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LEGACY SERIES 2

How Agricultural Research for Development Achieves Developmental Outcomes:

Learning Lessons to Inform One CGIAR Science and Technology Policy Research

Boru Douthwaite and Keith Child

IN PARTNERSHIP WITH:

CGIAR Research Program on Water, Land and Ecosystems (WLE)

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Front cover photo: A farmer uses a solar water pump on his farm, India; Prashanth Vishwanathan / IWMI.

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Contents

Acronyms and abbreviations

A4NH	CGIAR Research Program on Agriculture for Nutrition and Health
AfSIS	Africa Soil Information Service
AR4D	Agricultural research for development
ATA	Ethiopian Agricultural Transformation Agency
BMGF	Bill & Melinda Gates Foundation
CBSD	Cassava brown streak disease
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CIAT	International Center for Tropical Agriculture
CMD	Cassava mosaic disease
CPWF	CGIAR Challenge Program on Water and Food
CRP	CGIAR Research Program
DISCOM	Distribution company
EIAR	Ethiopian Institute of Agricultural Research
EthioSIS	Ethiopian Soil Information System
FCDO	Foreign, Commonwealth and Development Office, UK
GERMI	Gujarat Energy Research and Management Institute
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Corporation for International Cooperation)
GLCI	Great Lakes Cassava Initiative
GUVNL	Gujarat Urja Vikas Nigam Limited
ICRAF	World Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IITA	International Institute of Tropical Agriculture
ITP	IWMI-Tata Water Policy Research Program
IWMI	International Water Management Institute
KUSUM	Kisan Urja Suraksha evam Utthaan Mahabhiyan (Farmer Energy Security and Upliftment Campaign)
MEDA	Mennonite Economic Development Associates
MNRE	Ministry of New and Renewable Energy
NDDB	National Dairy Development Board
OECD	Organisation for Economic Co-operation and Development
OT	Outcome trajectory
RBM	Results-based management
RTB	CGIAR Research Program on Roots, Tubers and Bananas
S&T	Science and technology
SPaRC	Solar Power as a Remunerative Crop
TARI	Tanzania Agricultural Research Institute
ToC	Theory of Change
TOSCI	Tanzania Official Seed Certification Institute
USAID	United States Agency for International Development
WLE	CGIAR Research Program on Water, Land and Ecosystems

Abstract

At the end of 2021, CGIAR Research Programs (CRPs) will be replaced by Initiatives housed within One CGIAR. This new modality is intended to achieve higher levels of impact at a faster rate and at reduced cost compared to the CRPs. As One CGIAR begins, there is a unique opportunity to reflect on what has worked in different contexts. In this paper, we provide findings that relate to One CGIAR's overarching view of how it will achieve positive and measurable impacts, and for agricultural research for development (AR4D) more generally. Specifically, we draw from three related CRP evaluations to identify how different types of AR4D approaches have contributed to successful outcomes. In the final section of the paper, we present our conclusions and provide a list of recommendations for the science and technology policy of One CGIAR and possibly other integrated research for development programs.

Introduction

For at least the past ten years, donors have insisted that agricultural research for development (AR4D) organizations map out and track their pathways to outcomes and impact. At the same time, these organizations, particularly CGIAR (a global network of 15 AR4D organizations), have been expected to 'take impact to scale' to maximize the number of their beneficiaries with the aim of also maximizing the return on donor investment.

This push grew out of public sector reforms carried out by many Organisation for Economic Co-operation and Development (OECD) countries in the 1990s (Binnendijk 2000), and the subsequent widespread implementation of results-based management (RBM) in government agencies. RBM provided the framework and tools for strategic planning, risk management, performance monitoring and evaluation (Binnendijk 2000). It involved identifying expected results and monitoring progress towards them to fulfill accountability obligations and support institutional learning.

In the early 2000s, against a backdrop of growing financial constraints and global questioning of the efficacy of aid, the use of RBM spread to development cooperation, funded by the same governments (Vähämäki et al. 2011). Donors in the vanguard of AR4D, like the Bill & Melinda Gates Foundation (BMGF) and the UK's Foreign, Commonwealth and Development Office (FCDO) (a merger of the UK Department for International Development [DFID] and the Foreign and Commonwealth Office [FCO]), quickly adopted RBM expectations as an accountability mechanism. One of the more widely-adopted RBM frameworks in both fields has been the 'theory of change' (Stein and Valters 2012; Vogel 2012).

In response to the greater emphasis on impact, in 2011, CGIAR reorganized its research portfolio into CGIAR Research Programs (CRPs). Each CRP proposal included a theory of change (ToC). Fifteen CRPs commenced in 2012, all of which were scheduled to be completed by the end of 2021; they will be succeeded by a (yet to be determined) number of Initiatives housed within One CGIAR. One CGIAR justifies this transition as necessary to achieve greater and more targeted impact, arguing that "[S]cientific innovations [will be] deployed faster, at a larger scale, and at reduced cost, having greater impact where they are needed the most" (CGIAR 2021a).

CGIAR's problem in achieving impact at scale is that its funding for AR4D is relatively small compared to funding for development cooperation. Official development assistance provided by OECD countries in 2020 was USD 161 billion; CGIAR's 2020 annual budget of about USD 1 billion was just 0.6% of this figure (OECD 2021). The second problem is that expectations have been set extremely high. For example, in negotiating for funding for second phase CRPs, running for six years from 2016 to 2022, CGIAR told prospective donors that its aspirational target was, with partners, to bring 30 million people out of poverty for an annual investment of USD 1 billion.[1] This equates to about USD 233 per person benefited, not including investment by partners. To put the number and timeframe in perspective, in his book *The End of Poverty*, Jeffrey Sachs estimated that this endeavor would cost USD 2,900 per person and would take 20 years (Sachs 2006).

If One CGIAR is to meet impact expectations, it must do so with relatively small, well-planned and strategic interventions that result in disproportionally greater change than might reasonably be expected. Clearly, triggering and harnessing non-linear processes will be key. Using these processes is

[1] Calculated from figures provided in CGIAR (2015: 3).

helped by having a good understanding of how underlying generative mechanisms are triggered in different contexts for different types of technology.[2]

As the CRPs end, and One CGIAR begins, there is a unique opportunity to reflect on what worked for different CRPs in different contexts for different types of intervention. These reflections can them inform science and technology (S&T) policy in One CGIAR. We understand One CGIAR S&T policy to cover the measures designed for the creation, funding, support and mobilization of scientific and technological resources (Arvanitis 2002).

