Standing Panel on Impact Assessment

CGIAR

Estimating the Returns on Investment for Select CGIAR Innovations

The Standing Panel on Impact Assessment (SPIA)

February 2026

The Standing Panel on Impact Assessment

The Standing Panel on Impact Assessment (SPIA) is an external, impartial panel of experts in impact assessment appointed by the CGIAR System Council and accountable to it. SPIA is responsible for providing rigorous, evidence-based, and independent strategic advice to the broader CGIAR System on efficient and effective impact assessment methods and practices, including those measuring impacts beyond contributions to science and economic performance, and innovative ways to improve knowledge and capacity on how research contributes to development outcomes.

https://iaes.cgiar.org/spia

Permissions

SPIA encourages fair use of this material under the terms of Creative Commons Attribution 4.0 (BY-NC-SA 4.0), providing proper citation is made.

Recommended Citation

SPIA (2026). Estimating the Returns on Investment for Select CGIAR Innovations. Rome. The Standing Panel on Impact Assessment (SPIA)

Authors

The Standing Panel on Impact Assessment (SPIA)

Editor

Elyse Franko-Filipasic

Design and layout

Luca Pierotti, Elyse Franko-Filipasic

Countries and Territories Disclaimer

Boundaries used in the maps do not imply the expression of any opinion whatsoever on the part of CGIAR concerning the legal status of any country, territory, city, or area, or its authorities, or concerning the delimitation of its frontiers or boundaries. Border lines are approximate and cover some areas for which there may not yet be full agreement. The term country also refers, as appropriate, to territories or areas.

Cover Photo: IRRI Cultivation Project, Bogra, Bangladesh
Credit: b.a.sujan/Map PhotoAgency/IRRI

Estimating the Returns on Investment for Select CGIAR Innovations

The Standing Panel on Impact Assessment (SPIA)

A farmer poses with paddy seedlings ready for transplantation in his field in Boro Bochapukur, Birganj Upazila, Dinajpur, in northwest Bangladesh. Credit: Tanmoy Bhaduri/IWMI

Contents

List of Figures

List of Tables

Acronym List

AFP	Axial Flow Pump
ANCOVA	analysis of covariance
AR4D	Agricultural Research for Development
AWD	Alternate Wetting and Drying
BCR	benefit-cost ratio
BIHS	Bangladesh Integrated Household Survey
BINA	Bangladesh Institute of Nuclear Agriculture
BRRI	Bangladesh Rice Research Institute
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CSISA	Cereal Systems Initiative in South Asia
DRIVE	De-Risking, Inclusion, and Value Enhancement of Pastoral Economies Program
DTM	Drought-Tolerant Maize (also: DT Maize)
DTMA	Drought-Tolerant Maize for Africa
FTRV	Flood-Tolerant Rice Varieties
GIFT	Genetically Improved Farmed Tilapia (also: GIF Tilapia)
IBLI	Index-Based Livestock Insurance
iDE	International Development Enterprises
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IRR	internal rate of return
IRRI	International Rice Research Institute
IWMI	International Water Management Institute
ILRI	International Livestock Research Institute
ISP	input service provider
KLIP	Kenya Livestock Insurance Program
NDVI	Normalized Difference Vegetation Index
NPV	net present value
OPV	open-pollinated carieties
PPP	public-private partnership
ROI	return on investment

SDGs	Sustainable Development Goals
SIIPE	Satellite Index Insurance for Pastoralists in Ethiopia
STMA	Stress-Tolerant Maize for Africa
TFP	total factor productivity
TLU	total livestock unit

Acknowledgments

SPIA engaged Professor Mywish Maredia as a consultant to lead the development and implementation of the approach to estimate ROI of selected CGIAR showcases successes. SPIA acknowledges her valuable contributions, which provided the basis for preparing this report.

Executive Summary

To estimate the returns on CGIAR's investments in agricultural research, the System Council commissioned SPIA to undertake a study for select CGIAR innovations. This report presents the ROI estimates, based on a harmonized benefit-cost analysis framework, for four innovations which SPIA deemed both "ROI-Appropriate" and "ROI-Feasible": Index-Based Livestock Insurance (IBLI) in Kenya and Ethiopia, axial flow pumps (AFPs) in Bangladesh, flood-tolerant rice varieties (FTRVs) in Bangladesh, and drought-tolerant (DT) maize in Ethiopia.

Key Findings

Based on a stochastic sensitivity analysis, ROI distributions were created for each innovation instead of point estimates. All four innovations indicate positive ROIs, although the degree of returns varies. Notably, the ROI distribution for IBLI (Kenya and Ethiopia) shows that there is a 50% chance that every USD 1 invested in IBLI development and dissemination yielded benefits worth USD 7.1 dollars. There is a 95% chance that every dollar invested led to benefits worth at least USD 2.5, and a 90% chance that they led to benefits worth at least USD 3.4.

ROI distribution for AFPs in Bangladesh shows that there is a 50% chance that every dollar invested in AFP development and dissemination yielded benefits worth USD 42.5. There is a 95% chance that every dollar invested led to benefits worth USD 17.5 and above, and a 90% chance that they led to benefits worth at least USD 22.3.

For FTRVs in Bangladesh, ROI distribution shows that there is a 50% chance that every dollar invested in FTRV development and dissemination yielded benefits worth $US1.5. There is a 95% chance that every dollar invested led to benefits worth at least USD .70, and a 90% chance that they led to benefits atleast worth USD .90.

ROI distribution for DT maize in Ethiopia shows that there is a 50% chance that every dollar invested in DT maize development and dissemination yielded benefits worth $US7.6. There is a 95% chance that every dollar invested led to benefits worth at least USD 4.3 dollars, and a 90% chance that they led to benefits atleast worth USD 5.

Challenges

ROI estimation is neither universally appropriate nor always feasible for CGIAR research. Of 14 identified SPIA showcase successes, only four proved ROI-feasible due to availability of cost, reach and impact data. Furthermore, many valuable CGIAR contribution simply may not be appropriate for quantification through ROI frameworks. While the above estimations account for uncertainty through sensitivity analyses, further discussion is warranted to determine methods to better tackle measurement error, as well as on the topics of extrapolation and the stochastic nature of agricultural benefits in ROI calculations.

Takeaways

CGIAR centers and programs should develop robust systems to track the costs, benefits and impacts linked to specific innovations.

It must be acknowledged that returns to agricultural R&D are highly skewed, and large returns from "big wins" can justify system-wide investment, but these wins are only identifiable ex-post. A portfolio approach that learns from both successes and failures remains essential.

Focusing exclusively on ROI risks missing innovations and interventions with significant but difficult-to-quantify benefits across CGIAR.

A farmer brings his flock to a water source in the Siti zone of the Somali region of Ethiopia in 2016. At the time, the country was experiencing the worst drought in 50 years, killing an estimated 90% of livestock in the region. Credit: EU/ECHO/Anouk Delafortrie

Staff at Robani Agriculture Enteprises in Ethiopia remove maize from the cob then separate the husks.
Credit: Robin Hammon/Panos Pictures

1. Introduction

As part of its mandate to expand and deepen evidence of the impact of CGIAR's research on outcomes in five areas, SPIA's 2019-2024 workplan delivered insights about the reach and impacts of innovations from across the CGIAR research portfolio (SPIA 2024). The dissemination of this evidence aimed to support CGIAR's goal to be a learning organization, and to inform decision-making in the system. It was also hoped that the communication of SPIA's findings would support the case for investment in CGIAR activities, helping funders pursue their development and sustainability goals around the world.

