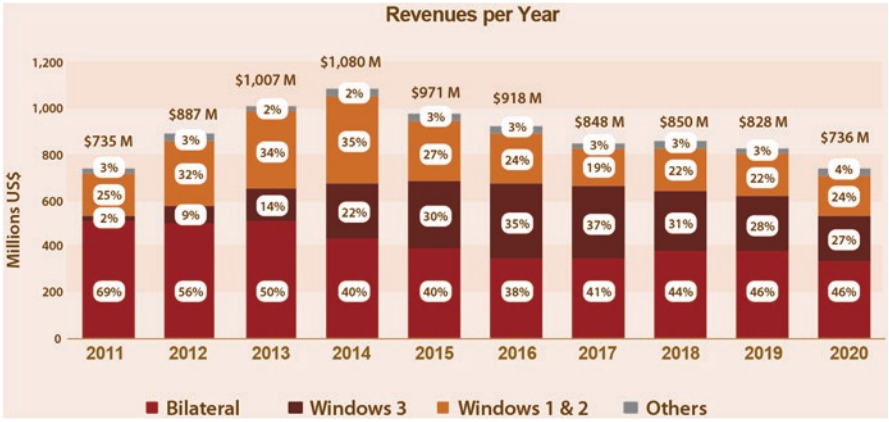

Fig. 2.2 CGIAR revenues per year

comprised of seven agri-food system programs and four interlocking globally integrating programs (Fig. 2.3).

2.5 RTB Program

The planning and evolution of the RTB program is part of the long history of CGIAR reform described above, comprising three phases of activity: a preparatory design phase (2009–2011), Phase 1 (2012–2016), and Phase 2 (2017–2021), summarized in Fig. 2.4.

During its design and Phase 1, RTB was conceived as one of the commodity CRPs, which aimed at modernizing crop breeding programs, creating synergies based on the commonalities of clonal crops and linking breeding to seed systems; these domains made up about 40% of total investment. In the design phase, a group of scientists from four CGIAR centers,[5] CIP (as the lead center), with Bioversity, CIAT, and IITA, met up to develop a scope of work and identify research components of the participating CGIAR centers (CRP-RTB 2011).

To design its program impact pathway and ensure consistency with the system-level outcomes, RTB sought to link relevant center activities at multiple levels, from farm households to wider production systems, and across national, international, and regional levels with diverse public and private sector stakeholders. A central part of the impact pathway focused on programmatic integration across CGIAR

[5] Following a scoping analysis, led by the RTB Steering Committee, other strategic science partners and CIRAD (a non-CGIAR center representing the French research partners) were subsequently invited to join the consortium.

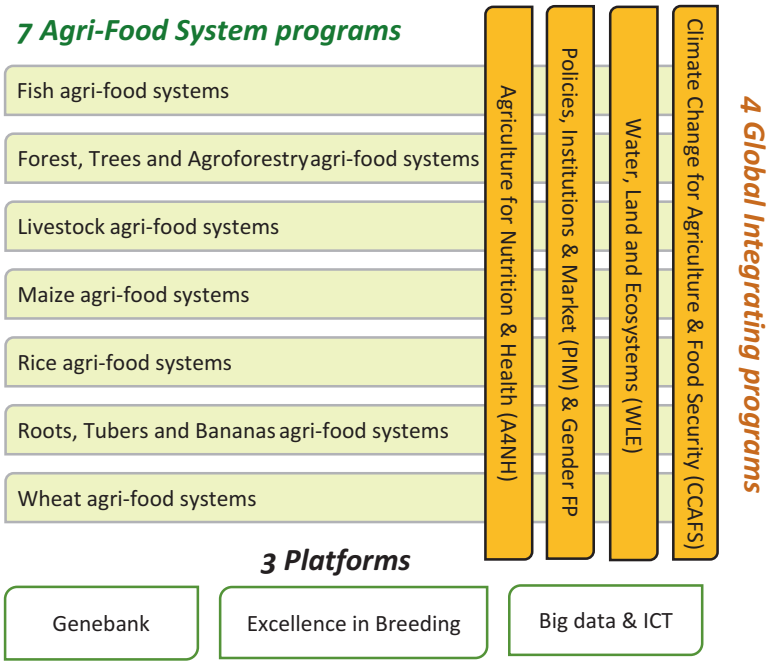

Fig. 2.3 Comprehensive and integrated CGIAR portfolio for Phase 2

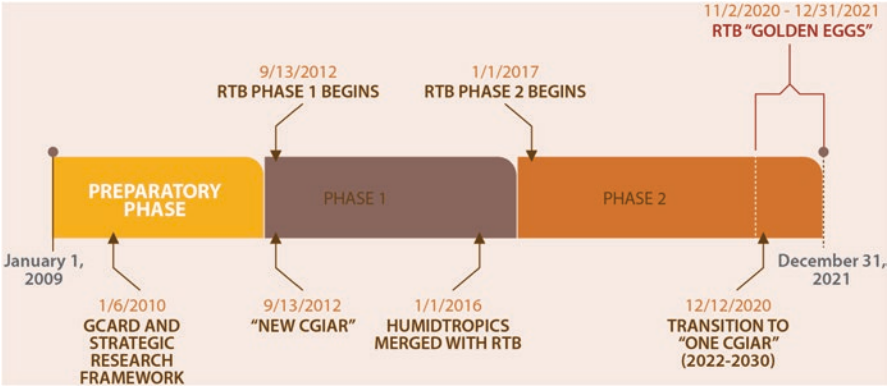

Fig. 2.4 RTB timeline (2009–2021)

core skills, adding value and capturing synergies across the five prioritized[6] crops (banana, cassava, potato, sweetpotato, and yam) and across the five research centers.

[6] RTB also included the minor root and tuber crops such as taro and several Andean crops. However, these were not prioritized for pooled funding despite their importance in some localities.

During implementation in Phase 1, new AR4D partnerships were created through RTB's strategic use of the W1/W2 funds. One outstanding example that began in the first phase was for work on metabolomics across all crops with Royal Holloway, University of London (Price et al. 2020). RTB also linked with other CRPs, in particular to Humidtropics, which was noted in its 2016 annual report:

> Tremendous success was made towards the incorporation and mainstreaming of components of Humidtropics research within some AFS-CRPs. The biggest success in this regard was in relation to partnership with CRP Roots, Tubers and Bananas (RTB) Agri Food Systems. RTB was open to partnership with Humidtropics and took on a number of research activities including Innovation Platforms and place-based systems research operations in a number of locations. Humidtropics contributed in the mainstreaming of systems approaches and the development of a Livelihoods Flagship within RTB.[7]

Against this backdrop of continuous reform, RTB developed as a complex institutional innovation that made purposeful change in governance and program management, drawing on "soft skills" (Woodhill 2010) such as communication, trust building, networking, and leadership with clear goal orientation. This enabled enhanced collaboration by cultivating and pursuing collective action against shared goals, which is highly challenging if institutions and organizations work alone (Roberts and Bradley 1991; Arena et al. 2017). Early on, RTB management recognized that collaborative practices were key to driving innovation and responding strategically to shifts in the external environment. The main institutional innovations that facilitated collaborative practices, described in this section, are the following:

1. Collective action in management, leadership, and associative governance
2. Stakeholder consultation and participatory design
3. Priority setting to guide investments and build/adapt the portfolio
4. Portfolio organized by aggregated innovations
5. Programmatic embedding of strategic and integrated gender research
6. Internal funding mechanisms and incentives
7. Dynamic interactive communication capability to build a shared vision and stakeholders' support
8. Purposive engagement of national partners

[7] See https://cgspace.cgiar.org/bitstream/handle/10568/89312/HUMIDTROPICS-Annual-Report-2016.pdf?sequence=1&isAllowed=y.

2.5.1 *Collective Action in Management, Leadership, and Associative Governance*

Early on, during the design phase, the centers involved in RTB opted for an associative style of governance. In terms of a "hard contract," CIP is the lead center, and its Board of Trustees holds fiduciary responsibility for RTB. Yet with an equally important "soft contract" approach, through the management committee, participating centers in RTB were given an equal weight in taking decisions with transparent access to information, particularly on finances. The different management and governance levels in RTB recognized that mechanisms were needed to support collective action, which could not be achieved by any of the centers acting separately (Horton et al. 2009). An associative style of governance was both a reason for and a result of collective action in RTB. Each participating center in RTB was an important contributor to the overall impact of clonally propagated crops, and bananas and cassava had mandates shared by two centers.

In Phase 1, RTB governance involved a steering committee comprised only of center DGs and a science advisory committee known as the PAC (Program Advisory Committee) whose membership included subject and regional specialists from Non-Governmental Organizations (NGOs), universities, and research institutes around the world (Fig. 2.5). The PAC played a role as part of the system of checks and balances by looking out for collective interests above those of each of the centers.

Operationalizing collaboration was facilitated by the full-time RTB Program Director (PD) supported by the Project Management Unit (PMU) in close communication with the RTB Management Committee composed of apex research managers in the participating CGIAR centers (usually Deputy Director General of Research). The PD led the Program Management Unit (PMU) that included five to seven full-time support staff responsible for grants, finance, communications, planning and reporting, and gender research, with a science officer included from 2015.