Ideally, learning from what worked in going to scale would be carried out across all 15 CRPs. However, this is impractical given the significant investment in time and resources it would require. In this paper, we take advantage of three outcome evaluations carried out over the past two years across four CRPs: Water, Land and Ecosystems (WLE); Climate Change, Agriculture and Food Security (CCAFS); Roots, Tubers and Bananas (RTB); and Agriculture for Nutrition and Health (A4NH). In doing so, we chose three cases aligned with Systems Transformation, one of the three One CGIAR 'Action Areas'. CGIAR defines systems transformation as "a major shift – bringing about significant positive change for the majority of people involved – in the governance and functioning of a system" (CGIAR 2021b: 35). We chose the Systems Transformation Action Area (Figure 1), rather than the Resilient Agrifood Systems or Genetic Innovation Action Areas, because it is the least familiar to CGIAR and may also be the action area in which research has the most leverage to bring about desired positive change.

The objective of our study is to provide findings that relate to One CGIAR's overarching view of how it will achieve positive and measurable impacts so as to inform S&T policy in One CGIAR, and for AR4D generally. Specifically, the paper examines similar approaches that resulted in successful outcomes in the Action Area of Systems Transformation. In the first section of the paper, we discuss our methodological approach and assumptions. We then apply this approach to our three case studies in order to illuminate similarities and differences between them. In the final sections, we draw conclusions from our analysis and present recommendations for the future One CGIAR.

[2] We understand a generative mechanism to be what influences the reasoning and reactions of actors in regard to the resources available in a given context, including program resources. Program interventions trigger mechanisms that can evolve over time within a social system of relationships (Lacouture et al. 2015: 1).

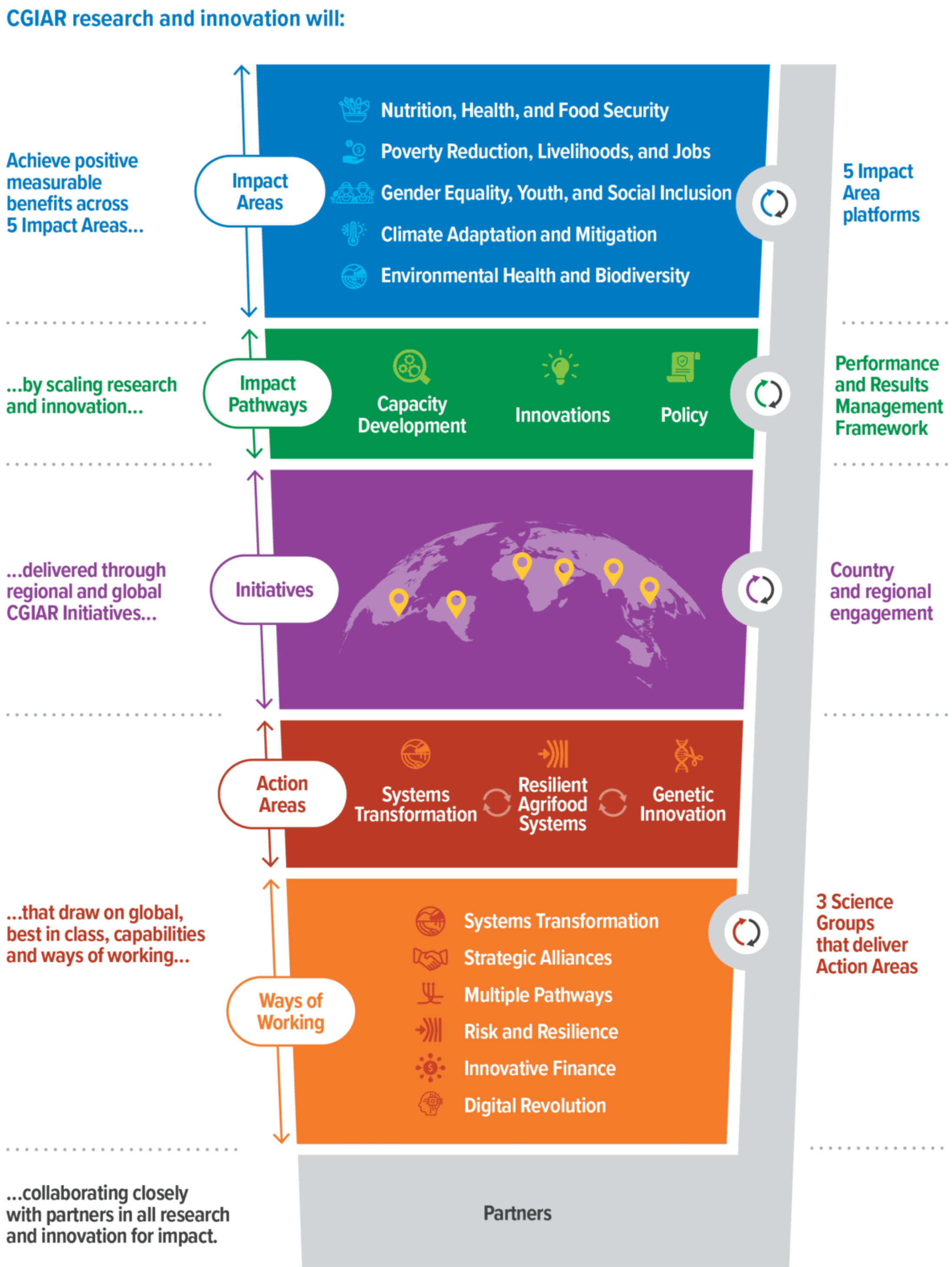

Figure 1: One CGIAR overarching view of how it will achieve positive and measurable impacts (*source:* CGIAR 2021b).

Materials and methods

Our approach takes advantage of three published outcome evaluations that have used a similar methodology: to identify significant outcomes that have been achieved and then trace causal relationships backwards to understand how the relevant CRP contributed to them. The three evaluations are:

- *Outcome evaluation of the work of the CGIAR Research Program on Water, Land and Ecosystems (WLE) on soil and water management in Ethiopia* (Douthwaite and Getnet 2019)
- *Outcome evaluation of climate-smart research on solar-powered irrigation in India* (Douthwaite and Shepherd 2020)
- *Development of a cassava seed certification system in Tanzania: Evaluation of CGIAR contributions to a policy outcome trajectory* (Douthwaite 2020).

To ensure diversity between the cases, we chose one project from each of the three evaluations based on its potential to bring about transformational change. The chosen case studies are:

- Development and use of an integrated database on soil and agronomic data by advisory services in Ethiopia.[3]
- Inclusion of solar power as a remunerative crop (SPaRC) as part of a large government-funded program in India, Kisan Urja Suraksha evam Utthaan Mahabhiyan (KUSUM)
- Development and use of cassava clean seed systems in Tanzania

We assume that the main outcomes in each case resulted from an outcome trajectory (Paz and Douthwaite 2017). We define an outcome trajectory (OT) as the interacting and co-evolving system of actors, knowledge, technology and institutions that produce, sustain and sometimes scale a coherent set of outcomes over time. This definition reflects our observation that reported outcomes are rarely, if ever, one-off events, but rather are generated over time through interacting and co-evolving systems, as described by Axelrod and Cohen (1999) and similarly by Douthwaite et al. (2003). The evaluations from which the cases are drawn also used the concept of an OT.