Figure 1: Determination of ROI-Feasibility

In addition to its technical reporting, SPIA communicated the emerging evidence about the reach and impact of CGIAR's activities through a set of written briefs and presentations. These highlighted several CGIAR successes and identified challenges in achieving sustained adoption of CGIAR innovations at scale, and also highlighted how impacts for some of the innovations disseminated differed from anticipated results.

Although the different CGIAR stakeholders welcomed the insights from the SPIA portfolio, the System Council also felt that it would be helpful to focus on particular "Showcase Successes" that could help support the business case for the CGIAR system. As a first step, SPIA provided concise, high-level summaries about these showcase successes, but further consultation with System Council members identified the need to estimate returns on investment (ROI) for these particular cases.

While SPIA has consistently documented rigorous evidence of the benefits generated by several CGIAR innovations in a number of CGIAR priority countries, the estimation of ROI for individual innovations goes beyond SPIA's mandate. This is mainly because SPIA has not been tasked with collecting cost or investment data — something the CGIAR centers and programs spearheading the research are better suited to do.

Since this new request from the System Council did not fit the planned SPIA activities for 2025, SPIA agreed to engage an external consultant to develop an approach to estimate the ROI of successful individual CGIAR innovations, and then implement this approach for select cases. This report summarizes the main findings of this work, conducted by the consultant with guidance from SPIA.

2. An Approach to Estimate ROI of Agricultural Innovations

2.1 Insights from Economics Literature

Does it pay to invest in agricultural research? Since its founding, CGIAR has been attempting to provide answers to this question, in line with prominent methodological approaches from economics literature. Until the mid-2000s, ex-post impact assessments were dominated by the partial-equilibrium approach proposed by Griliches (1957), where an innovation reduces the marginal cost of producing an agricultural product, and this then generates a stream of benefits (economic surplus) over time (Stevenson et al. 2023).

This approach for estimating the rate of returns on research has been widely used in cost-benefit analysis within CGIAR, and can inform the allocation of agricultural research investments in the System (Alston et al. 1995, Raitzer and Kelley 2008). While there is a continued demand for these aggregate estimations among CGIAR funders for making investment decisions, an important concern is that they often incorporate strong assumptions, which can lead to implausible estimates of rates of returns (Hurley et al. 2016).

It has also been argued that the impact of agricultural innovation comes about through complex pathways, so that rather than assessing impact at the micro-level, analyses should be carried out at the macro-level. Often, such analyses include a simulation of the impact of a single innovation on total factor productivity (TFP) or growth rates. Fuglie and coauthors use regression approaches to estimate the impact of research investments on changes in agricultural TFP over time and space (Fuglie 2018).

However, this approach also has drawbacks. Firstly, the risk and heterogeneity inherent in agricultural products makes it very difficult to estimate TFP (Gollin & Udry 2021). Furthermore, at the macro level it can be challenging to cleanly identify the impact of research on agricultural TFP when institutional features, world prices, weather and climate have changed concurrently (Stevenson et al., 2023).

Recent work by Akerman et al. (2025) avoids this problem in their estimation of the overall effect of public R&D investment on agricultural innovation and productivity growth in Brazil. By exploiting the staggered establishment of regional research centers across the country, they are able to identify the effects of R&D investments on agricultural productivity and input use, leading to increased agricultural output. While this is a promising approach that addresses some of the challenges identified above, there is still work to do in adapting it to complex innovation systems like CGIAR.

For innovations that may not require strong assumptions, the estimation of ROI using the partial-equilibrium approach could be performed using some variations of the cost-benefit framework. The net present value (NPV) estimates the gain in money generated by a particular project until a certain point in time, while the benefit-cost ratio (BCR) explicitly compares the stream of benefits of an innovation/project with the investment required. Likewise, the internal rate of return (IRR) is the maximum rate at which investors/donors break even their investments. While all these indicators aim to assess the efficiency of public expenditures, they do this in different ways: NPV needs to be greater than zero, BCR to be greater than one and IRR greater than the discounted rate used (Shively 2012, GIZ 2023). Each of these variants offer advantages and disadvantages for their calculations, but the selection of any or all of them will depend on data availability (Alston et al. 1995).

Below, we explain the approach used to address the recent request to estimate ROIs for individual innovations and discuss the conditions needed to come up with reliable and informative results.

2.2 ROI-Appropriateness and ROI-Feasibility

As described above, much of the estimation of returns to investment in agricultural research for development organizations has focused on the benefits of increasing agricultural productivity. However, this methodological approach has fallen short in the era of the Sustainable Development Goals (SDGs), which recognize that development is multi-faceted, that increased productivity does not automatically guarantee positive outcomes in all domains, and that multiple objectives should therefore be tracked and pursued simultaneously. Furthermore, there have been concerns about distributional consequences of the benefits generated.

In addition, considerable CGIAR activity is focused on influencing policy at the national or sub-national level, the returns of which are not always tangible or — more importantly for the purpose of estimating rates of return — quantifiable. CGIAR also increasingly engages the private sector in the co-design and dissemination of several innovations. These public-private partnerships likely boost the potential for both reach and impacts, but the CG system is unlikely to have accurate information about the costs and benefits to the private sector. To the extent that private sector involvement is pivotal to an innovation’s success, our inability to quantify its worth complicates the assessment of the CG’s investment.

Finally, and just as importantly, CGIAR’s mandate includes the production of and contribution to global public goods, such as seed banks that allow the continuing development of seed varieties across the world and for posterity. The stream of benefits from such activity can be difficult to assess at a point in time or in a particular place. All of this implies that many of the research activities, innovations and investments of CGIAR lie outside the ROI framework — in other words, they are not ROI-Appropriate.

Even those investments that are ROI-Appropriate may not always be ROI-Feasible. In practical terms, three types of information are necessary for the estimation of returns on investment (Figure 1). First, there should be information about the costs of developing and disseminating a particular innovation. This requires evidence of a clear R&D pathway to the distinct innovation, and a documentation of CGIAR's role in this process. Second, one needs rigorous evidence on the reach of the innovation. Depending on the nature of the innovation, it may be adopted at — and the adoption rates best measured at — different levels: household, community, subnational, or national. Third, one needs rigorously estimated estimates of the impacts of the innovation, ideally taking into account not just the immediate but also the longer-term impacts, as well as the downstream benefits on others who may not directly adopt it. Since impacts of new technology do not come about directly through the technology but through their application by people, it is important that impacts are estimated in settings that are as close to the real world as possible (Stevenson et al. 2023, Laajaj et al. 2020).

Should any of these pieces of information be unavailable (or only partially available), ROI estimation would not be feasible. As shown in Figure 1, only innovations that lie at the intersection of the three components will be strictly ROI-Feasible. However, in some cases, rigorous evidence of the impacts of some innovations may exist, but for different settings/locations. In these cases, the extrapolation of this rigorous evidence could be carefully explored and used to estimate the ROI. Following this pathway will also require accounting for the uncertainly introduced in the extrapolation process, as we show below for Drought-Tolerant maize and axial flow pumps.

2.3 ROI-Feasible Cases Selected

The synthesis of the findings of the SPIA 2019-2024 portfolio highlighted several "Showcase Successes", or innovations that have been adopted at scale, and have rigorously estimated evidence of impacts to a large extent. SPIA identified eight such CGIAR innovations. Since some have been adopted in more than one country, this made a total of 14 potential cases.[1]

When it came to estimation of ROI, on the cost side, the ROI exercise relied on availability of cost data recorded by CGIAR centers and that could be linked reliably to the development or dissemination of the selected innovations.