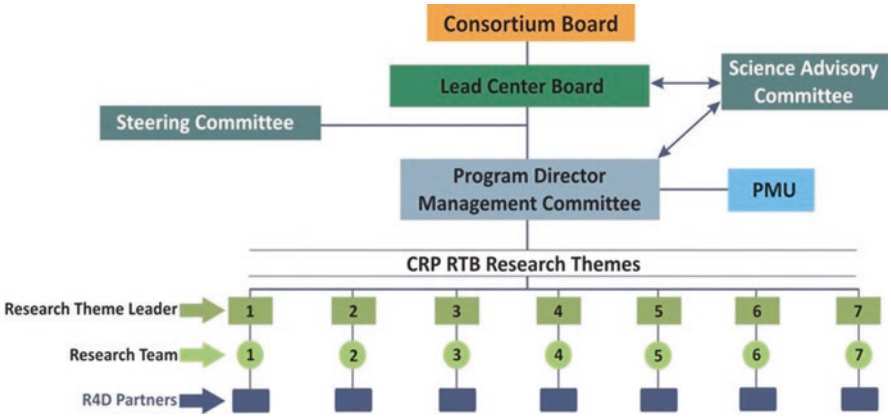

Fig. 2.5 RTB organogram Phase 1

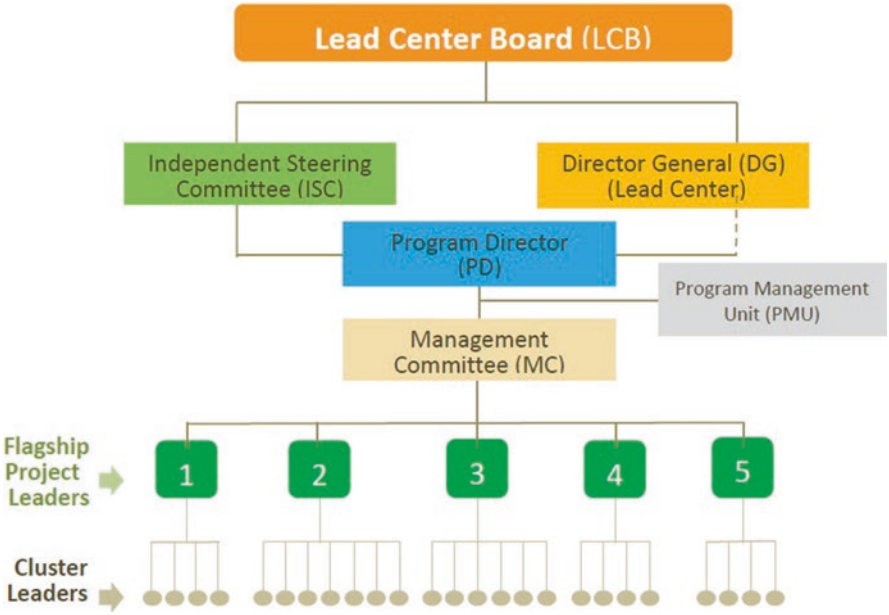

Fig. 2.6 RTB organogram for Phase 2 showing governance and oversight functions

The PD, guided by the Management Committee, oversaw FP leaders and the cluster leaders with a programmatic reporting line (Figs. 2.5 and 2.6). Reflecting the soft contract approach, FP and cluster leaders were drawn in a balanced way from all five participating centers.

During Phase 1, the RTB collaborative governance structure evolved further, following system guidelines for all CRPs, into the Independent Steering Committee (ISC, formerly the Program Advisory Committee) where the center DGs are represented, but most independent members are selected according to needed competencies for program oversight while ensuring some level of regional and gender representation. The ISC Terms of Reference specified that it had advisory input to the RTB to ensure oversight of the strategic alignment of the RTB with the SRF at crucial periods such as the design of CRP-level program proposals, draft annual Plan of Work and Budget (PoWB), and Annual Reports. The Chair of ISC reported annually to the CIP Board of Trustees, which had fiduciary responsibility for RTB. The Program Committee of the CIP Board received regular reports on program progress and approved the RTB annual PoWB. RTB developed a comprehensive and coordinated governance function with collaborative practices such as collective review of the PoWB and the review of FPs' progress and plans as a central feature of ISC annual meetings.

RTB's associative style of governance and collaborative management was further reinforced following a recommendation from the Independent Evaluation Arrangement (IEA) review (2016) to create an "alliance compact" as a trust-built, soft contract among the participating centers to bolster the legal agreements

established between the lead center and the other centers. The ISC played a key role in translating the alliance compact into a specific set of partnership statements, signed by the DGs of the centers in 2017, as follows:

(a) *RTB Partnership Collaboration* – RTB is a shared asset that should be jointly promoted and nurtured in a collaborative way to support collective action and add value to members in the long term.
(b) *Inclusive Partnership* – Openness, trust, and mutual respect and learning lie at the core of effective partnerships in support of the RTB goals, recognizing the different and complementary roles of all members.
(c) *Strengthening Business Partnerships* for RTB for cross-cutting, multi-crop, collective action research for development that would not be possible by each of the members acting separately.
(d) *Donor Relations* – Promoting joint stewardship to maintain the engagement of the existing set of Window 2 donors and sharing responsibilities for resource mobilization intelligence for potential new Window 2 funding for RTB. Centers agree to pursue a policy of minimal reciprocal overheads for pass-throughs that relate to transfers across the members. For Window 3 or bilateral funding connected to the RTB Program, members agree to map the funding and results into the RTB Program so that the program as a whole could benefit.
(e) *Talent Management* that flows across centers for RTB management positions such as FP and cluster leaders is a key part of the overall compliance mechanism.
(f) *Communications* – Ensure that communication/public relations activities accurately reflected collaborative efforts and the contribution of each member.

In summary, this associative governance style supported major transitions within the first and second phases of RTB, including after 2016, the incorporation of parts of the Humidtropics CRP. The soft contract of the "alliance compact" recommended by IEA was acted upon, and a collective approach to management and governance was adopted.

2.5.2 Stakeholder Consultation and Participatory Design

Stakeholder consultation was an institutional innovation supporting the design process, particularly in the preparatory phase of RTB. There was a short timeframe between the start of proposal writing (late June 2010) and the deadline for submitting the proposal (the first week of September 2010); 255 stakeholders, about half from developing-country national agricultural research systems (NARS) and universities, were consulted using surveys. This resulted in an initial RTB structure with seven disciplinary themes, each with a mix of existing, expanded, and new product lines as well as cross-cutting activities. To create its initial structure, more than 25 researchers from Bioversity, CIAT, CIP, and IITA participated in a 3-day workshop, held at CIP's headquarters in 2010, to define and organize a strategy for developing the proposal for a CRP. Writing teams were formed across topics to

Table 2.2 RTB stakeholders' aggregated score of importance assigned to seven themes in the proposal

Theme	Regional survey	Global survey
Theme 2: Accelerating the development, delivery, and adoption of varieties with stable yields, stress resistance, and high nutritional value	4.60	4.55
Theme 6: Enhancing postharvest technologies and adding value in markets	4.58	4.22
Theme 4: Promoting sustainable systems for clean planting material for farmers	4.51	4.38
Theme 1: Conserving and accessing genetic resources	4.42	3.81
Theme 3: Managing priority pests and diseases and beneficial microbial communities	4.29	4.24
Theme 7: Enhancing impact through partnerships	4.33	4.00
Theme 5: Developing tools for more productive, ecologically robust crops	4.12	4.05

Note: Themes were scored on a 0–5 scale (0 meant "not important" and 5 was "very important")

encourage cross-center collaboration, and writing responsibilities were assigned. A proposal development schedule was developed and agreed upon, as was a protocol for writing, editing, and managing the draft sections. The inter-center workshop proposed seven core themes for RTB (Table 2.2).

The seven CRP-RTB themes were ratified by the stakeholders (Table 2.2). The stakeholder surveys during the design phase confirmed previous findings that RTB crops are generally absent from government rural development strategies (Woolley et al. 2011). Following the design workshop and stakeholder consultation, RTB was organized by these seven themes. Each theme was ordered by crop. Each theme leader was drawn from a different center, and each theme included cross-cutting work in gender, biophysical research, and processes and partnerships for scaling innovations.

By 2014, with the implementation of results-based management in the CGIAR, and more consideration of its theory of change, the PMU realized that the first thematic structure (labelled RTB 1.0) had limitations for creating a compelling and viable theory of change and for organizing science teams. RTB 1.0 neatly arranged work by different themes but lacked a process to bridge the different themes, e.g., connecting varietal development with seed system development for each crop.[8] Working groups in the 2014 RTB annual meeting in Kampala considered options for a new program structure (referred to as RTB 2.0). Before the start of Phase 2, which began in 2017, the RTB portfolio had been reorganized into five FPs and clusters of activities (CoA) that encompassed five crops, four CGIAR centers, and by this point a non-CGIAR center, CIRAD (CGIAR-IEA 2015a, b, 2016). The

[8] The analogy was that RTB 1.0 was like a closet with separate groups of clothes on hangers, but no way to combine them into complete and matching outfits.

transition toward the RTB 2.0 structure, which replaced seven themes with five FPs, was gradually completed in 2016.

The proposal for Phase 2 (RTB 2016a) including a scope of work and a theory of change for each of the five FPs was prepared by design teams drawn from RTB scientists from each FP (see Sect. 2.5.5). Key staff from the Humidtropics CRP joined RTB on these writing teams, particularly around scaling innovation (FP5), which included researchers from Wageningen University & Research (WUR). Additional teams worked on cross-cutting topics of gender-responsive research, capacity development, and partnerships (Fig. 2.7). This proposal combining flagships and cross-cutting topics was reviewed and approved by the ISPC in a two-stage submission process. RTB received one of the highest ratings of any CRP by the ISPC (2016).