Our comparison between the cases is framed by a middle-range theory that applies to all three cases. Middle-range theories (Pawson et al. 2010; Pawson 2013) are positioned between universal social theories and more location- and context-specific program theories or ToCs. Middle-range theories apply to clusters of similar programs and can therefore help develop cross-case learning and insight. A number of middle-range theories exist in the policy realm (Sabatier and Weible 2014).

We adapt a middle-range theory developed by Douthwaite and others (Douthwaite and Hoffecker 2017; Douthwaite et al. 2017) to describe how AR4D contributes to OTs (Figure 2).

[3] This was one of the three areas of change considered in the evaluation, in particular Douthwaite and Getnet (2019: 44-48).

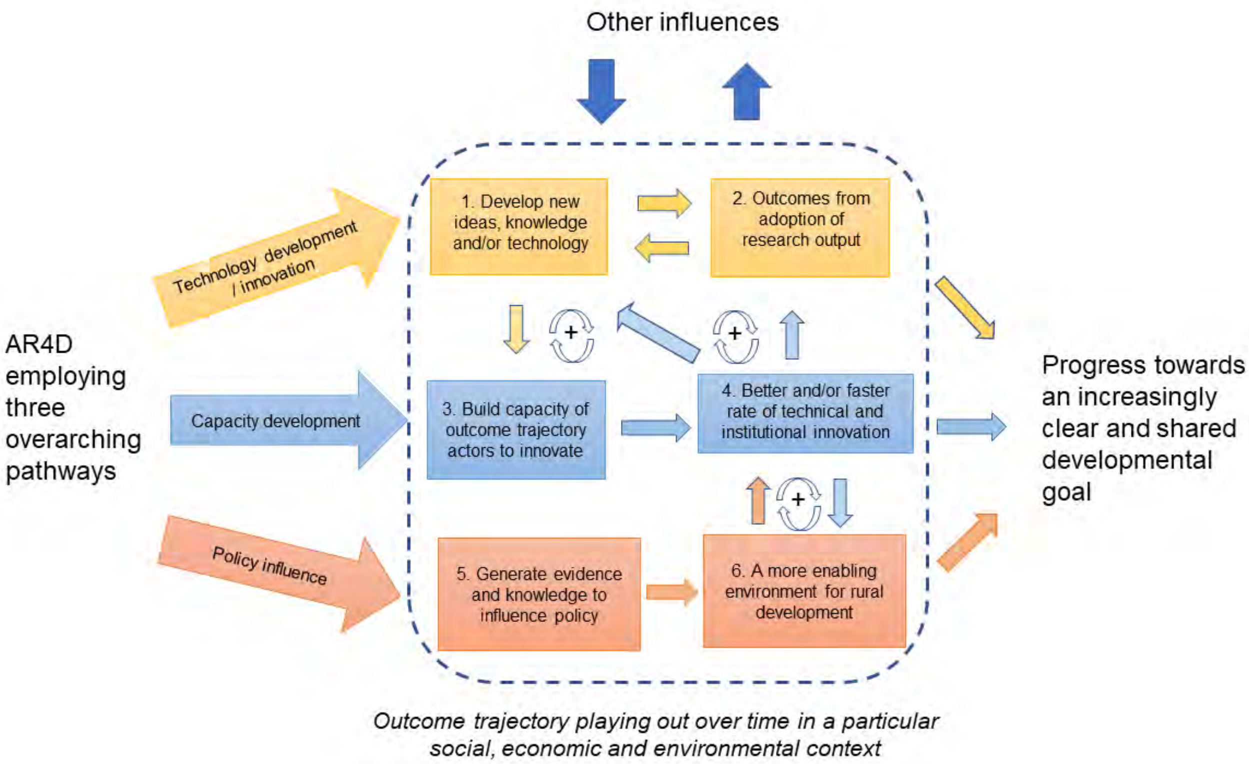

Figure 2: A middle-range theory showing how AR4D contributes to an OT through three interconnected pathways (*source:* adapted from Douthwaite et al. 2017).

The model in Figure 2 shows that AR4D contributes to an OT through three overarching pathways. As part of the technology development/innovation pathway, AR4D contributes by developing new knowledge and/or technology that addresses a problem or an opportunity, which trajectory actors adopt and benefit. As part of the capacity development pathway, outcomes result from trajectory actors developing both technical and functional capacities that help them act in ways they have not done so before.[4] As part of the policy influence pathway, OT outcomes are supported through the enactment of new policies that influence the behavior of OT actors. The model shows interactions within and between the three pathways. For example, learning from early adoption of a new technology helps develop it further, leading to greater benefits from its adoption. The model also shows how the main outcome sought by the OT actors (i.e., their purpose) emerges from their interactions and becomes clearer over time.

We chose this model because One CGIAR has identified the same pathways as being responsible for scaling research and innovation. Hence, we assume insights into how the three pathways have worked and interacted in the past will be applicable to research on S&T policy in One CGIAR.

[4] Functional capacities are capacities, such as the ability to navigate complex systems, that help facilitate innovation processes.

Findings

The characteristics of the three case studies are summarized in Table 1. The ultimate goal of each – system transformation – is suggested by the extent of the desired potential impact sought by each. All three relate to the governance and function of the systems in which they are embedded. The following section of the paper explores how the three impact pathways identified in Figure 2 were manifest in the three cases.

Table 1: Characteristics of the three cases.

	Case A: Agronomy and fertilizer advisory services in Ethiopia	Case B: Solar irrigation in India	Case C: Clean cassava seed in Tanzania
Potential beneficiaries	Farmers in Ethiopia earn more by improving their use of fertilizer	Farmers in India earn more and reduce groundwater depletion	Cassava farmers in Tanzania earn more by planting clean seed
Outcome sought	Integrated soil database developed and used by agronomic advisory services in Ethiopia to improve farmers' use of fertilizer	Farmers supported in selling surplus electricity to the grid as a 'remunerative crop' and reducing the use of aquifer water as a result	Cassava seed certification system implemented by the Tanzanian government
Year the OT took shape	2011, when World Agroforestry (ICRAF) worked with the Africa Soil Information Service (AfSIS) and the Ethiopian Agricultural Transformation Agency (ATA) to set up the Ethiopian Soil Information System (EthioSIS) to use satellite technology and spectral analysis to create comprehensive digital soil maps in Ethiopia	2012, when the International Water Management Institute (IWMI)-Tata Water Policy Research Program (ITP) began promoting solar power as a remunerative crop	2007, with the start of the Great Lakes Cassava Initiative (GLCI)
Technological advances involved	Soil spectroscopy; digital mapping; integrated databases; identifying optimal formulations and application rates for specific soil types and crops; developing apps to allow advisers to make agronomic and soil recommendations	A solar irrigation system by which farmers can sell solar power back to the grid	Development of good phytosanitary practices
Main achievements to date	ICRAF/WLE contributed to the development of soil maps for Ethiopia. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)/WLE developed a first version of a decision guide providing crop and soil-specific nutrient advice in landscapes. The International Center for Tropical Agriculture (CIAT)/WLE contributed to the development and implementation of a national soil and agronomy data sharing policy	IWMI/WLE/CCAFS developed and promoted the concept of SPaRC, which was subsequently adopted within the USD 50 billion government KUSUM scheme	Standards published; Tanzania Official Seed Certification Institute (TOSCI) 5-year action plan for Cassava Seed Certification approved