As described in Table 1, rigorous evidence on the reach of CGIAR was available in most cases, except for flood-tolerant rice varieties in India and Drought-Tolerant maize in Mozambique and Tanzania — cases where the literature provides rigorous evidence of impacts, but where SPIA had not yet focused measurement efforts. In other cases, such as salt-tolerant rice, Genetically

[1] At this stage, it was not yet anticipated that ROI estimates would be requested for these showcase successes, and therefore ROI-Appropriateness or ROI-Feasibility were not included as selection criteria. However, given SPIA's recent efforts (2019-2024) to use nationally representative household survey data to measure the reach of CGIAR's innovations that have scaled in four countries, the shortlist is heavily weighted toward cases where there is evidence of widespread adoption. This also means that innovations which do not reach households directly but scale through other pathways did not make it to this shortlist.

Improved Farmed (GIF) tilapia, and improved poultry and forages, SPIA has evidence that the innovations have scaled in particular countries, but the impact estimates do not yet exist. Finally, in some cases, such as GIF tilapia in Bangladesh and poultry in Ethiopia, it proved difficult to obtain data on the cost of investments undertaken at CGIAR centers. As a result, only four innovations were ROI-Feasible: flood-tolerant rice in Bangladesh, drought-tolerant maize in Ethiopia, axial flow pumps in Bangladesh and Index-Based Livestock Insurance (IBLI) in Kenya and Ethiopia.

Table 1: Availability of Cost, Reach and Impact Data for CGIAR "Showcase Successes"

Innovation (Center)	Country	Reach evidence	Impact evidence	Cost Data
Flood-tolerant rice varieties (IRRI)	Bangladesh Vietnem India	**Yes** **Yes** No	**Yes** No **Yes**	**Yes** **Yes** **Yes**
Drought-Tolerant Maize (CIMMYT)	Ethiopia Mozambique Tanzania	**Yes** No No	No* **Yes** **Yes**	**Yes** **Yes** **Yes**
Axial Flow Pump (CIMMYT)	Bangladesh	**Yes**	Only field trials	**Yes**
Index-Based Livestock Insurance (ILRI)	Kenya Ethiopia	**Yes** **Yes**	**Yes** **Yes**	**Yes** **Yes**
GIF Tilapia (WorldFish)	Bangladesh	**Yes**	No	No
Poultry (ILRI)	Ethiopia	**Yes**	No	No
Salt-tolerant rice (IRRI)	Bangladesh Vietnam	**Yes** **Yes**	No No	Incomplete Incomplete
Impoved forages (ILRI)	Ethiopia	**Yes**	No	**Yes**

* Impact data extrapolated from rigorous studies in Mozambique and Tanzania

2.4 Methodology for Estimating ROI

The consultant that SPIA engaged applied a harmonized benefit–cost analysis (BCA) framework to estimate the Return on Investment (ROI) in the four innovations identified. The approach was designed to be transparent, empirically grounded, and comparable, although the innovations differ in type, scale, and evidence base. The ROI is defined as the ratio of total monetized benefits generated by an innovation to the donor-attributable research and dissemination costs required to produce those benefits, and is computed as:

$$\text{ROI} = \frac{\text{Total benefits}}{\text{Total CGIAR costs}}$$

Reported ROI values therefore represent the realized economic return over the period covered by available data.[2] Annexes 2.1, 2.2, 2.3 and 2.4 outline how benefits were quantified and monetized, how donor-attributable costs were compiled and harmonized across cases, and how these inputs together underpin the ROI estimates in this report.

2.5 Addressing Uncertainty of ROI Estimations

To account for parameter uncertainty and to assess the robustness of estimated returns, we conducted a Monte Carlo-based sensitivity analysis for each intervention. This approach systematically propagates uncertainty from input parameters through to the computed ROI. It thus provides a more realistic depiction of potential outcomes than a single deterministic estimate.

In general, the key cost and benefit parameters were modeled as random variables, typically following normal distributions centered on their best available estimates with a standard deviation of 5 percent of the mean, unless we had empirical evidence that suggested different bounds. In addition, in cases where the impact estimates that were relied on referred to a different context than ours, we incorporated uncertainty around the extrapolation that was made.[3] In addition, when the impact estimates come from experimental studies in laboratory settings rather than field settings, we incorporated uncertainty around real-world gaps between these estimates and expected field performance.

Each simulation run involved 100,000 random draws, generating an empirical distribution of ROI values. This distribution allows us to compute the expected ROI estimate and the share of simulated outcomes with ROI below 1 (break-even) or below 0 (zero gain).[4] Details of how the ROI distributions were constructed are provided in Annex 1.

This stochastic sensitivity analysis enables a transparent quantification of the uncertainty around the estimates and allows identification of interventions whose expected returns are high, and those that are resilient to parameter variability. The approach helps decision-makers prioritize investments under realistic ranges of economic and agronomic conditions, rather than relying on point estimates alone.

[2] One exception is IBLI, where a core benefit in the ROI is the increase in children's educational attainment among insured households. That benefit is valued as the present value of gains in education-induced lifetime earnings, net of additional schooling costs.

[3] For example, in the case of DT maize, the impact estimates in the literature come from Mozambique and Tanzania whereas the ROI is estimated for Ethiopia. In the case of axial flow pumps, the literature reports fuel cost savings for only three major crops, not for all crops that Bangladeshi farmers grow.

[4] An ROI of 1 would indicate that each dollar spent on the investment was recovered, but there was no additional gain. An ROI of 0 would indicate the investment generated no return.

3. The ROI Estimation of Four CGIAR Innovations

3.1 Index-Based Livestock Insurance (IBLI) in Kenya and Ethiopia

IBLI is an insurance product developed by the International Livestock Research Institute (ILRI) and U.S. university partners to address the impact of drought on pastoralist households. The product uses satellite-derived vegetation indices (NDVI) to trigger payouts to households when forage scarcity in their area reaches a critical threshold. This is expected to help protect livestock assets and stabilize incomes and consumption in arid and semi-arid regions (Mude et al. 2011; Jensen et al. 2024). The core innovation is the shift from indemnity-based insurance models to index-based contracts. This allows providers to deliver fast, objective, and scalable insurance at low transaction costs, better suited to settings with limited financial infrastructure.

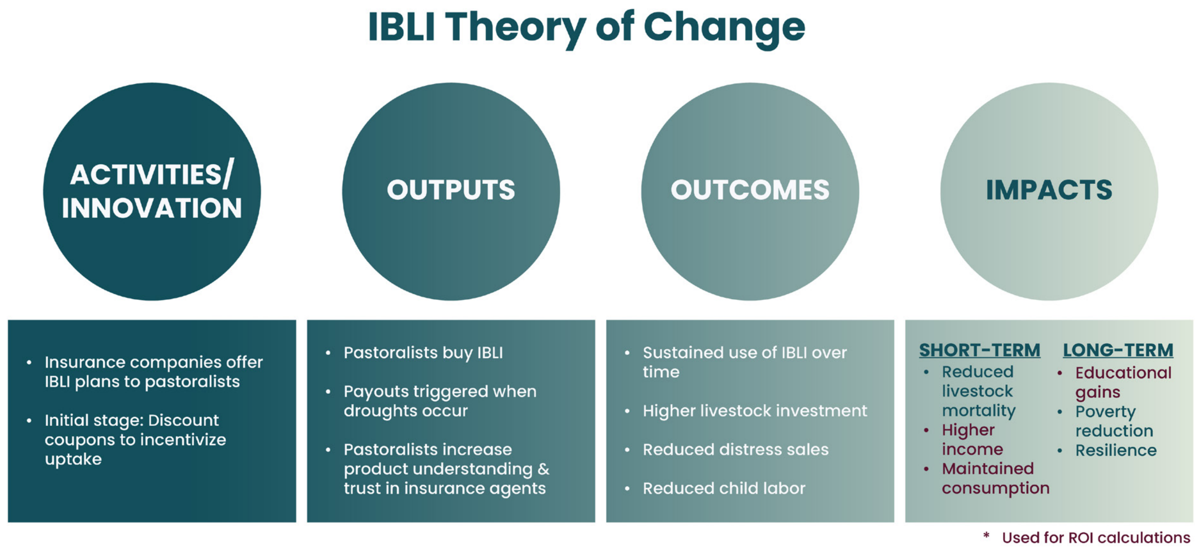
IBLI originated in 2007 as a research partnership between ILRI, Cornell University, and University of California—Davis. Following several years of research, product design, and stakeholder engagement, the first IBLI policy was launched in Marsabit County, Kenya, in 2010. IBLI then evolved through successive phases — from early micro-level commercial models to meso- and macro-level public-private and government-led programs. These laid the foundation for large-scale public-private partnerships (PPP) such as the Kenya Livestock Insurance Program (KLIP), Satellite Index Insurance for Pastoralists in Ethiopia (SIIPE), and the regional World Bank–supported De-Risking, Inclusion, and Value Enhancement of Pastoral Economies (DRIVE) program. While detailed data on private sector costs and investments into scaling are unavailable, private insurers, reinsurers, and distribution partners appear to have played a pivotal role in underwriting risk, refining index products, testing commercial viability, extending market reach, and supporting the transition from donor-supported pilots to government-backed scaling models.