In summary, RTB 1.0 became RTB 2.0 by supporting the interaction between innovations, which is essential for wider adoption and scaling (see Sect. 2.5.4). At the same time, there was extensive CGIAR consultation during 2014–2016 that restructured all CRPs with shared design and management principles around FPs and clusters for Phase 2.

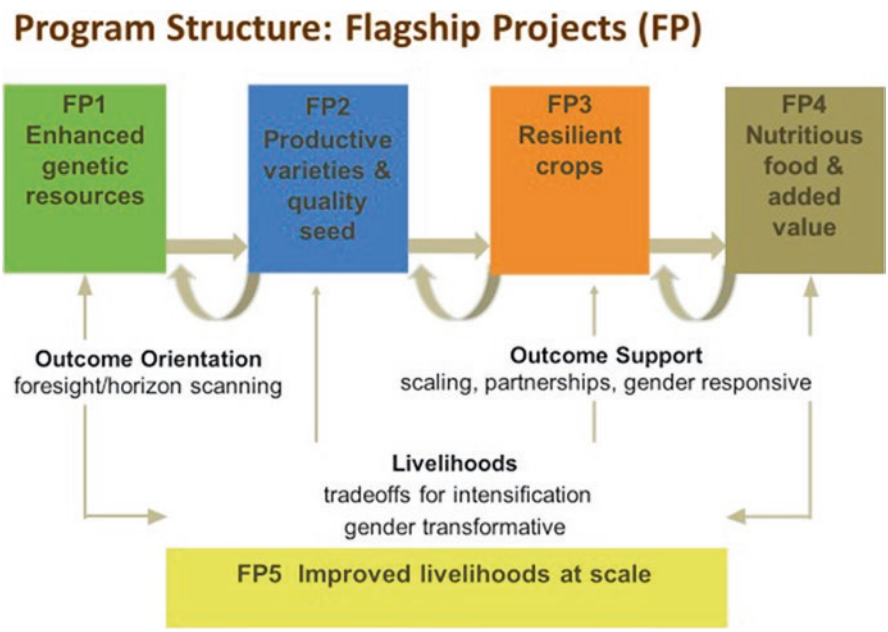

Fig. 2.7 Program structure organized by FPs, 2016–2021 – RTB 2.0

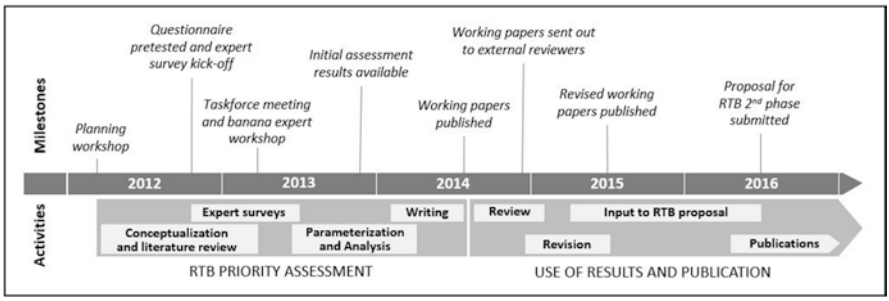

Fig. 2.8 Timeline and key activities of RTB priority assessment. (Source: Pemsl et al. 2022)

2.5.3 Priority Setting to Guide Investments and Build the Portfolio

Reflecting on the stakeholder consultations in 2010, RTB responded to a direct request from donors and the ISPC to conduct a rigorous priority assessment as a precondition for funding. The steps of the priority assessment method ran in parallel with the participatory design/redesign of the portfolio and the comprehensive framework, including the impact pathways described above (Fig. 2.8).

Priority setting in RTB covered five crops (cassava, banana, potato, sweetpotato, and yams) using a harmonized method that drew on the approach developed earlier at CIP (Fuglie and Thiele 2009). The assessment included four key steps: (1) elicitation of major production constraints and research opportunities through global and regional expert surveys; (2) identification of priority research interventions by crop; (3) ex ante estimation of costs and benefits for two adoption scenarios using partial equilibrium economic surplus models with poverty impact simulations; and (4) publication and use of findings. For the first step, to identify key constraints and research opportunities, 1709 experts were consulted, from a wide variety of disciplinary backgrounds, mostly scientists from national agricultural research organizations.

Specific research options were selected based on overall and regional scores from the expert survey (step 2) in consultation with experts and center scientists, considering the scope of RTB's research activities to ensure a good match of options with the program portfolio.

The results (Table 2.3) showed large benefits for all potential research investments and provided useful outcome and impact indicators (adoption area, number of beneficiaries, net present value, internal rate of return, and poverty reduction). In Table 2.4, results of computed performance indicators suggest two key findings: (1) expected adoption areas are large, ranging from several hundred thousand to almost four million hectares, which translates into high numbers of beneficiaries (estimated to be as high as 36 million persons), and (2) all options have large positive net present values. There was a high level of congruence between the research options of highest priority in the assessment and the crop-specific clusters in RTB's

Table 2.3 Results of RTB priority assessment – adoption, beneficiaries, economic benefits, and poverty impacts (lower adoption scenario)

Top ranked research options by crop	Adoption area (million ha)	Number of beneficiaries (million HH)	(million persons)	Net present value (NPV) (US$ million)	Internal rate of return (IRR) (%)	Poverty reduction (million persons)
Banana						
Banana Xanthomonas wilt (BXW) management cultural practices	0.64	3.22	15.67	1982	72	1.61.
Recovery from banana bunchy top virus (BBTV)	0.40	2.02	9.67	1337	61	0.64
Resistant plantain (RELEASE)	0.45	1.70	7.57	1111	64	0.25
Cassava						
High-quality planting material production and distribution systems for improved varieties	3.38	6.73	33.08	7585	416	2.10
Sustainable crop and soil fertility management	3.27	6.43	31.72	8284	210	2.66
High yielding, drought-tolerant varieties and increased water-use efficiency	3.99	7.89	36.49	3025	61	2.00
Potato						
Late blight resistance	0.77	6.73	33.08	7585	416	2.10
Virus-resistant varieties	0.36	6.43	31.72	8284	210	2.66
Bacterial wilt-resistant varieties	0.64	1.72	7.85	253	29	0.20
Sweetpotato						
Orange-flesh sweetpotato (OFSP)[a]	0.67	3.00	14.60	563	35	0.48
Weevil-resistant varieties	0.72	2.94	14.11	363	41	0.36
Sweetpotato virus disease (SPVD)-resistant varieties	0.48	1.96	9.41	673	116	0.34
Yam						
Clean planning materials and agronomic practices	0.68	2.39	17.72	570	37	0.18

(continued)

Table 2.3 (continued)

Top ranked research options by crop	Adoption area (million ha)	Number of beneficiaries (million HH)	(million persons)	Net present value (NPV) (US$ million)	Internal rate of return (IRR) (%)	Poverty reduction (million persons)
Improved varieties with complementary ICM	0.43	1.58	11.74	3026	60	0.66
Yam pest and disease management options	0.43	1.60	11.85	412	43	0.10

Source: Pemsl et al. (2022)
[a]Including health benefits from the adoption of OFSP (DALY method) substantially increases benefits: NPV: US$1298 million, IRR: 51% (lower adoption scenario)

Table 2.4 RTB portfolio organized by clusters or "innovation packages"

Discovery	Delivery		
FP1: Enhanced genetic resources	FP2: Productive varieties and quality seed	FP3: Resilient crops	FP4: Nutritious food and added value
DI1.1 Breeding CoP **DI1.2** Next generation breeding **DI1.3** Game-changing traits **DI1.4** Genetic diversity	**CC2.1** Access to quality seeds/varieties **BA2.2** User-preferred banana cultivars/hybrids **CA2.3** Added value cassava varieties **PO2.4** Seed potato for Africa **PO2.5** Potato varieties for Asia **SW2.6** User-preferred sweetpotato varieties	**CC3.1** Pest/disease management **CC3.2** Crop production systems **BA3.3** Banana fungal and bacterial wilts (Foc/BXW) **BA3.4** Banana viral diseases (BBTD) **CA3.5** Cassava biological constraints, Asia/Americas **CA3.6** Cassava biological threats, Africa	**CC4.1** Post-harvest innovation **CA4.2** Cassava processing **CA4.3** Biofortified cassava **SW4.4** Nutritious sweetpotato
FP5: Improved livelihoods at scale			
CC5.1 Foresight and impact assessment **CC5.2** Sustainable intensification and diversification for improvement resilience, nutrition, and income **CC5.3** Gender equitable development and youth employment **CC5.4** Scaling RTB agri-food system innovations			

programmatic structure for FPs 2, 3, and 4 where most delivery research is located (Pemsl et al. 2022). Hence, the exercise gave coherence to the selection of crop clusters for Phase 2, discussed below. The findings informed the development of RTB's research portfolio and were critical for facilitating continued program funding.

In summary, RTB responded to a direct request from donors and the ISPC to conduct a rigorous priority assessment as a precondition for funding. The entire exercise brought social scientists, breeders, agronomists, and other disciplines from different centers together around a shared task and method to provide consistent metrics across crops. Establishing such a community of practitioners was an

institutional innovation, which provided a strong, collaborative base and set an example for cross-center cooperation.