	Case A: Agronomy and fertilizer advisory services in Ethiopia	Case B: Solar irrigation in India	Case C: Clean cassava seed in Tanzania
Further work required	Build on achievements to develop an advisory service that gives farmers better, location-specific fertilizer and agronomy advice	Trajectory actors to continue to champion SPaRC so that it can compete against other solar irrigation arrangements also promoted by KUSUM that do not take groundwater depletion into account	Develop a market-led cassava seed system that takes standards into account
Key trajectory actors	Integrator: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and Ministry of Agriculture R&D: CGIAR, ATA, EthioSIS, AfSIS Donor: United States Agency for International Development (USAID), BMGF, German government	Integrator: Ministry of New and Renewable Energy (MNRE) R&D: ITP-CGIAR; Gujarat Energy Research and Management Institute (GERMI); Gujarat Urja Vikas Nigam Limited (GUVNL); Distribution companies (DISCOMs); National Dairy Development Board (NDDB) Donor: German Government; CCAFS; IWMI	Policy owner: TOSCI Research: CGIAR, Tanzania Agricultural Research Institute (TARI), Mennonite Economic Development Associates (MEDA) Donor: BMGF
Potential impact	Millions of farmers in Ethiopia in terms of higher yields, better soil health and more appropriate use of fertilizers	440,000 farmers deriving additional income in Gujarat, out of a target population of nearly 1 million, over 20 years. Other impacts expected from reduced greenhouse gases and from reduced pumping of aquifers	Millions of cassava farmers in Tanzania

Technology development/innovation pathway

The evaluation reports show that in each of the three cases, the technology development/innovation pathway began with efforts to identify and frame a problem and efforts to develop and frame a technological solution. These related efforts co-evolved over time with the development of new ideas as well as knowledge and/or technologies. Benefits from adoption stemmed from efforts to scale the technical advances and publicize the results of that work (Figure 2).

Case A: Ethiopia

In Case A, the problem was framed as the underuse and misuse of fertilizer as a major contributor to poor soil health that was costing Ethiopia billions of dollars a year. About half of all farmers were not applying any chemical fertilizers, contributing to severe degradation of soil health. Those farmers with access to chemical fertilizers had been applying only urea and phosphorous to manage soil fertility (Sheahan and Barrett 2017). Research by trajectory actors showed that soils were being made increasingly acidic through continued fertilizer use, which in turn made fertilizer increasingly ineffective. Other research found that there was a lack of other nutrients, such as sulfur, potassium, zinc and copper, in farmers' fields, which made urea and phosphorous fertilizers much less effective.

Trajectory actors carried out research to develop components of the solution even before an appropriate solution was widely accepted. From 2000, technological advances were made in soil spectroscopy as a way to rapidly analyze soil samples. Advances were also made in digital soil mapping, machine learning, development laboratory workflows, development of protocols to allow databases to be linked up, establishment of fertilizer blending plants, and online apps that would enable extension workers to make location-specific agronomy and soil recommendations. GIZ played an important role as a 'site integrator', helping to establish improved soil health advisory services as the goal by bringing together the component parts through the projects it designed and funded. Specifically, GIZ funded a project, "Supporting Soil Health Initiatives in Ethiopia," that began in 2017 and was subsequently extended to run until 2025. This supported trajectory actors in forming themselves into a 'coalition of the willing'. The coalition was committed to achieving the vision of Ethiopia saving billions of dollars through more effective fertilizer application and better agronomic practices, as the result of reliable location-specific recommendations of what fertilizer to add and in what quantity. The coalition played an important role in communicating the benefits of more effective fertilizer application in conferences and professional meetings.

Case B: India

In Case B, the problem was the long-running difficulties of providing highly-subsidized electricity for farm pumping, avoiding over-extraction of groundwater and allowing farmers' incomes to increase. The pivotal role played by CGIAR, through ITP, was to link these three problems, calling the ensemble the 'energy-water-agriculture' nexus. The technical innovation developed by ITP was to connect solar panels of the right capacity to both irrigation pumps and the electric grid, enabling farmers to meter and sell their surplus power to the grid. None of the components were novel: the innovation was making them work in a new way that addressed all three nexus issues by moving power generation to farmers' fields and providing an incentive to pump less water, while increasing farmer incomes through payments for surplus capacity. ITP labeled the innovation 'solar power as a remunerative crop,' or SPaRC.

Crucial to the adoption of the concept of SPaRC was the setting up of pilot cooperatives that showed how SPaRC worked in practice while at the same time promoting the model as a solution for key decision-makers in a number of very high-level meetings. The case shows that making a theoretically-compelling argument for a three-way solution, while simultaneously allowing decision-makers to see it work in practice, either by visiting a pilot site or by watching a video, proved to be very persuasive. The publication of related articles in the *Economic and Political Weekly* and national newspapers, including the *Hindu*, the *Times of India* and the *Business Post*, also proved important to winning over decision-makers. The decision to include SPaRC in the USD 50 billion KUSUM program was taken before the research results from the pilot sites had been thoroughly analyzed.

Case C: Tanzania

In Case C, the problem was the threat posed by cassava diseases, particularly cassava mosaic disease (CMD) and cassava brown streak disease (CBSD). CBSD and CMD have been present in Tanzania for at least 85 and 110 years, respectively. Research has been carried out on cassava in Tanzania since 1935. Since 1995, both diseases have caused large-scale losses as they became more virulent. According to an analysis conducted by the International Institute of Tropical Agriculture (IITA), CBSD and CMD together cause production losses worth more than USD 1 billion every year in East and Central Africa and threaten food and income security for over 30 million farmers (IITA 2017). Dealing with the threat had been a political priority for a number of years because cassava is the most important subsistence and food security crop in Tanzania, providing protection against hunger should less drought-tolerant staple crops fail.