Estimates of the costs of developing and disseminating IBLI were obtained from ILRI. These include expenditures for research, product design, pilot testing, extension, and delivery support between 2010 and 2025. Using numbers provided by ILRI, costs on development and dissemination appear to have been approximately USD 14 million during 2010-2021 (or USD 17.7 million if the period is extended to 2025).

The product was delivered to households by insurance agents, initially at discounted rates to incentivize uptake. The indemnity was calculated as a fraction of the total sum insured, corresponding to the estimated cost of keeping one total livestock unit (TLU) alive (Jensen et al 2024), so that payouts were proportional to the severity of the forage deficit. Jensen et al. (2024, p. 49) estimate that a total of 43,931 policies were sold in Kenya and Ethiopia between 2010 and 2020.

As the theory of change described in Figure 2 indicates, the primary intent was to protect against catastrophic herd losses and stabilize consumption during drought years. Impact assessments found that insurance coverage also influenced household behavior and welfare outcomes — reducing precautionary livestock hoarding, enabling investment in productivity, and, in some cases, increasing children's school attendance and educational attainment.

Figure 2: IBLI Theory of Change



3.1.1 *IBLI ROI Estimation*

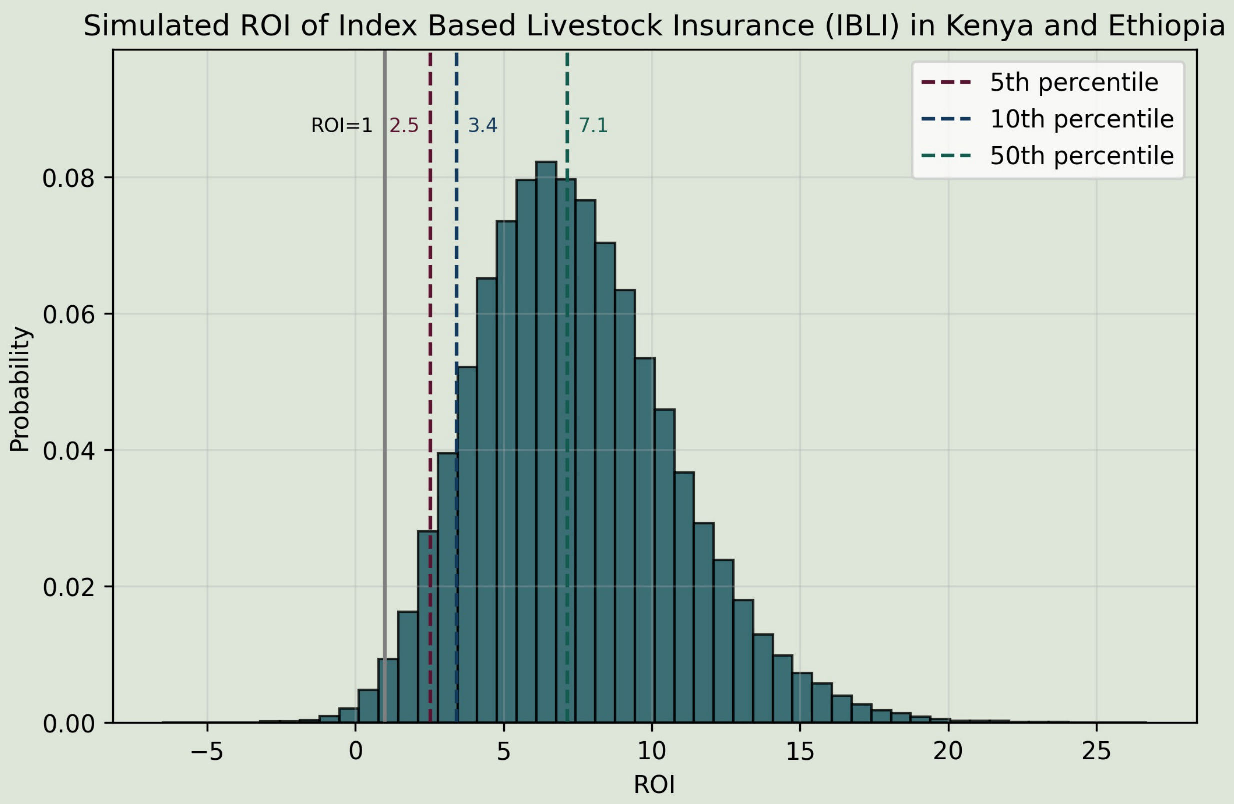
To estimate the ROI for IBLI, the consultant used the number of households that purchased IBLI at least once over the period 2010-2021 (as documented in Jensen et al. 2024), and the estimated increase in lifetime earnings and short-term income gains to first estimate the benefits of the innovation (as reported in Barrett et al. 2024). It was necessary to acknowledge the uncertainty in these estimates for the following reasons. Some households may have purchased IBLI multiple times, and so benefited more from it. However, since it is not clear how many purchases each household made, inferring the exact reach of IBLI from the number of policies sold necessarily involved assumptions. Barrett et al.'s estimates of the increases in schooling attainment needed to be translated into economic returns. And finally, we incorporate the uncertainty driven by the two alternative estimates of the short-term income gains from holding IBLI policies. Our sensitivity analysis propagates the uncertainty around the estimates into the ROI estimates.

Annex 2.1 describes the calculations involved in estimating the ROI. Figure 3 shows the distribution of the simulated ROI estimates and gives a probabilistic interpretation of the ROI into IBLI in Kenya and Ethiopia.

Subject to the assumptions in this simulation, we estimate that there is a 99% chance that the investments into IBLI were fully recovered through the development and adoption of the product in these two countries. We also estimate that there is a 95% chance that every dollar invested led to benefits worth 2.5 dollars and above, and a 90% chance that they led to benefits worth 3.4 dollars and above.

In Figure 3, the median of the distribution is 7.1, indicating that we estimate a 50% chance that a dollar invested in IBLI development and dissemination yielded benefits worth 7.1 dollars.

Figure 3: Simulated ROI of Index-Based Livestock Insurance (IBLI) in Kenya and Ethiopia



3.2 Axial Flow Pumps in Bangladesh

The axial flow pump (AFP) is a mechanical irrigation technology adapted for shallow water conditions. Compared to traditional centrifugal pumps, AFPs offer high-efficiency water delivery with lower fuel use and operating costs (Krupnik et al. 2015; Brown et al. 2024), enabling small-scale irrigation service providers (ISPs) to reach more farmers in critical dry-seasons.