2.5.4 RTB 2.0: Portfolio Organized by Aggregated Innovations with Linked Impact Pathways

After 2016, RTB 2.0 was used as a comprehensive framework for planning, implementing, reporting, and learning. FPs were organized into 25 clusters of activities comprising the full RTB CRP portfolio. The three types of clusters were the following:

- Discovery clusters that included the upstream work, feeding into the crop-specific clusters.
- Crop-specific delivery clusters generating direct impact
- Cross-cutting clusters that synthesized, linked, and supported work across the crop-specific clusters

The cross-cutting clusters are a key institutional innovation as they contribute to establishing communities of practice across different crops and centers. Few other CRPs had such clusters (Jill Lenné, personal communication).

Each cluster was designed with a lead or core innovation (lead product) and an array of complementary innovations (linked products). The clusters sought to include multidisciplinary expertise from the RTB themes. Each cluster was designed by a science team that was responsible for developing the innovations and preparing a business case for the cluster that demonstrated the value added (Table 2.4).

The lead innovation[9] is the centerpiece of a work package that also consists of complementary, linked, or enabling products and includes a theory of change with quantified indicators (RTB 2013b). A lead innovation was defined as:

1. A significant measurable and time-bound product (including knowledge, technology, and organizational and institutional models) that results from a research activity or set of related activities attributable to RTB
2. Used by a well-defined group of next users who may be researchers or development actors, with strong evidence of demand-pull from these users
3. Near market-ready set of ideas, technologies, or science products that generate excitement among researchers and other users
4. With potential for contributing to large-scale impact

RTB 2.0 recognizes that a single innovation cannot be used at scale on its own as it requires complementary innovations for broader use (Sartas et al. 2020). This is illustrated by the seed potato for Africa cluster (Fig. 2.9). “Business models for

[9] The lead innovation was referred to as a flagship product or flagship products. We use the term “lead innovation” here so as not to be confused with FPs.

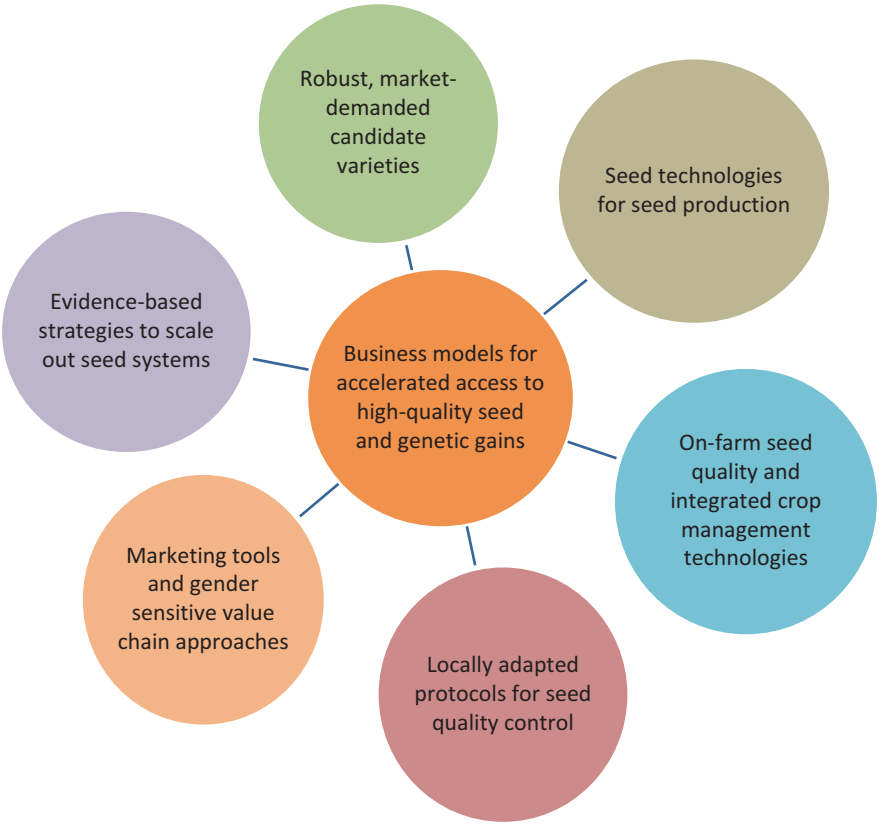

Fig. 2.9 Lead innovation and complementary innovations for the cluster of seed potato for Africa

fostering farmers' access to seed" was the lead innovation that could facilitate farmer access to market-demanded varieties and would require new seed production and quality management technologies, gender-sensitive approaches for value chain development, and scaling strategies. Thus, by organizing each cluster as aggregated innovations, connections could be made to the theory of change developed for the FP, potentially bringing together the bilateral projects mapped under the cluster of activities.

RTB 2.0 paid attention to impact pathways linked to the Intermediate Development Outcomes (IDOs) as set out in the CGIAR Strategic Research Framework (SRF) (CGIAR 2015b). Impact pathways were not drafted by one individual at a desk but were designed with the FP and cluster teams and articulated to the SRF IDOs. Where possible, RTB consulted with stakeholders, using participatory and reflective tools like pathway visualization (Fig. 2.10) to develop impact pathways (Fig. 2.11). During 2014 and 2015, as part of the piloting of CGIAR results-based management, RTB held workshops with a broad group of stakeholders for a detailed validation and co-construction of four cluster impact pathways. Some clusters identified

Fig. 2.10 Stakeholders co-constructed the impact pathway for potato quality seed in Africa during the workshop in Kenya in 2014. (Photo: G. Thiele)

quantified performance indicators to guide results-based management based on the impact pathway (Fig. 2.12). RTB did not, however, have sufficient resources to implement the monitoring and evaluation (M&E) system as initially planned with all of the cluster teams, considering the intensive convening and facilitation required.

RTB's 2.0 comprehensive framework also supported institutional innovations for monitoring and reporting. A major improvement introduced in Phase 2 was the use of the Monitoring, Evaluation, and Learning (MEL) software platform co-developed among several CGIAR centers. MEL allowed systematic tracking of progress and aggregation of results across the RTB and other CRP portfolios. Figure 2.13 illustrates the indicators and case studies included at the output, outcome, and impact level. MEL used a generic description of the program's scope of control (output), scope of influence (research outcomes with next users), and scope of interest (development outcomes with end users) developed by the CGIAR System Office. MEL enabled reporting through a CGIAR-wide dashboard.[10]

Initially, MEL had limitations for comprehensive results-based management. First, it did not show the progress of innovations moving from one state of readiness to the next in successive years. Second, it did not adequately capture the aggregated innovations within a cluster. Third, there was an issue of synchronicity, as the

[10] See the system dashboard at https://www.cgiar.org/food-security-impact/results-dashboard/.

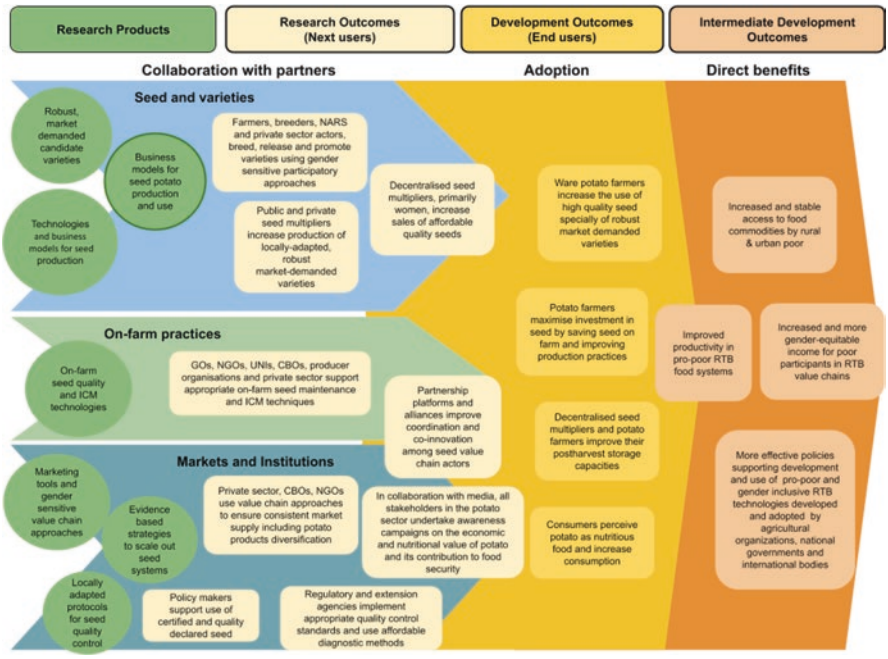

Fig. 2.11 Co-constructed impact pathway for seed potato in SSA

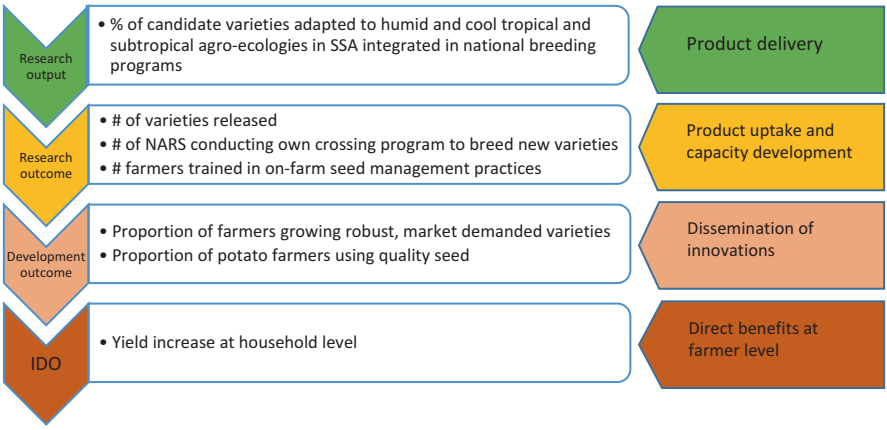

Fig. 2.12 Variables initially proposed for tracking along the impact pathway for seed potato in SSA

outcome cases and the adoption and impact studies reported in any year related to innovations developed earlier, sometimes much earlier. MEL was improved, and from 2018, in coordination with the CGIAR System Office, the readiness of each innovation was assessed, and the progress of the innovations was tracked as they moved from one level of readiness to the next. This permitted a visualization of