The technological solution, developed over several project cycles since 1997, was the development of phytosanitary practices in which cassava cuttings could be produced disease-free. This required establishing a viable seed system, including developing and implementing cassava seed certification and an inspection protocol. Part of the solution was also to provide farmers with varieties of cassava resistant to CBSD and CMD. From 2013, trajectory actors worked together to develop a cassava seed certification and inspection protocol to use in practice. The protocol was signed into law in 2017 as part of amendments to the 2003 Seed Act. However, the widespread use of the protocol still depends on developing a seed system whereby seed producers can produce the seed and have it inspected, at a cost that farmers can afford. This is a continuing area of work for three trajectory actors in particular: TOSCI, IITA, and MEDA. These actors are developing workable business models with 400 entrepreneurs and have developed a mobile phone app called SeedTracker. SeedTracker allows farmers to link up to providers of clean seed.

Capacity development pathway

The three cases show that an essential part of making a technological solution work, as well as advocating for its broader use, was capacity development. This involved building technical and functional capacities, both of which are required to build the innovation capacity of OT actors (Figure 2).

Case A

In Ethiopia, building technical capacity involved improving the ability of the trajectory actors to develop and implement the component parts of the advisory services solution. For example, from 2013 to 2017, ICRAF and WLE provided six training events for EthioSIS staff on soil spectroscopy and digital mapping, in addition to on-the-job training on spatial prediction of soil properties, machine learning, laboratory workflows, quality control, soil archiving and databases. ICRAF and WLE helped EthioSIS establish spectral technology at National Soil Testing Center and five satellite laboratories across Ethiopia.

In Ethiopia, the main functional capacity built was the capacity of individuals to engage in strategic and political processes in support of the end goal. This capacity was identified and labeled by senior Ethiopia-based researchers as ‘impact tracking’, which is described by Child et al. (2021). Impact tracking involves researchers using their professional networks to establish and move an OT forward, using a set of behaviors akin to a product champion. A product champion is an individual who is intensely interested and involved in the overall OT and the outcomes it can deliver. They also play an important role in many of the research-implementation interaction events, overcoming technical and organizational obstacles by sheer force of will and energy.[5]

It was not clear how the capacity to be an impact tracker was built, although it is possible that the way of thinking may have been influenced by the CGIAR Challenge Program on Water and Food (CPWF), in which the impact trackers had previously been engaged. CPWF worked to develop impact pathways for each of its projects, including drawing network maps to help show the importance of partnerships and influence.

Case B

In India, technical capacity was built along the value chain linking solar pumps to the state and national distribution grid through agricultural feeders.[6] The case study shows the capacity to link farmers to feeders was built in previous schemes through a requirement imposed upon DISCOMs, who were obliged to allow households to sell power back to the grid. The main technical training and

[5] Adapted from the definition of a product champion described by Chakrabarti (1974: 58).

[6] A feeder is the line from a step-down transformer on the main grid to a farm.

backstopping provided by ITP-CGIAR was to enable farmers to understand, operate and maintain their solar pump installations.

Case B shows that advocacy was critical to the success of the SPaRC trajectory. ITP began to successfully advocate for SPaRC in 2012. This involved the head of ITP being invited to attend high-level meetings on nexus issues and effectively make the case for SPaRC. As with impact tracking in Ethiopia, it is not clear how he developed the functional capacity to make good use of time in front of key policymakers. That he was invited to the meetings in the first place was a result of having provided good advice to the State of Gujarat with respect to establishing agricultural feeders (Shah et al. 2004). Other functional capacities included the capacity to write persuasively and publish articles in national newspapers, which helped pique and direct the interest of the broader print and TV media.

ITP was fortunate in its membership of CCAFS, which provided the relatively small amount of funding required to establish the Dhundi pilot as the world's first solar power cooperative. A well-recognized strength of CCAFS, WLE and CRPs in general is their quick and straightforward provision of relatively small grants for innovative yet sometimes risky ideas.

Case C

In Tanzania, building technical capacity was required along the value chain, providing farmers with disease-free seed. This involved building the capacity of TOSCI to diagnose cassava diseases both in the laboratory and by 60 seed inspectors in farmers' fields. It also included training more than 400 seed entrepreneurs to produce and sell planting material to meet quality standards for basic, certified and quality-declared seeds.

A long-term close working relationship between IITA/RTB and the Ministry of Agriculture in Tanzania meant that the development and approval of cassava seed standards did not require overt advocacy. IITA and TOSCI staff, who had been part of earlier projects that had identified the importance of clean cassava seed systems, were able to advance their OT without the explicit identification and training of champions to influence policymakers in the Ministry of Agriculture.

MEDA, one of the OT actors, trained champions at the district level to influence how District Councils use the funds allocated to them to support cassava production, processing and commercialization. This has involved a project advocacy team training 'champions' at the district level. The case found that less emphasis may have been put on seed certification advocacy than warranted because of a prohibition on 'lobbying' imposed by BMGF on its grantees, and a lack of clarity on the difference between 'lobbying' and 'advocating.'

Policy influence pathway

Renkow (2018: 2) acknowledged five types of policy-oriented outcomes to which CGIAR research contributes:

- Changes in or creation of laws, regulations, standards and guidelines
- Creation of institutions
- Changes in government and/or donor investment priorities and budget allocations
- Innovations to the operations and management of government agencies and programs
- International treaties, declarations or agreements among parties reached at major policy conferences.

This typology helps to explain what policy-related outcomes can contribute to a more enabling environment for the OT in question (Figure 2).

Case A

At the core of a soil health advisory system is the data sets that drive it. If data sets are to work together then common data standards are required. The existence of common data standards is a policy-related outcome. There also needs to be an inter-organizational agreement to share data, which is another policy-related outcome. Box 1 describes how both outcomes were achieved in Ethiopia, with the help of a 'coalition of the willing,' i.e., an institution. Here, a coalition is defined simply as an alliance for combined action. The advisory system, when developed, will lead to far-reaching changes in the operation and management of the Department of Agriculture and other government and non-government organizations.

Box 1: Policy-related outcomes supporting the development of a soil health advisory system in Ethiopia.

The following is an extract from the report (Douthwaite and Getnet 2019) upon which this case is built:

When EthioSIS started to carry out soil surveys and produce soil maps, a number of organizations and individuals asked to be allowed access to the data sets. EthioSIS was slow in meeting the requests largely due to a lack of a data sharing policy and guidelines. Various bilateral discussions took place to resolve the issue but progress was limited until 2015, when CIAT/WLE, supported by GIZ, held more than five awareness creation meetings to facilitate data sharing, including the potential of 'big data' analytical approaches which require data sharing to work. CIAT/WLE, together with the Ethiopian Institute of Agricultural Research (EIAR), played a leadership role in establishing a coalition of the willing to bring together about 50 individuals from a wide range of organizations who volunteered to share data and support the process of collective data sharing. The coalition of the willing established a task force that developed a set of data sharing guidelines.