Although the first prototypes of AFPs were developed at the end of the 18th century (Stepanoff 1957), there have since been additional developments to improve their performance (Miyake et al 1987, Nagahara et al. 2013). They were introduced into Bangladesh under the USAID-funded CSISA-MI (Cereal Systems Initiative for South Asia – Mechanization and Irrigation) project, led by CIMMYT in partnership with iDE. Public R&D and demonstration de-risked the technology and catalyzed its commercial production. CIMMYT research supported the promotion of this innovation and the engagement of the private sector.

Based on data provided by CIMMYT, it is estimated that the CSISA–Mechanization and Irrigation (CSISA–MI) project cost approximately USD 4.87 million over the six-year period between 2013 and 2018. This includes spending on public R&D, testing, and demonstration activities.

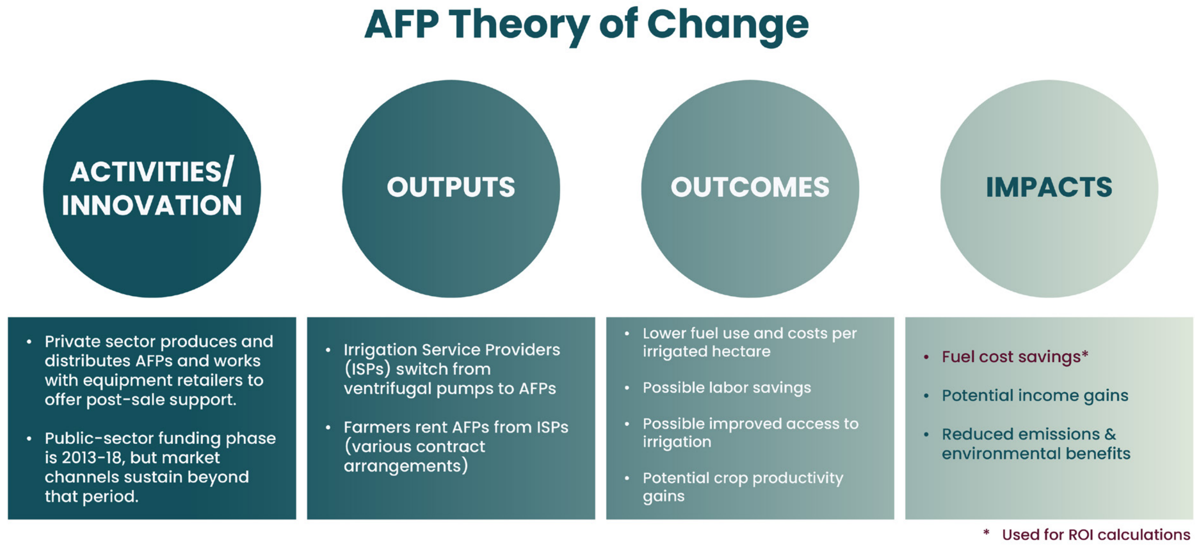
The dissemination of AFPs in Bangladesh built on CSISA-supported research that showed that prototype AFPs are more efficient than alternatives for many applications in southern Bangladesh. Based on engineering field trials, Krupnik et al. (2015) estimate that farmers may save between USD 10 and USD 37 per hectare per season if they used AFPs rather than centrifugal pumps to irrigate wheat, maize, or boro rice.

This was part of a broader initiative to build public-private partnerships to promote AFPs and train farmers to use them, enabling them to establish irrigation service businesses.

The private sector played an important role in distributing AFPs to Bangladeshi farm equipment retailers and provided after-sales support, who in turn sold them to input service providers (ISPs). Presumably this reduced ISPs' irrigation costs, and they served more farmers. Data from the Bangladesh Income and Household Survey (BIHS) show that the number of households that reported irrigating their fields with AFPs increased from 0.5% in 2015 to 12.6% in 2023.

Figure 4 presents the theory of change, demonstrating how AFPs may have improved agricultural and environmental outcomes. It is believed that the use of AFPs improved dry season cropping intensity. It is also possible that the increased fuel efficiency improved profitability for ISPs, raised farm productivity, and contributed to lower emissions through reduced fuel consumption.

Figure 4: AFP Theory of Change



3.2.1 ROI Estimation for Axial Flow Pumps

The ROI calculations for AFPs required an estimate of the cropped area in Bangladesh irrigated with AFPs as an indicator of reach for the years between 2015 and 2024. In the absence of information for non-BIHS years, aggregate statistics from 2023 on the area under different crops irrigated with AFPs (obtained from SPIA, based on the BIHS 2023) were used to infer reach for the three BIHS years and then interpolated to other years. Our sensitivity analysis attempts to account for the arbitrariness of these assumptions. We are also constrained in that the estimated fuel cost savings are derived from engineering field trials rather than field experiments where ISPs operate the AFPs on farmers' fields, subject to real-world conditions. Given this potential overestimation of the AFP impacts, the per-hectare benefits were scaled by 0.465 corresponding to the observed ratio of actual (on-farm) to potential (experimental) yield benefits from irrigated rice in Bangladesh, as reported in the Global Yield Gap Atlas.[5] The trials

[5] https://www.yieldgap.org/

also estimate different savings depending on crop, lift height and high or low-water use, and these had to be averaged to estimate the savings for actual farmers. Our sensitivity analysis incorporates the empirical measurement error around each estimate.

We also allow for a standard deviation equal to 5% of the estimated USD 4.8 million spent on research and development, testing and demonstration. Details of the ROI calculations are described in Annex 2.2.

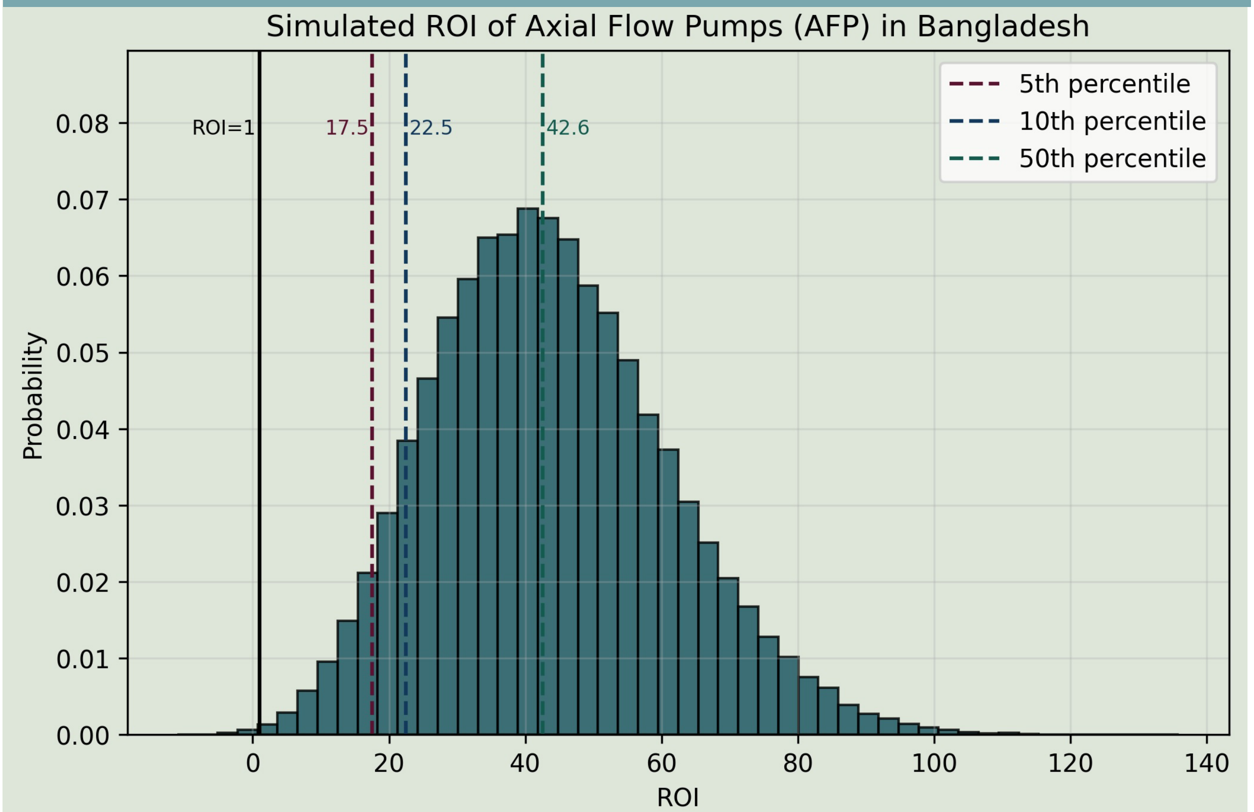
Figure 5 shows the results of the sensitivity analysis. Again, the distribution of the simulated ROI estimates gives a probabilistic interpretation of the ROI into AFP in Bangladesh. Given the level of uncertainty in the available information for the estimation, the distribution of AFP ROI is wide and suggest high returns to investments.