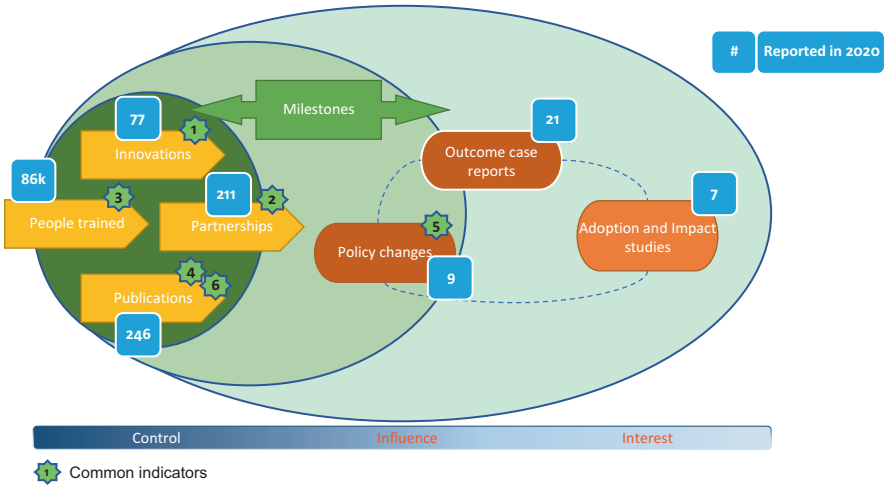

Fig. 2.13 Systematic reporting of deliverables, research outcomes, and development outcomes with MEL in 2020

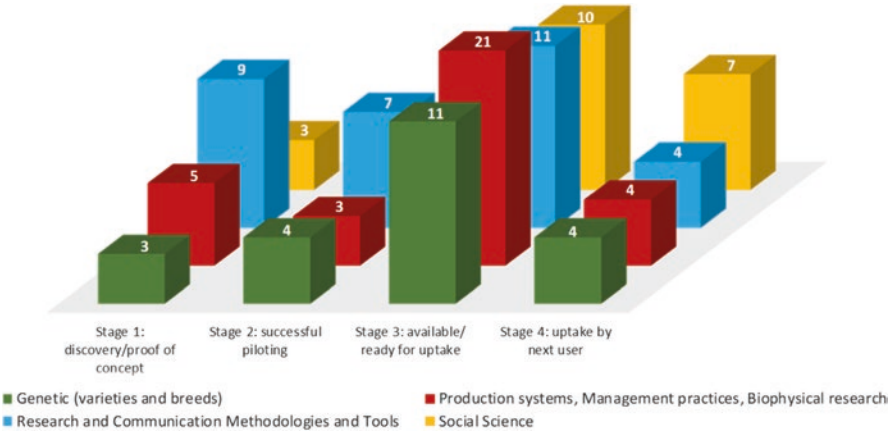

Fig. 2.14 Innovations in the RTB portfolio and their stage of readiness (2019)

aggregated innovations by type and level of readiness across the program and for each flagship (Figs. 2.14 and 2.15).

In summary, aggregated innovations made up the 25 clusters in the RTB portfolio in Phase 2. RTB's comprehensive framework for the portfolio also provided the basis for determining and linking groups of lead and complementary innovations. Aggregated innovations were embedded in a FP that included a theory of change with quantified indicators. Although RTB did not have sufficient resources to implement the M&E system as initially planned with all the cluster teams, where they were developed, co-constructed impact pathways helped to identify policy changes,

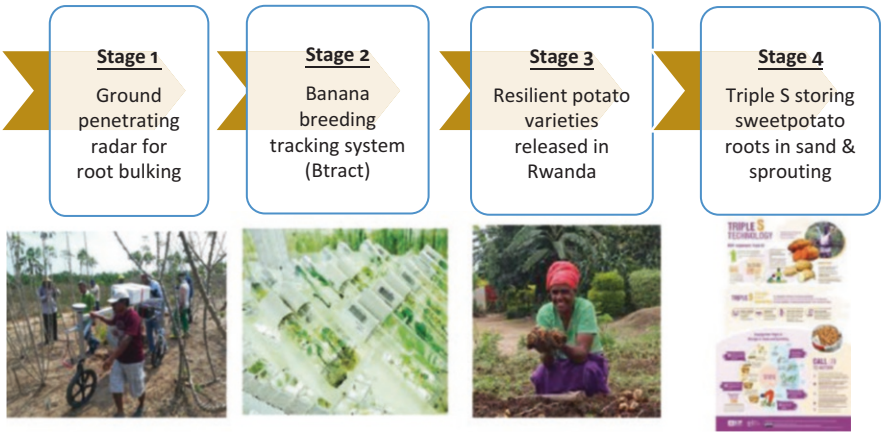

Fig. 2.15 FP 2: innovations reported (2017–2019)

outcomes, and milestones. The MEL software was effectively used in RTB monitoring and evaluation and adapted to better assess innovation readiness. This contributed to CGIAR-wide CRP reporting and performance assessment by the System Office.

2.5.5 Programmatic Embedding of Strategic and Integrated Gender Research

A key institutional innovation in RTB was to differentiate and embed two different, complementary types of research: (a) integrated gender research on specific technologies where gender scientists worked with biological and other social scientists to address specific gender constraints and opportunities for that technology and (b) strategic research addressing the knowledge gaps on how gender roles and norms affect the uptake of RTB technologies generally (Fig. 2.16).

During its first phase, RTB adopted a strategy to integrate gender in technical areas across the entire CRP and to conduct strategic gender research. The gender team comprised one gender specialist in each center, a gender coordinator based in the PMU, and part-time support from a senior gender specialist at CIP. The RTB gender team linked up with other gender scientists, in particular as key members of the CGIAR global study on Enabling Gender Equality in Agriculture and Natural Resource Management (GENNOVATE). RTB gender scientists wrote 15 case studies in target countries including Uganda (4), Malawi (2), Burundi (1), Nigeria (2), Colombia (4), Bangladesh (2), and Vietnam (2). GENNOVATE was a strategic research endeavor that explicitly sought to understand how household and community power relations and self-perceptions of personal power shape innovation decisions. A key learning from this strategic research was that when interventions do not

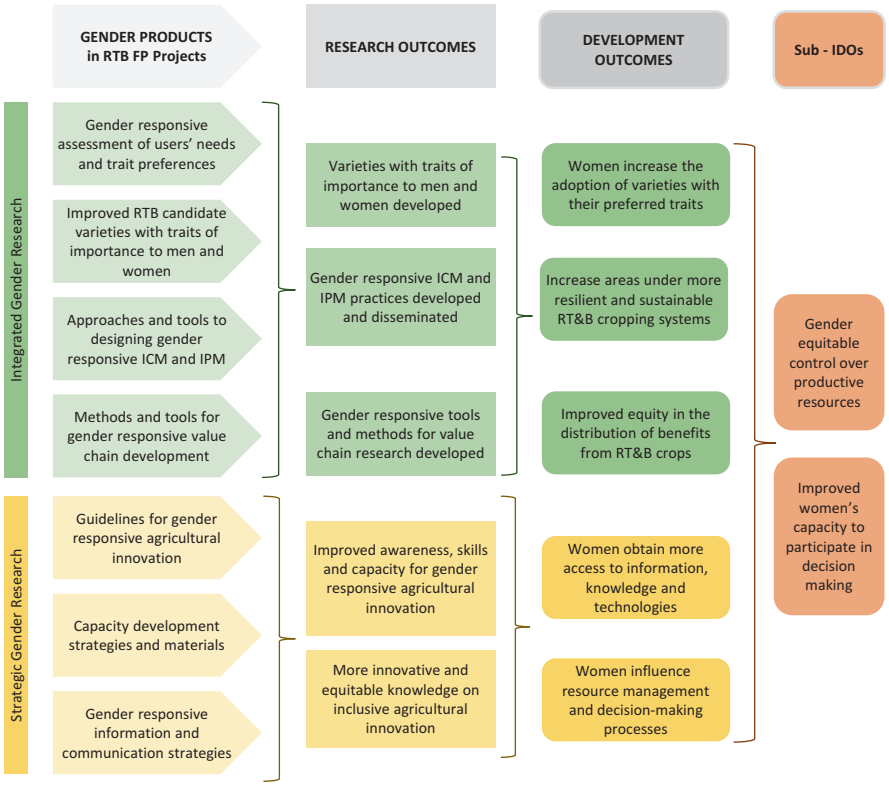

Fig. 2.16 Key elements from RTB gender impact pathway

consider underlying social structures and gender norms related to household decision-making and control of income, agriculture research may not benefit women.