While this exercise was ongoing, the Ministry of Agriculture noted the potential and constituted a national taskforce, made up of several coalition of the willing task force members, to develop a national soils/agronomy data sharing policy. The taskforce developed a national soils/agronomy data sharing policy that was endorsed and launched at a national workshop held in June 2019. After endorsement of the policy, various organizations received letters from the Ministry to request them to share their data.

GIZ supported generation of the policy-related outcomes through a project "Supporting Soil Health Initiatives in Ethiopia" that ran from November 2017 to June 2021, and was subsequently extended, and is likely to be granted a second phase. The goal of the project is to help coordinate the creation of an integrated database of soil and agronomic data to allow advisory services to provide optimal site-specific recommendations to improve soil health and fertility.

Case B

The main policy-related outcome in Case B was the inclusion of SPaRC in the Indian government's USD 50 billion KUSUM initiative, which aims to help 2 million farmers adopt SPaRC by 2022. How CGIAR actors were able to influence this decision is described in the section on capacity development. What appeared to work can be summarized as a combination of a compelling win-win-win argument that applied to the three dimensions of the water-energy-agriculture nexus.

More granular policy-related outcomes contributed to making the pilots work, not least the agreement with the DISCOMs servicing the SPaRC adopters to purchase power at an attractive rate that was above the market rate. A second outcome was the formation of SPaRC farmers into so-called 'solar cooperatives.'

The evaluation of SPaRC found that while ITP/WLE had been very effective in influencing solar irrigation policy in India, it was unique in CGIAR in several ways:

- Its equal partnership between a CGIAR Center (IWMI) and a foundation concerned with development (Tata Trusts)
- Its objective to help policymakers at all levels address their water challenges by translating research findings into practical policy recommendations – this was not a research objective but rather one that spoke to bridging research and development
- Its employment of people with a background in business management rather than research; this aligns well with ITP's mandate for 'problem-solving' research with a strong bias toward field action and impact
- Its practice of giving more credit to policy-relevant publications than academic ones
- Its level of comfort with policy engagement.

The evaluation identified ITP as a bridging organization (Davila et al. 2012), which is characterized as a type of organization that is important for research impact (Spielman et al. 2009).[7] The evaluation findings suggest that there is much for CGIAR to learn from ITP's experience, should it wish to see a greater return on its research investment through influencing policy.

Case C

The main policy-related outcome in Case C was the passing into law of cassava seed standards for all seed qualities. In 2012, BMGF funded three projects on cassava seed systems in Tanzania, based on learning from the previous GLCI. Under the auspices of one of the projects, researchers began discussing the establishment of a safe cassava seed system with TARI. TOSCI began organizing meetings to develop regulations in consultation with the key stakeholders, including nongovernmental organizations, commercial seed producers and farmers' representatives. TARI, IITA and MEDA supported the work. TOSCI convened a technical committee to draft a cassava clean seed inspection and certification protocol approved by the National Seeds Committee and published in January 2017. In the same month, seed regulations for cassava were gazetted. This included a description of how inspections and certification should happen, including fees to be charged by TOSCI inspectors. As of October 2020, 80 extension officers were gazetted by the Ministry of Agriculture.

In parallel, MEDA has led two projects, with IITA and TARI as partners, to develop and pilot cassava seed entrepreneur business models (i.e., institutional innovations with 400 individuals, providing the inspectors will work). At the same time, the projects strengthened an existing institution, TOSCI, by setting up and supporting the Cassava Seed Growers' Association to help seed entrepreneurs coordinate the testing of their fields by TOSCI inspectors.

The evaluation found that the four organizations most involved in the trajectory – IITA, MEDA, TARI and TOSCI – had formed a de facto coalition funded by BMGF. The coalition had been able to develop and implement a series of projects that contributed to the OT, beginning with the GLCI in 2009 and set to continue at least until 2024.

[7] Key features of a bridging organization are that it helps to find useful information, mediates between researchers and other actors in the OT, and identifies internal and external barriers to innovation.

Discussion

In this section, we explore the implications of the findings above for S&T policy in One CGIAR, and for AR4D more generally, where S&T policy covers the measures designed for the creation, funding, support and mobilization of scientific and technological resources.

Insights from understanding the cases as outcome trajectories

Evidence supports the assumption that the outcomes achieved in each of the three cases were generated by an OT – an interacting and co-evolving system of actors, knowledge, technology and institutions that produce, sustain and sometimes scale a coherent set of outcomes over time to which a variety of actors contributed, including CGIAR.

Understanding the cases as OTs allowed a number of insights to be drawn, all of which have implications for S&T policy. The three OTs at work in the three respective cases were similar in a number of ways. Each gained momentum ten or more years before the main outcome had been identified and the respective evaluations commissioned. Each had roots that went back even further.

The ultimate, positive outcome was not clear at the beginning of the trajectories. Each trajectory began by clarifying and defining a compelling problem while at the same time posing a potential, but convincing, solution. In each case, the problem was clearer than the solution at the start and, not surprisingly, more resources went into the latter. Only in one case were champions formally acknowledged as such (Tanzania). In the other cases, the senior leaders most involved in the trajectory advocated for the solution during interactions with colleagues in meetings and conferences, and when making courtesy calls to government ministries. Initially, they did not necessarily think of themselves as champions.

Similar to the role of a champion was that of an impact tracker, identified as an important role in Ethiopia by the trajectory actors themselves (Child et al. 2021). Impact tracking involves researchers using their professional networks to establish and move an OT forward. An impact tracker is an individual who is intensely interested and involved in the overall OT and the outcomes it can deliver, and who plays an important role in many of the research-implementation interaction events, overcoming technical and organizational obstacles. An important part of impact tracking is keeping the OT intact from one project to the next, which is necessary given that the lifespan of an OT is likely to be longer than one project.

Another important driver in two of the OTs were coalitions: a so-called 'coalition of the willing' in Ethiopia and a de facto coalition in Tanzania. The formation of coalitions, as described in the literature and which fits reasonably well with the two cases, is that groups of stakeholders coalesce around broad, shared agendas. Members bring resources to the table, including strategic knowledge, capacity to act on that knowledge, relationships with other allies and constituencies, and control of financial and other resources (Stachowiak 2013: 13).

The cases also helped identify the role of a 'site integrator' as the organization that becomes the focal point of the OT. This was GIZ in Ethiopia and IITA in Tanzania. The site integrator helped support the respective coalitions in both countries. In Ethiopia, GIZ played an important part in bringing three CGIAR Centers to work together towards a common goal, when previously they had been competing with each other. In India, the dynamic was somewhat different, with ITP/WLE functioning as a well-respected think tank that provided policy solutions that were needed. It seemed as though policy advice was more accepted coming from the well-known individual leading ITP, rather than from ITP itself.