We estimate that there is a 99% chance that the investments into AFP were fully recovered through the promotion and adoption of the innovation in Bangladesh. We also estimate that there is a 95% chance that every dollar invested led to benefits worth USD 17.5 and above, and a 90% chance that they led to benefits worth USD 22.3 and above.

In Figure 5, the median of the distribution is 42.5, indicating a 50% chance that a dollar invested in by CGIAR in the promotion and dissemination yielded benefits worth USD 42.5.

Note that costs incurred by the private sector are not included in the calculation, and the ROI may have been lower for society as a whole. However, it is also likely that our calculation understates the benefits to the private sector investors in AFPs, since this was presumably a

Figure 5: Simulated ROI of AFPs in Bangladesh



3.3 Flood-Tolerant Rice Varieties in Bangladesh

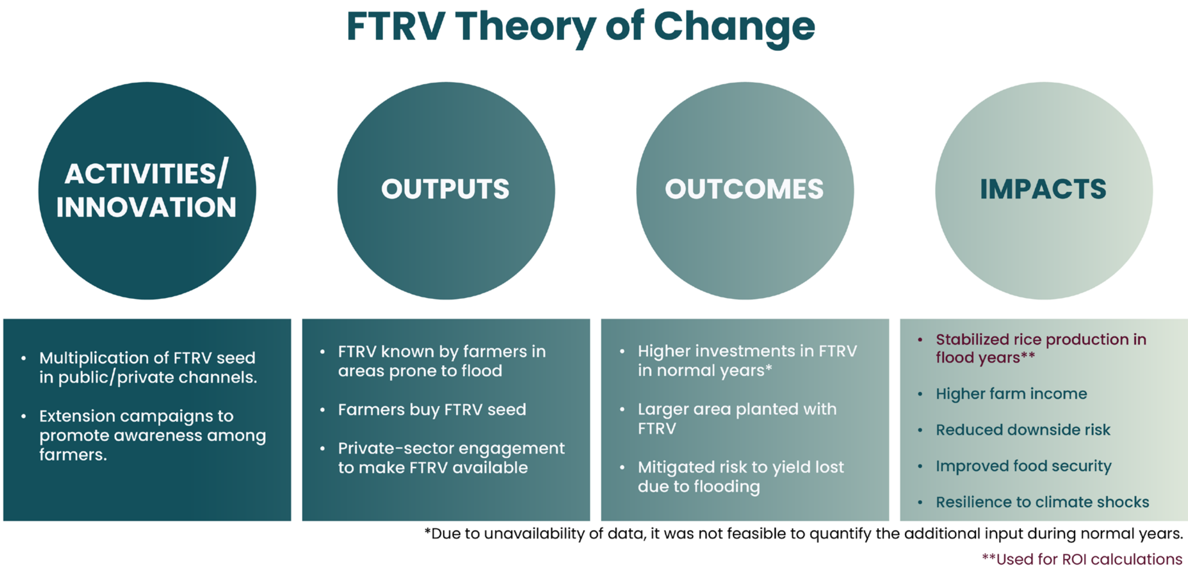
Research by the International Rice Research Institute (IRRI) and partners has led to the development of flood-tolerant rice varieties (FTRVs), notably those carrying the Sub1 gene, such as the Swarna-Sub1 and BRRI dhan varieties (Xu et al. 2006; Mackill et al. 2012). These varieties were bred so that rice plants grown from these seeds could survive complete submergence for up to two weeks. This "insurance in the seed" was meant to protect yields in flood-prone ecosystems that were previously highly vulnerable (Anumalla et al. 2025). Furthermore, the risk reduction associated with the production protection in bad years, could incentivize crowding in investments in other inputs, extending positive yield effects during normal years with no flood events (Emerick et. al 2016).

The foundational research by IRRI was complemented by varietal release through the Bangladesh Rice Research Institute (BRRI), followed by systematic efforts to multiply and distribute seed through both public and private channels. Parallel extension campaigns by Bangladesh's Department of Agricultural Extension in partnership with IRRI promoted farmer awareness (Ismail et al. 2013). Using data provided by IRRI, it is estimated that about USD 5.7 million (in 2022 dollars) were spent on the development of FTRVs between 1993 and 2025.

There are multiple sources of information about the adoption of FTRVs in Bangladesh, based on seed production and distribution data, and household-level adoption data from different surveys. However, the exact range of flood conditions under which FTRVs would deliver yield protection was only characterized through more recent agronomic studies. These find that FTRVs confer benefits during shorter and shallower floods than previously believed — cases in which the submergence is long enough to threaten conventional varieties, but short enough for Sub1 plants to recover once waters recede (Dar et al. 2013; Michler et al. 2025). Using remote sensing data, it was identified that floods of this particular depth and duration had occurred 16 times (or in only 1.25% of the possible observations) over the 20-year period between 2002 and 2021, across the 64 districts of Bangladesh. Putting this together with the reach of FTRVs, it is estimated that somewhere between 49,000 and 102,000 hectares of land under rice was planted with FTRVs and experienced a flood of the type where yield protection could be expected.

The theory of change (Figure 6) links genetic flood tolerance to reduced crop loss during a flood, which in turn was expected to stabilize farm income and foster resilience for farm households. Likewise, moral hazard investments in complementary inputs are expected to increase, which may lead to higher yields and income gains. Michler et al. (2025) report estimates for improvements in the remotely sensed enhanced vegetation index (EVI), writing that a moderate-flood area planted with FTRVs has a 0.0001147 higher EVI than a moderate-flood area where FTRV were not planted. However, estimating income impacts requires a translation to improved yield. A simple regression using data from the yearbooks of agricultural statistics in Bangladesh provides an estimate that a 0.01 increase in EVI would correspond to approximately 7.4 kg/hectare additional yield. Put together, this suggests that area under FTRVs exposed to moderate floods had an estimated 37,104 tons higher yield, corresponding to an income gain of USD 9,197,103.