Besides the strategic research in GENNOVATE, there was integrated gender research. For example, in Phase 1, a gender specialist in a seed potato project helped the team to realize that women did not have access to quality potato seed because they lacked access to credit and training and did not control household income to purchase seed (Mudege et al. 2015). Research on long shelf-life banana and potato ambient storage technology in Uganda reached similar conclusions.

During Phase 2, increased emphasis was given to integrated gender research supported by specific earmarked funding grants for gender research in some technological clusters. For example, in the breeding community of practice cluster, earmarked funding supported gender specialists and breeders to develop tools for gender-responsive breeding. Similarly, earmarked funding for gender research was provided to clusters working on seed systems and pest and disease management. By 2021, gender knowledge resources were organized in the Gender Responsive AR4D

Portal and shared with other CRPs its work on Gender Plus (G+) tools for gender-responsive breeding.

In summary, RTB adopted an approach to strengthen its gender research capacity, fostering feedback loops between strategic and integrated gender research. This required leadership of the RTB PMU, with support from the ISC, and earmarked funding directed to technological clusters and to the gender and youth cluster in FP5 that supported strategic research. This programmatic embedding generated concrete outputs to help address the challenges of gender and social inclusion for innovation design and scaling.

2.5.6 Internal Funding Mechanisms and Incentives

In Phase 2, total funding across all sources averaged around $80 million a year, making RTB the largest of all CRPs and the largest single program of any sort in the CGIAR. About 80% of RTB funding was managed directly by the centers (W3 and bilateral funding, or non-pooled funding[11]). Only about 20% was directly managed by RTB through contracts with CIP as the lead center (W1 and W2, or pooled funding[12]). This pooled funding was managed by the PMU, with the management committee and under the guidance of the ISC and, ultimately, the CIP Board of Trustees. Nevertheless, the proposals for both phases, the theories of change, and the milestones and deliverables were planned and reported for both pooled and non-pooled funding. Pooled funding was the smaller part of the overall budget, but it was carefully planned to add value and complement non-pooled funding to ensure the greatest impact.

Internal funding mechanisms for pooled funding evolved over time as PMU acquired more experience but broadly fell into three categories:

1. Earmarked funding (Table 2.5) represented about 31% of the budget allocated each year by RTB and was targeted to areas with the greater scope for synergistic value addition. This was related to multicenter investments that ordinarily were not covered through bilateral funding grants. Much of this was linked to multicenter work in the discovery and cross-cutting clusters. Additionally, some of the earmarked funding was linked to multicenter work in cassava and banana clusters where the mandate was shared between several centers. Each earmarked funding request was organized as a project with specific deliverables proposed in funding submission and then tracked over a 3-year period.

[11] Bilateral funding was where the donor did not cover the 2% charge made by the center to the system.

[12] Pooled funding was of two types: W1 funding, which was received from the system from donors contributing to all system entities with no restrictions, and W2 funding, which was awarded by donors specifically to RTB, sometimes with conditions on which flagship it should be used in.

Table 2.5 Earmarked funding awards in Phase 2 – 2017–2021

FP	Name of earmarked funding	Center/partners	Duration	Funding (USD, 000)
FP1	Breeding platform	Bioversity – CIAT – CIP – IITA	2017–2021	2184
FP1	Next-generation breeding	Bioversity – CIP – IITA – CIRAD	2017–2018	436
FP1	Game-changing traits	Bioversity – CIAT – CIP – IITA	2017–2021	1410
FP1	Genetic diversity	Bioversity – CIAT – CIP – IITA – CIRAD	2017–2021	1376
FP2	Quality seeds and access to improved varieties	Bioversity – CIAT – CIP – IITA – WUR	2017–2021	4343
FP2	GBI gender tool	IITA	2020	25
FP3	Pest/disease management	Bioversity – CIAT – CIP – IITA	2017–2021	3587
FP3	Crop production systems	Bioversity – CIAT – CIP – IITA	2017–2018	268
FP3	Banana fungal and bacterial diseases/ FOC/ BXW	Bioversity – CIAT – IITA – CIRAD	2017–2021	1355
FP3	Banana viral diseases/BBTV	Bioversity – IITA – CIRAD	2017–2021	1531
FP3	Cassava biological constraints, Asia/ Americas	CIAT – IITA	2019–2020	170
FP4	Postharvest innovation and nutrition improvement	Bioversity – CIAT – CIP – IITA	2017–2021	1128
FP4	Cassava processing	CIAT – IITA – CIRAD – NRI	2017–2021	1942
FP5	Foresight, impact, monitoring, and co-learning	Bioversity – CIAT – CIP – IITA – CIRAD – WUR	2017–2021	3663
FP5	Sustainable intensification and diversification for improved resilience, nutrition, and income	Bioversity – CIP – IITA – WUR	2017–2018	252
FP5	Gender equitable development and youth employment	Bioversity – CIP – IITA	2017–2021	1099
FP5	Institutional innovation, scaling	Bioversity – CIAT – CIP – IITA – CIRAD – WUR	2017–21	3075

2. Non-earmarked funding, about 57% of the annual budget, was available for centers to invest on specific deliverables in alignment with the proposal for the phase and theories of change and to complement Window 3 investments but was not projectized and therefore more flexibly managed.
3. Scaling funds, about 12% of the yearly budget, were allocated through competitive calls. These funds supported the scaling of innovations that had higher levels of readiness.

Earmarked funding was awarded and renewed through an internal competitive process with submissions of project proposals evaluated by the PMU based upon criteria developed collaboratively with the Management Committee and ISC. After feedback, many submissions received some funding, and the strongest ones received the most. This created a space for constrained competition, ensuring that most areas of synergistic investment received some funding.

During Phase 2, an institutional innovation called the RTB Scaling Fund was introduced to foster the scaling of innovations, generate an evidence base of their scalability, and improve scaling strategies (Sartas et al. 2020). As discussed above, scaling was a critical limitation identified in Phase 1. In 2017, RTB held a workshop with some stakeholders to review best bet scalable innovations. Later, RTB clusters with innovation packages in advanced stages of readiness were invited to apply for the RTB Scaling Fund. These awards were made for 2 years in order to move innovation packages to a higher level of scaling readiness. This funding was competitive with two external reviewers and one PMU member evaluating submissions against clearly defined criteria (Table 2.6).

The innovation packages receiving scaling fund support and the allocations are shown in Table 2.7.

In summary, RTB's use of W1, W2, and W3 funding mechanisms enabled maximum and strategic collaboration. The RTB Scaling Fund was a significant innovation to address scaling more comprehensively.

Table 2.6 Scaling Fund selection criteria (for concept notes and full proposals)

Criteria	Score Max (100)
1. Relevance Is the proposal relevant to the purpose of the fund? Is the contribution of the proposal in moving the innovation along the scaling readiness levels convincing? Are the objective and outcomes significant and realistic (number of actual beneficiaries already reached and number of expected beneficiaries in the coming 2 years)?	25
2. Partnerships Does the concept note provide solid elements to build the partnership and scaling strategies? Is the description of stakeholders' roles and synergies clear and convincing?	20
3. Scaling strategy Does the scaling strategy identify key opportunities and bottlenecks to achieve the project outcomes? Does the strategy clearly present how scaling of the proposed innovations will contribute to achieving project outcomes?	20
4. Strength of the proposed multidisciplinary team (it may include partners and staff funded through different sources)	15
5. Level of co-investment by key government, public or private scaling partners	20

Table 2.7 Scaling fund awards in Phase 2

Flagship	Innovation package	Center/ partners	Duration	Funding (USD, 000)
FP3/ FP5	Broadening the scaling of BXW management in East and Central Africa (Chap. 10)	Bioversity – IITA – WUR	2018–2019	700
FP2/ FP5	Scaling Sweetpotato Triple S PLUS – gender-responsive options for quality planting material, higher yields and extended shelf life for storage roots (Chap. 12)	CIP – WUR	2018–2019	701
FP4/ FP5	Scaling the transformation of wet cassava peels into high quality animal feed ingredients (Chap. 6)	IITA – CIAT – WUR	2018–2019	404
FP4/ FP5	Scaling approach for flash drying of cassava starch and flour at small scale (Chap. 4)	CIAT – IITA – CIRAD – WUR	2019–2020	903
FP2/ FP5	Market-driven scaling up and adoption of potato in Africa through a technology package combining climate resilient, novel potato varieties with a seed system innovation (Chap. 13)	CIP – WUR	2019–2020	1013
FP4/ FP5	Orange Fleshed Sweetpotato (OFSP) Puree for Safe and Nutritious Food Products and Economic Opportunities for Women and Youths in Kenya, Uganda and Malawi (Chap. 5)	Bioversity – CIP – WUR	2019–2020	977
FP3/ FP5	Scaling AKILIMO, a digital fertilizer recommendation service	CIP – IITA – WUR	2020–2021	1021
FP1/ FP5	Scaling RTB crop variety validation and diffusion using farmer citizen science in Ghana and Rwanda	Bioversity – CIP – IITA – WUR	2020–2021	1000

2.5.7 Dynamic Interactive Communication Capability to Build a Shared Vision and Engage Stakeholders

Using a strategic communication approach, RTB pursued shared goals that would not have been achievable if the centers had worked alone. RTB developed its goal-oriented strategy through a SWOT analysis in 2013 (RTB 2013a). The PMU hired a full-time specialist to develop the communication strategy, using social media campaigns and joint blogs and coordinating with focal points in the RTB centers. Building on the SWOT analysis, RTB communications served multiple functions, including the following:

(a) To advance the *image of RT&B crops* as relevant for investment and research for nutrition, food security, and women farmers' income generation. RTB communicated the importance of RT&B crops to policymakers, donors, and researchers.