Insights from modeling AR4D contribution to outcome trajectories as the result of three high-level pathways

Evidence from the cases also supports the assumption that the AR4D contributed to the respective OTs through three impact pathways, as shown in Figure 2. Table 2 summarizes the main strategies used by trajectory actors in pursuing each pathway in each case.

Table 2: Strategies employed in each case relating to three impact pathways.

Strategy	Case A: Ethiopia	Case B: India	Case C: Tanzania
Pathway 1: Technology development/innovation			
Framing the problem	The problem of poor soil health was well-established when the trajectory started	ITP was instrumental in establishing the energy-water-agriculture nexus as three problems that needed solving at the same time	The problem of viral diseases in cassava was well-established when the trajectory started
Framing the solution	GIZ was instrumental among trajectory actors in agreeing an ambitious common goal of developing a system for making location-specific recommendations for type and amount of fertilizer applied, based on regularly-updated soil maps and local field trials	ITP and NDDB established pilots that showed an apparently workable solution to the nexus	Researchers involved in the GLCI were instrumental in establishing a clean cassava seed system as crucial to reduce spread of viral diseases of cassava
Technological advances	Use of soil spectroscopy to speed up analysis of soil samples, digital mapping, identifying optimal formulations and application rates for specific soil types and crops, and developing apps allowing advisers to make agronomic and soil recommendations	A solar irrigation system that allows farmers to sell solar power back to the grid	Development of good phytosanitary practices
Communication about the performance of the solution based on research findings	Publication of articles and presentations at conferences and meetings	Prioritization of press and TV media over research	Publication of articles and presentations at conferences and meetings
Pathway 2: Capacity development			
Building capacity to advocate, formally or informally	No capacity built for formal advocacy. Extensive informal advocacy employed by impact trackers and the coalition of the willing	No capacity built for formal advocacy. Extensive informal advocacy by one well-respected individual in particular, using his	Capacity of champions built to encourage districts in Tanzania to support commercial cassava supply chains. Extensive informal

Strategy	Case A: Ethiopia	Case B: India	Case C: Tanzania
	through their existing presenting and networking abilities	reputation and existing presenting and networking abilities	advocacy by a de facto coalition through their existing presenting and networking abilities
Building capacity to implement the solution	Building capacity in soil spectroscopy and database management	Building capacity of farmers in pilot schemes to operate their solar pumps and grid connections	Building capacity of laboratory staff (to test for diseased material), seed inspectors, and seed entrepreneurs
Pathway 3: Policy influence			
Changes in or creation of laws, regulations, standards and guidelines	Development of a national soils/agronomy data sharing policy and guidelines	Contribution to the regulations/subsidies applied to farmers adopting SPaRC under the KUSUM program	Support to the development of standards for cassava seed
Creation of institutions	Support to the setting up of EthioSIS	Creation of solar cooperatives as SPaRC pilots	Development of business plans for cassava seed entrepreneurs, including efforts to commercialize the value chain
Changes in investment priorities and budget allocations	Long-term support of OT, in particular EthioSIS by BMGF and USAID	Pivotal role in achieving the inclusion of SPaRC in the Government of India's KUSUM program	Continual funding support from BMGF from 2009 to 2021

Describing AR4D contributions in terms of the three pathways helped generate a number of insights with possible implications for S&T policy.

Overall, evidence shows that AR4D contributions involved employing technology development/innovation, capacity development and policy influence strategies. This was done simultaneously and in a self-reinforcing manner, over a time period much longer than that of a typical project or program.

Technology development/innovation

Each OT confronted a well-established problem of sufficient priority to help drive progress. In India, the coupling of three problems provided an additional impetus.

In all three cases, the solution needed to be communicated and established in a way that trajectory actors could agree on the solution and saw a role for themselves in bringing it about. This took time. Pilots that showed the solution working proved particularly influential in India, where a major scaling decision was made before the pilot site research had been completed. In Ethiopia and Tanzania, continued funding by BMGF was key. In India, a small, flexible grant by CCAFS to fund the first SPaRC pilot was catalytic.

Scientific communication happened as a result of professional interactions, particularly in conferences and meetings in which other trajectory actors were present. In India, ITP-authored articles in *Economic and Political Weekly* proved an important conduit to key decision-makers.

Capacity development

AR4D contributed to building both the technical and functional capacity of OT actors. Building technical capacity involved training supply chain actors to implement the solution. Demonstrating that people were trained, willing and able, provided an impetus to the respective OTs.

Most of the functional capacities required by the OTs to progress were innate, such as the ability to track impact seen in Ethiopia, or to form coalitions in Ethiopia and Tanzania. The exception was the training of champions at district level in Tanzania.

All three OTs also benefited from innate technical capacity. For example, the capacity of DISCOMs in India to meter and buyback solar power from households made it easier to connect solar cooperatives to the grid.

Policy influence

AR4D actors in the three OTs contributed to three of the five policy-related outcomes identified by Renkow (2018: 2). The manifestation of the outcomes was different in the three cases. Achieving the outcomes took time, receiving and giving impetus to the capacity development and technology development/innovation pathways. Coalitions played an important role in Ethiopia and Tanzania.

Substantial, continuous BMGF funding spanning more than eight years was important in Ethiopia and Tanzania. In India, IWMI and the Tata Trusts' long-term support to ITP, together with a flexible and relatively low amount of funding provided by CCAFS to set up a SPaRC pilot, proved catalytic to SPaRC's inclusion in the KUSUM program.

Conclusions

The three cases support the idea that AR4D projects and programs helped to bring about positive outcomes by contributing to the OTs from which the outcomes emerged. The cases also support the notion that the dynamic by which contribution happens within OTs can be usefully represented by the three-pathway middle-range theory (Figure 2). Together, the two concepts have wide-ranging implications for AR4D S&T policy, particularly the Action Area of Systems Transformation in the CGIAR 2030 Research and Innovation Strategy, and possibly other integrated research for development programs.

The key findings from this study are given below:

- Spending more time and resources at the beginning of a new project to describe the OT or trajectories to which it will contribute
- Be more realistic about timeframes, given it can easily take 5-10 years to achieve outcomes at any scale
- Realizing that OTs become clear when looking back from achieved outcomes, and therefore to plan for regular ‘after action reviews’, or similar, to identify emerging positive interactions upon which to build
- When looking for positive interactions, look for dynamics in which the three AR4D pathways – technology development/innovation, capacity development and policy influence – work together in a synergistic manner
- Find ways of identifying and valuing existing OTs as high-level generative mechanisms through which AR4D can achieve impact
- Expect the solution, and the messaging around it, to evolve and become more compelling over time, and that coordinated communication can help make this happen
- Acknowledge and amplify innate functional capacities of staff, particularly with respect to informal advocacy and impact tracking
- Better identify and support incipient and established coalitions
- Require that end-of-project evaluations identify the OT or trajectories to which the project contributed
- Give monitoring and evaluation for learning a more explicit role from project conceptualization to make sure that the points above are given due consideration, and that learning is fed back to support adaptive management.