Figure 6: FTRV Theory of Change



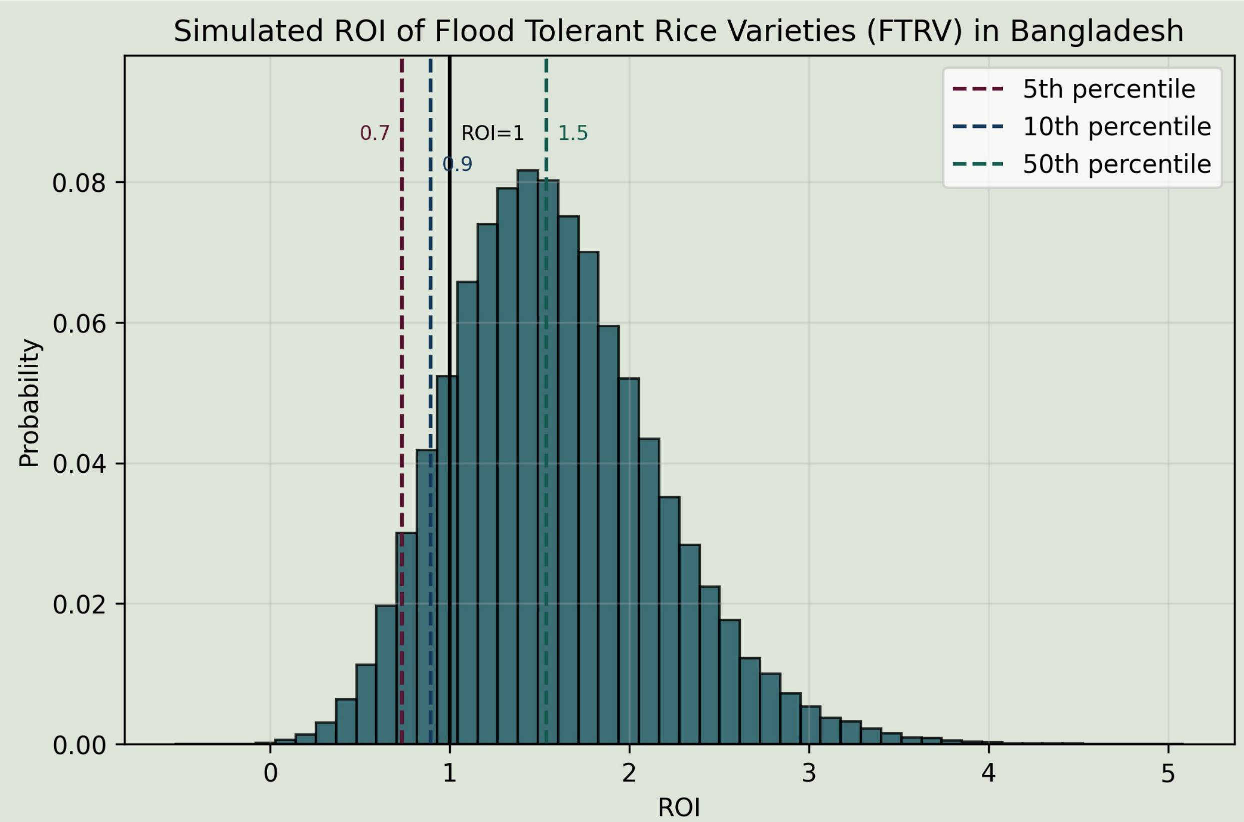
3.3.1 ROI Estimation for Flood-Tolerant Rice Varieties

Details of the ROI calculations are described in Annex 2.3. Here we note the sources of uncertainty that we account for in the sensitivity analysis. These include the stochastic nature of the benefits of FTRVs, the conversion of the empirical estimated effects on the remotely sensed vegetation indices to impacts in terms of increased rice yield, and the different estimates of adoption based on different sources.

Results for the sensitivity analysis of the FTRV ROI are presented in Figure 7. We estimate that there is a 95% chance that every dollar invested led to benefits worth at least 70 cents, and a 90% chance that they led to benefits worth at least 90 cents. Our estimated likelihood that the investment into FTRVs was fully recovered (i.e. that a dollar invested generated a return of 1 dollar) is 88%.

In Figure 7, the median of the distribution is 1.5, indicating a 50% chance that a dollar invested in FTRV development and dissemination yielded benefits worth 1.5 dollars.

Figure 7: Simulated ROI of FTRVs in Bangladesh



3.4 Drought-Tolerant Maize in Ethiopia

Drought-Tolerant (DT) maize varieties are designed to enhance yield stability under rainfall variability. They were developed by CIMMYT and national partners through the Drought-Tolerant Maize for Africa (DTMA) and Stress Tolerant Maize for Africa (STMA) initiatives. Ethiopia has been a major hub for DTM breeding, testing, and adoption, with CGIAR and the Ethiopian Institute of Agricultural Research (EIAR) collaboration spanning over two decades.

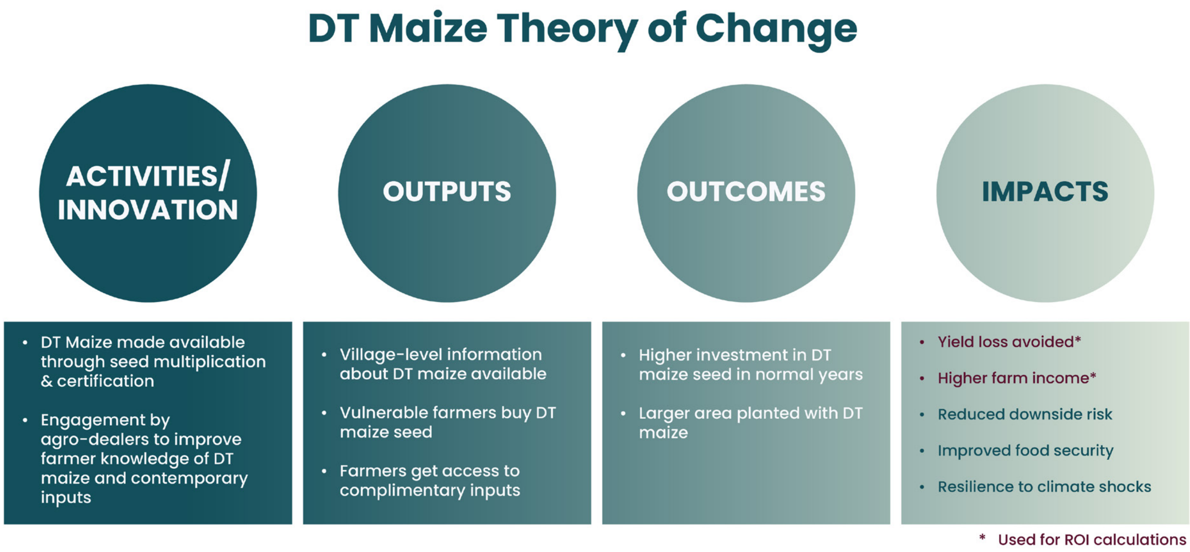
Based on information provided by CIMMYT about the budgets of past DT maize research and dissemination through its DTMA, STMA and related initiatives, it is estimated that about USD 21 million (in 2022 dollars) were spent on research costs for DT maize in Ethiopia, between 2006 and 2024.