(b) To promote the program externally as *a globally recognized leader on knowledge and research about RT&B crops* with its own branding. RTB developed branding guidelines, publication and acknowledgment guidelines, and an "about us" statement to ensure the brand was understood internally and could be differentiated from other CRPs and centers externally. RTB had its own website and published several blogs monthly about scientific achievements and development impact. RTB developed an illustrated annual report for stakeholders that complemented more technical reporting (CGIAR Research Program on Roots, Tubers and Bananas, 2021). This showcased the breadth of the program, its integrated vision, and specific focus on the collective assets and collaborative innovations. Communication products included videos and podcasts on social media (Facebook, Twitter, LinkedIn, YouTube). Activities and achievements were summarized in blogs and in a quarterly newsletter. RTB supported several international and regional events each year, in particular meetings of the International Society for Tropical Root Crops (ISTRC) where national partners participated.

(c) To support *internal communications* on RTB vision and goals. The communication function targeted RTB scientists, emphasizing why the program added value to what the centers and their scientists did and the demonstrated value of collaboration. RTB held community meetings to report progress and plan cross-cutting collaboration about every 18 months; these were organized around the thematic subthemes and then FPs. The RTB communication specialist supported networking among researchers and encouraged FP and cluster teams to communicate in the ways they were more comfortable with.

(d) *To identify and nurture collective knowledge assets*. As discussed in Sect. 2.5.6, RTB earmarked funding and the cross-cutting clusters that created multicenter communities of practice and generated collective knowledge assets. With the end of RTB in 2021 and the creation of new initiatives within One CGIAR, there was an urgent need to ensure that RTB's legacy and collective assets would find a place in future initiatives. The collective knowledge assets at risk in the transition were designated "golden eggs" (Fig. 2.17). The landing page of the RTB golden eggs and writing descriptions of each golden egg and promoting them through social media was a communications goal in 2021. The CAS Secretariat (2020) evaluation considered it critical for "RTB to develop and expand these packages to inclusively cover the full program achievements." The CGIAR as a whole subsequently adopted this legacy initiative.

In summary, RTB effectively used communications to manage program complexity by drawing on goal-oriented internal and external communications and using communications strategically to draw attention to RT&B crops. As an institutional innovation, the RTB collective knowledge assets or golden eggs identify the legacy of the RTB CRP, and the close link between scaling innovations and communications informs new initiatives in One CGIAR.

Fig. 2.17 RTB golden eggs, key collective knowledge assets

2.5.8 Purposive National Partner Engagement

RTB works with national partners, especially within the national agricultural research systems (NARS) through principal program participants, and the CGIAR centers. Consequently, RTB's higher-level, coordinating role is not always visible to those partners. Nevertheless, RTB had a strategy for engaging national partners, for instance, during stakeholder consultations and in some cases while preparing theories of change. However, RTB also opted to use existing events where national partners came together, rather than creating its own dedicated partnership platforms. RTB supported three such partnership platforms, the most important of which was the ISTRC (http://www.istrc.org/).

RTB supported both the general meeting of the ISTRC and of its Africa branch (ISTRC-AB). These meetings brought ownership of and participation by national scientists and extensionists, with an increasing participation of African members. The ISTRC meetings came the closest to a generalized platform for the RT&B crops, as all are included with the exception of bananas. RTB also co-organized its own meetings to follow up on these events. This strengthened the ISTRC meetings by enhancing attendance and knowledge sharing. On multiple occasions, RTB organized presentations of the program and of each flagship on the final day of ISTRC meetings, preceding the RTB meeting, where national scientists shared their experiences. RTB also engaged national partners at the Africa Potato Association and the Global Cassava Partnership for the 21st Century. For all these meetings, RTB made small travel grants to encourage young female and male scientists to present their work. This national partner engagement created a broader awareness of RTB's contributions and its role in partnerships and advocacy on RT&B crops.

RTB also had two experiences where the PMU directly managed projects in Uganda with the RTB-ENDURE project (Bentley et al. 2021) and in Nigeria with BASICS (Bentley et al. 2020a, b). These two experiences created deeper collaborative networks with national partners in these two countries and helped to capitalize on experiences from the wider RTB community to benefit national partners.

2.6 Program Outcomes

RTB's institutional innovations facilitated various outcomes across centers (Table 2.8). These outcomes are concentrated in the areas of breeding, seed systems, pests and diseases, and postharvest, all of which were built on significant bilateral investment that complemented the earmarked funding for cross-center collaboration. Agronomy was a high priority for RTB, but in the absence of significant bilateral investment, its cross-cutting outcomes were limited. This changed in 2019 with the cassava agronomy decision support tool AKILIMO (https://www.akilimo.org/) led by IITA. This digital application and database could incorporate other RTB crops and therefore scale to other contexts and uses. Table 2.8 does not include other notable center-specific outcomes such as breeding and scaling of the orange-fleshed sweetpotato (Low and Thiele 2020).

As discussed in Sect. 2.5, the RTB 2.0 portfolio identified impact pathways that could be linked directly to the Intermediate Development Outcomes (IDOs) as set out in the CGIAR Strategic Research Framework (SRF). Figure 2.18 shows how RTB tracked contributions to system-level outcomes linked to the United Nations' Sustainable Development Goals, particularly SDG1, SDG2, and SDG13.

2.7 Lessons Learned from RTB

One of the difficulties of a complex program like RTB is to grasp how the partnership contributed to research and development outcomes and to document evidence of value at scale (Horton et al. 2009). RTB's complex institutional innovations (Sect. 2.5) facilitated the outcomes presented in Table 2.8 and Fig. 2.16. RTB made value at scale possible because there was:

- A common, shared vision and purpose and realistically defined goals
- Support for the partnership from participating organizations
- Equitable sharing of resources, responsibilities, and benefits
- Transparent governance and decision-making
- Creation of genuine respect and trust between the partners
- Achievement of higher-level outcomes beyond the partnership itself
- Committed leadership in the RTB Management Committee and PMU, notably the role of the Program Director with deep RTB knowledge and many years of experience working in the CGIAR and its partnership networks.

RTB was considered a strong model of good partnering within the CGIAR and by its stakeholders with transparent and equitable decisions about the use of funding mechanisms and the program direction (CGIAR-IEA 2016; ISPC 2016; CAS Secretariat 2020). Collaboration and partnering were articulated with an effective structuring of its portfolio around cross-cutting clusters or innovation packages that facilitated reciprocal learning exchange across crops and among partners. This

Table 2.8 Eight key RTB research outcomes based upon multicenter collaboration

Cluster/partners	Research outcome	How/when
DI1.1 Breeding community of practice, with Excellence in Breeding (EiB)	Researchers use more focused design of breeding products to meet farmer and consumer demands and improved management of breeding product pipelines	2013: RTB brought breeders together 2016: Creation of a Breeding Community of Practice with earmarked funding, comparing breeding strategies and developing shared methods, including the Tricot citizen science approach for varietal testing 2019: Product profiles registered (47) for the main targets of RTB breeding registered with CGIAR EiB Platform 2020: Tools to incorporate gender into product profile development are tested and adapted in collaboration with EiB 2020: Hackathon, breeders, social scientists, gender specialists, and food scientists peer-review and improve market segment definitions and variety product profiles for four breeding programs
DI1.2 Next-generation breeding, with Royal Holloway, University of London (RHUL)	Scientists at IITA, CIAT, and CIP incorporate design, metabolite extraction, and interpretation and use metabolomic data for all crops	2013: Theme 2 leader (CIAT) puts together an earmarked funding proposal across all centers and crops to begin this work 2018–2020: Ten peer-reviewed publications published; see overview in Friedmann et al. (2019) 2020: Compound database and concentration range for metabolites detected in the major RT&B crops available for breeding programs
CC2.1 Seed systems (with WUR and U Florida)[a]	Improved seed systems. Seed system toolbox validated. Thirteen tools developed and web accessible, for improving the design and execution of seed-system interventions and the management of seed degeneration	2014: Researchers from CGIAR centers, Wageningen University & Research (WUR), and Kansas State University completed and analyzed 12 case studies of RT&B seed systems in Africa and Latin America using common framework (RTB 2016b). Improved models for seed degeneration management developed based on field trials and integrated seed health strategy. 2016: Community of Practice Cluster CC2.1 funded with earmarked funds 2017: Cluster CC2.1 collaborates to incorporate tools for understanding RTB seed systems into a single toolbox using a standard format. 2020: Toolbox validated in 14 projects in Asia, Africa, and South America across all major RTB crops 2021: Online version of the Toolbox available for use by government agencies, NARS, NGOs, and donors

(continued)

Table 2.8 (continued)