References

Arvanitis, R. 2002. Science and technology policy. In: *Encyclopedia of Life Support Systems (EOLSS)*. Paris, France: EOLSS Publishers. Pp. 811-847.

Axelrod, R.; Cohen, M. 1999. *Harnessing complexity: Organizational implications of a scientific frontier*. New York, USA: Free Press.

Binnendijk, A. 2000. *Results-based management in the development cooperation agencies: A review of experience.* Paris, France: Organisation for Economic Co-operation and Development (OECD).

CGIAR. 2015. *CGIAR strategy and results framework 2016-2030*. https://hdl.handle.net/10947/3865 (accessed on January 20, 2022).

CGIAR. 2021a. *One CGIAR*. Available at https://www.cgiar.org/food-security-impact/one-cgiar/

CGIAR. 2021b. *CGIAR 2030 Research and innovation strategy: Transforming food, land, and water systems in a climate crisis*. https://hdl.handle.net/10568/110918

Chakrabarti, A. 1974. The role of champion in product innovation. *California Management Review* 17(2): 58-62.

Child, K.; Desta, G.; Douthwaite, B.; Haileslassie, A.; van Rooyen, A.; Tamene, L.; Uhlenbrook, S. 2021. *Impact tracking: A practitioner-developed approach to scaling agricultural innovation in Ethiopia*. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Research Program on Water, Land and Ecosystems (WLE). 28p. (WLE Legacy Series 1). https://doi.org/10.5337/2021.226

Davila, T.; Epstein, M.; Shelton, R. 2012. *Making innovation work: How to manage it, measure it, and profit from it*. *Updated edition*. Upper Saddle River, USA: FT Press.

Douthwaite, B. 2020. *Development of a cassava seed certification system in Tanzania: Evaluation of CGIAR contributions to a policy outcome trajectory*. Lima, Peru: International Potato Center. 34p. https://hdl.handle.net/10568/110093

Douthwaite, B.; Kuby, T.; van de Fliert, E.; Schulz, S. 2003. Impact pathway evaluation: An approach for achieving and attributing impact in complex systems. *Agricultural Systems* 78(2): 243-265.

Douthwaite, B.; Hoffecker, E. 2017. Towards a complexity-aware theory of change for participatory research programs working within agricultural innovation systems. *Agricultural Systems* 155: 88-102.

Douthwaite, B.; Mur, R.; Audouin, S.; Wopereis, M.; Hellin, J.; Saley Moussa, A.; Karbo, N.; Kasten, W.; Bouyer, J. 2017. *Agricultural research for development to intervene effectively in complex systems and the implications for research organizations*. Amsterdam, Netherlands: KIT Royal Tropical Institute. 20p. (KIT Working Paper 2017:12).

Douthwaite, B.; Getnet, K. 2019. *Outcome evaluation of the work of the CGIAR Research Program on Land, Water and Ecosystems (WLE) on soil and water management in Ethiopia*. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Research Program on Water, Land and Ecosystems (WLE). 64p. https://hdl.handle.net/10568/107102

Douthwaite, B.; Shepherd, K. 2020. *Outcome evaluation of climate-smart research on solar-powered irrigation in India*. Colombo, Sri Lanka: CGIAR Research Program on Water, Land and Ecosystems (WLE). 59p. https://hdl.handle.net/10568/113398

IITA (International Institute of Tropical Agriculture). 2017. *Project brings ray of hope to fight against cassava viruses in Africa*. Available at https://www.iita.org/news-item/project-brings-ray-hope-fight-cassava-viruses-africa/ (accessed December 3, 2021).

Lacouture, A.; Breton, E.; Guichard, A.; Ridde, V. 2015. The concept of mechanism from a realist approach: A scoping review to facilitate its operationalization in public health program evaluation. *Implementation Science* 10(1): 153.

OECD (Organisation for Economic Co-operation and Development). 2021. *Detailed summary of ODA in 2020*. Available at https://www.oecd.org/dac/financing-sustainable-development/development-finance-data/ODA-2020-detailed-summary.pdf (accessed on December 3, 2021).

Pawson, R. 2013. *The science of evaluation: A realist manifesto*. Thousand Oaks, USA: Sage Publications.

Pawson, R.; Owen, L.; Wong, G. 2010. The *Today Programme*'s contribution to evidence-based policy. *Evaluation* 16(2): 211-213.

Paz, R.; Douthwaite, B. 2017. Outcome evidencing: A method for enabling and evaluating program intervention in complex systems. *American Journal of Evaluation* 38(2): 275-293.

Renkow, M. 2018. *A reflection on impact and influence of CGIAR policy-oriented research*. Rome, Italy: Standing Panel on Impact Assessment (SPIA), CGIAR Independent Science and Partnership Council (ISPC).

Sabatier, P.; Weible, C. 2014. *Theories of the policy process*. New York, USA: Avalon Publishing.

Sachs, J. 2006. *The end of poverty: Economic possibilities for our time*. London, UK: Penguin.

Shah, T.; Scott, C.; Kishore, A.; Sharma, A. 2004. *Energy-irrigation nexus in South Asia: Improving groundwater conservation and power sector viability. Second (Revised) Edition*. Colombo, Sri Lanka: International Water Management Institute. 34p. (IWMI Research Report 70). https://doi.org/10.3910/2009.088

Sheahan, M.; Barrett, C. 2017. Ten striking facts about agricultural input use in Sub-Saharan Africa. *Food Policy* 67: 12-25.

Spielman, D.; Ekboir, J.; Davis, K. 2009. The art and science of innovation systems inquiry: Applications to Sub-Saharan African agriculture. *Technology in Society* 31(4): 399-405.

Stachowiak, S. 2013. *Pathways for change: 10 theories to inform advocacy and policy change efforts*. Washington, DC, USA: Center for Evaluation Innovation.

Stein, D.; Valters, C. 2012. *Understanding theory of change in international development*. London, UK: The Justice and Security Research Programme. 23p.

Vähämäki, J.; Schmidt, M.; Molander, J. 2011. *Results based management in development cooperation*. Stockholm, Sweden: Riksbankens Jubileumsfond. 57p.

Vogel, I. 2012. *Review of the use of 'theory of change' in international development*. London, UK: Department for International Development (DFID).

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