Cluster/partners	Research outcome	How/when
CC3.1 Pests and diseases (with various NARS and ARIs)[b]	Researchers, agricultural ministry officials, national plant protection organizations, and extension agents use tools and strategies to manage major pests and diseases	2012: Joint RTB and CCAFS workshop on management of critical pests and diseases through enhanced risk assessment and surveillance and understanding of climate impacts through enhanced modeling 2015: In a cross-crop consultative intervention of all RTB centers, key regional target pests and diseases were identified for pest risk analysis (PRA) 2017: Cassava Disease Surveillance (CDS) virtual network supports accurate diagnosis and offers solutions for prevention and management. CGIAR and national partners strengthen capacities to perform PRAs predicting risk of insect-transmitted viruses and generation of georeferenced risk maps 2018: ICT tools used to identify major diseases in the field for surveillance and plant disease management 2020: Digital alliance for pests and diseases as a golden egg RTB ensures gender is addressed across topics in the webinars for the International Year of Plant Health
CA3.5 Cassava biological constraints, Asia/ Latin America, with 21 NARS, national plant protection organizations (NPPOs, U of Queensland)	Scientists use response plan developed to contain emerging cassava mosaic disease (CMD) in SE Asia	2015: CMD detected in Cambodia. Network of experts to monitor and manage cassava mealybug and cassava witches' broom disease in Asia, progress in helping farmers combat pests, with local partners 2018: Regional workshop supported by the Global Cassava Partnership for the Twenty-first Century and CIAT led to the joint development of a response plan, with IITA participation under the RTB umbrella 2018: Adoption of biological control for cassava mealybug using a host-specific parasitoid provided by IITA involving collaboration from CIAT, contributed to restoring the cassava yield that had dropped by 27% after the arrival of the cassava mealybug (first reported in 2008) 2019: Improved capacities of NPPOs and cassava farmers to contain CMD and implement management strategies in Cambodia, Laos, Thailand, and Vietnam following a multi-pronged approach (Siriwan et al. 2020)

(continued)

Table 2.8 (continued)

Cluster/partners	Research outcome	How/when
BA3.4 Banana viral diseases (with 14 NARS, FAO, U Queensland)	Multinational, multi-stakeholder Alliance coordinated action to halt the expansion of banana bunchy top disease (BBTD) and recover banana production in disease-affected areas, especially in sub-Saharan Africa	2014: RTB learning alliance to contain BBTD and help farmers recover from it in eight African countries; established field sites and capacity building for researchers from each participating country 2015: BBTD Alliance launched by RTB. Fifteen pilot sites in eight African countries set up to implement strategies for recovering banana production (https://www.bbtvalliance.org/) 2019: Training workshops in Togo, Nigeria, and Cameroon 2021: Gender roles analysis (Nkengla-Asi et al. 2021) 2021: Alliance developing capacity for disease recognition and control options, training farmers and entrepreneurs in field inspection, rogueing infected plants and production of clean planting material 2021: Training African scientists to continue surveillance on the extent of disease incidence to update the spatial distribution map of BBTV spread in SSA 2021: Location-specific clean banana production and distribution systems are being established to replenish banana plants that have been eradicated
CC4.1 Postharvest innovation, led by CIRAD with eight NARS and Cornell U	Framework and tools to breed for quality traits in 11 food products from RTB crops in five target countries	2015 RTB supported work on end-user preferences through initiatives with national partners and the Natural Resources Institute (NRI, UK) 2018: RTBfoods project funded by Bill & Melinda Gates Foundation (BMGF) (https://rtbfoods.cirad.fr/) 2020–2021: Special journal issue (Dufour et al. 2021) published with 17 articles on end-user preferences of RT&B crops and method to measure quality traits

(continued)

Table 2.8 (continued)

Cluster/partners	Research outcome	How/when
CC5.4 Scaling, with WUR[c]	Scaling readiness approach implemented across the RTB portfolio, in collaboration with the scaling experts of CC5.4	2017: Scaling Readiness Approach and RTB Scaling Fund developed and piloted 2018–2021: Eight projects supported by RTB Scaling Fund 2019: Scaling Readiness web portal (www.scalingreadiness.org) and principles (Sartas et al. 2020) published 2020–2021: Other CRPs, CGIAR centers, and the CGIAR System Office expressed interest in RTB's scaling work and using the Scaling Readiness approach 2021: RTB gender research, tools, and methods are compiled and shared for broader use in collaboration with the Gender Platform

[a]See Chap. 11 of this book
[b]See Chap. 9 of this book
[c]See Chap. 3 of this book

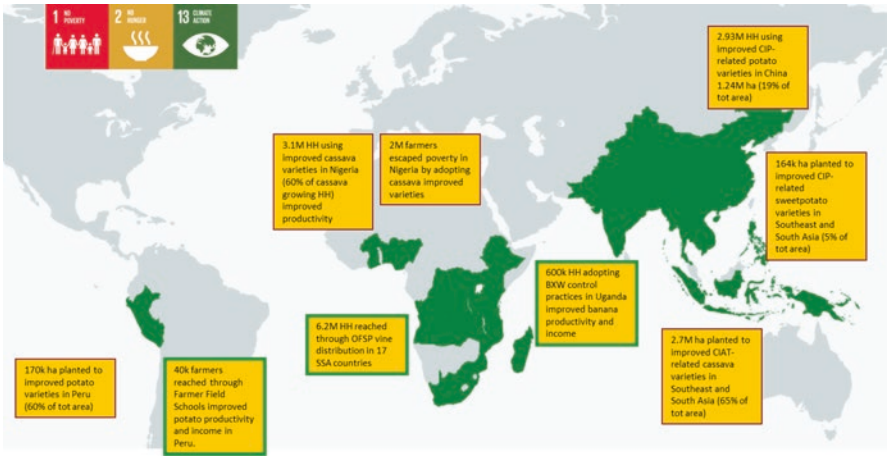

Fig. 2.18 RTB's contributions to system level outcomes, 2017–2020. (Source: CGIAR Research Program on Roots, Tubers and Bananas, 2018, 2019, 2020, 2021)

value addition by RTB aligned with institutional innovation around scaling that was a strong feature of RTB 2.0.

One challenge with RTB closing at the end of 2021 is that the organizing principles of the new initiatives in the One CGIAR (2022–2030) are not organized by crop type (CGIAR System Organization 2021). There should be significant work continuing on the RT&B crops, but the RTB program and its clusters will be redistributed and work will be organized in different ways. The RTB golden eggs provide some continuity of innovation packages, but not necessarily the synergies among

the teams. At the time of writing, there is interest in keeping the RT&B crops together as a work package in the One CGIAR seed initiative, but it is less clear what happens to other RTB work in One CGIAR.

In summary, various lessons emerge from the RTB experience that are relevant for future multi-organizational programs for agricultural research for development and for One CGIAR.

(a) *Build on the unique value proposition of the collaborative program.* For RTB, this relates to the commonalities of clonally propagated crops, with program design to add value to them through the cross-cutting clusters and their communities of practice on topics of breeding, seed systems, pests and diseases, and postharvest, all of which had dedicated funding. A recommendation for One CGIAR would be to keep clonally propagated crops together as a group within key research areas to further enhance synergies and achievements.

(b) *Use strategic communications to build broad-based stakeholder support around the value proposition.* RTB did this with stakeholder consultations and communications demonstrating progress.

(c) *Ensure that programmatic design can bring together the different innovations required for impact.* For RTB, this happened at three different levels. First, at the level of program architecture, the crop-specific clusters were purposively designed as aggregated innovations (technical, organizational, institutional) and contributed together to a systemic change. Second, at the level of context-specific scaling fund grants, where specific innovation packages were enabled to move to a high level of readiness and greater impact. And third, at the level of purposively engaged partners who could scale results further and created further systemic change.

(d) *Embed gender in technical research and engage with and support researchers to mainstream gender in biological sciences.* Without effort to resource and monitor the progress of gender in A4RD, the impact of socio-technical innovations can be limited or eroded. RTB's targeted support helped to achieve impact in gender in breeding and the uptake of G+ tools for breeding.

(e) *Establish structural incentives for integration among initiatives and across crops* if cross-CGIAR contributions to the IDOs and SDGs are to be fully captured. This was an area where RTB and other CRPs underachieved compared to the promise at program design. One of the primary reasons for this was insecurity and late award of funding, which made it more challenging to secure strategic partnerships.

(f) *Link theories of change with flexible and utilization-focused M&E systems* to strengthen adaptive management and reflexivity at different management levels. This can enhance planning and reporting, including milestones and indicators used to plan and report at the level of the CGIAR system, which were excessively rigid for CRPs.

(g) *Recognize and incorporate key partnerships* that add value to the program participants. These need to respect good partnering principles including identification of the value added from the partnership, transparency and access to funding, shared responsibilities, and clarity of the role of independent advisory groups to adjudicate any conflicts in the partnership. When the program is closed, attention needs to be paid to ensure that relationships (corporate, technical, and personal) built up by RTB and other CRPs are retained. For this reason, this book intentionally documents RTB experiences.
(h) *Develop mechanisms to promote continuity of key innovations and teams of collaborators associated with them (inside and outside of CGIAR) as the program is closed.* RTB, for example, used the concept of golden eggs with resourced and linked nurturing plans.

2.8 Conclusion

RTB demonstrates that institutional innovations involving collaborative program design and management can enable comprehensive research and development outcomes aligned to program goals. Over its 10 years, RTB evolved as a unique, global collaborative program with connections among multiple centers and stakeholders bridging upstream research, translational research, and innovation processes to deliver value at scale. RTB developed pragmatic institutional innovations to manage the program effectively, ensuring research outcomes and contributing to the global Sustainable Development Goals. Being embedded within the CGIAR has required RTB to adapt its capacity to respond to system change. One CGIAR could draw on the RTB approach to collaboration as complex institutional innovations organized by a portfolio of aggregated innovations that led to concrete achievements. These innovations include the strategic use of funding mechanisms, co-constructed impact pathways, stakeholder consultations and priority setting, goal-oriented communications, committed and effective program leadership, and governance and partnerships for strategic interventions to realize cross-cutting priorities, such as strategic and integrated gender research. The following chapters in this book describe RTB's legacy in greater detail.

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