Tolerance to drought is present in hybrid varieties (e.g., BH 661, MH-130/140, BH 546/547) and Open Pollinated Varieties (OPV), such as the Melkasa series and Gibe-2 available in Ethiopia. These seed varieties are tailored to altitude and rainfall zones (Fisher et al. 2015). In good seasons these varieties provide very similar or slightly lower yield than other maize varieties, but they help avoid crop loss in a mid-season drought. However, and similar to the case of FTRV, DTM can incentivize crowding in input use due to its risk reduction during years with no drought events (Boucher et. al, 2024)

CGIAR and national investments in breeding and seed-system strengthening led to the release and diffusion of drought-tolerant varieties. As we show in Figure 8, DT maize entered the seed system through seed multiplication and certification, and then agrodealers both provided complementary inputs and spread information of DT maize among farmers, possibly leading to village-level awareness and uptake. DNA fingerprinting data of farmers' maize crops in the SPIA-co-led Ethiopia Socioeconomic Panel Survey (Alemu et al. 2024) suggests that in 2021 about 14% of the area under maize in Ethiopia was planted with a drought-tolerant variety, a substantial increase from the 0.01% estimated in 2009 by the DIIVA study (Fisher et al. 2015).

It was expected that by planting DT maize, farmers would have stable yields, higher farm income and improved food security. Rigorous estimates of the impacts of planting DT maize come from an RCT conducted with Mozambique and Tanzanian maize farmers. Using two different estimation methods, they estimate the benefit of growing DT maize when faced with a mid-season drought to be in the range of 46 to 189 kg/hectares in the same season as the drought, and 117 to 145 kg/ha in the following season. During a normal year, the yield benefits of growing DT maize relative to regular varieties range from 34 to 76 kg/ha. These estimates did consider the effects of crowding in input during normal years on maize yields (Boucher et. al 2024).

Figure 8: DT Maize Theory of Change



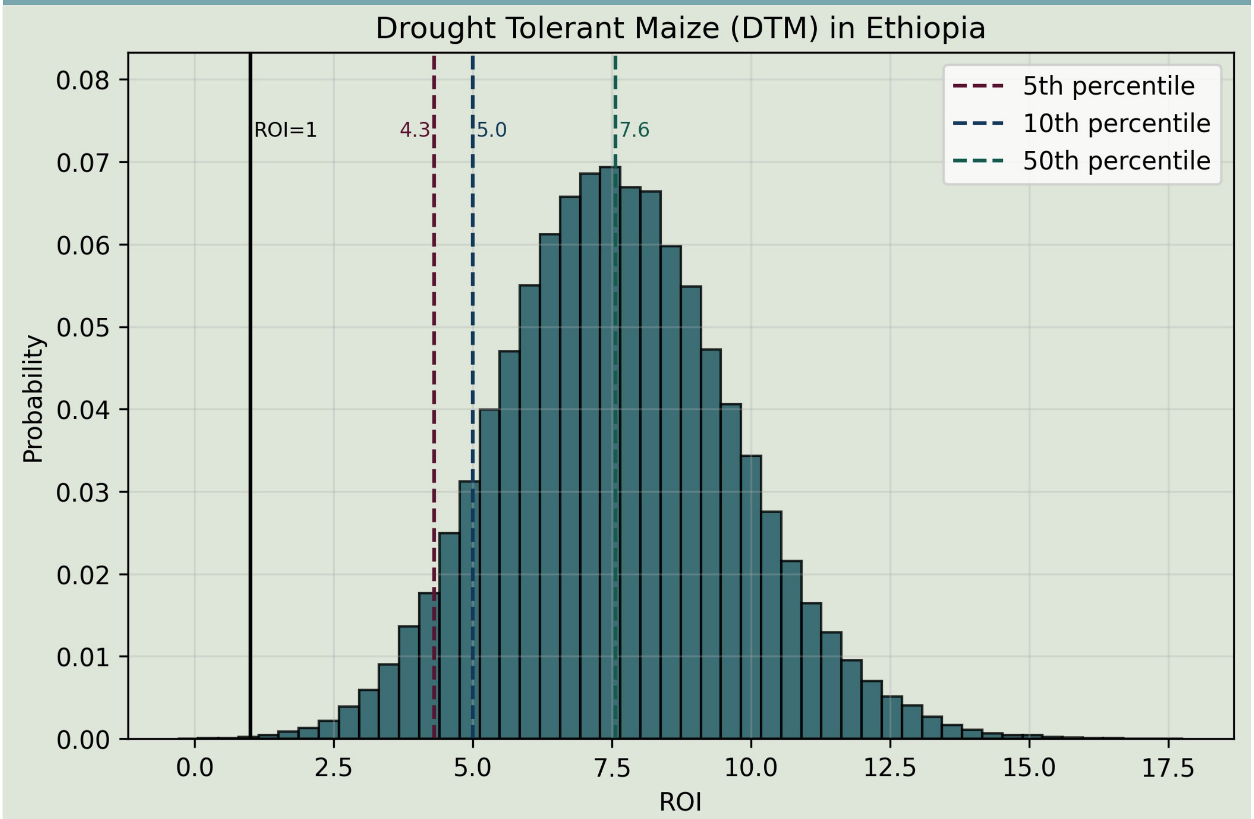
3.4.1 ROI Estimation for DT Maize

Details of the ROI calculations are described in Annex 2.4. Significant sources of uncertainty arise from the different estimates for the impacts that were obtained by different estimation methods, and the fact that the impacts were estimated in Tanzania and Mozambique whereas in Ethiopia maize yields are on average 10 times higher. We allow for the fact that the benefits of DT maize are unlikely to translate in a linear fashion and instead assume that the effects diminish at higher yield levels. However, our sensitivity analysis attempts to account for the arbitrariness of our choice of scaling parameter.

Results for the sensitivity analysis of the DT maize ROI are presented in Figure 9. The results again show high returns on investment of CGIAR innovations. We estimate that there is almost a 100% chance that the investments into DTM were fully recovered through the development and adoption of the innovation in Ethiopia, that there is a 95% chance that every dollar invested led to benefits worth 4.3 dollars and above, and a 90% chance that they led to benefits worth 5.0 dollars and above.

In Figure 9, the median of the distribution is 7.6, indicating a 50% chance that a dollar invested in DTM development and dissemination yielded benefits worth 7.5 dollars.

Figure 9: Simulated ROI of DT maize in Ethiopia



3.5 Who Benefited from the Positive Returns of the Innovations?

As stated above, ROI estimations are limited in their ability to determine the distribution of positive outcomes across different domains. However, it is important to explore ways to explain who might be the populations that may have benefit from the uptake of these successful CGIAR innovations. We first estimated correlates of adoption of the four selected CGIAR innovations using available data on the reach of CGIAR innovations in different priority countries. Then we conducted a literature review to bring evidence on heterogeneous treatment effects that these innovations may have experienced in different regions where CGIAR operates.

We found that the adoption of the four selected innovations appears to be equally accessible for male- and female-headed households (Table 2). However, there is some evidence in the literature of gender differentiated impacts of one of these innovations. Timu et. al (2023) found that IBLI payouts significantly increased food expenditures per adult equivalent among femal-headed households.

Table 2: Correlates of adoption of select CGIAR innovations

Innovation	Household Size	Female Household Size	Education Household Head	Age of Household Head	Wealth Medium Tercile	Wealth Upper Tercile	Total Farm Area	Livestock Ownership
IBLI	n.s.	n.s.	-0.063***	n.s.	n.s.	0.035*	0.016**	0.021***
AFPs	0.009*	n.s.	n.s.	-1.473***	n.s.	n.s.	0.089***	n.s.
FTRVs	n.s.	n.s.	n.s.	n.s.	0.051*	0.089**	n.s.	n.s.
DT Maize	n.s.	n.s.	-0.022*	-0.802**	0.031**	0.042***	n.s.	n.s.

Evidence from Kenya, Bangladesh and Ethiopia indicates that less wealthy households may be less likely to adopt the four CGIAR innovations (Table 2). However, several studies have reported significant positive impacts of these innovations on poverty, food security and productivity and among more vulnerable target groups. In Tanzania, the adoption of DTM generated higher productivity benefits among less wealthier farmers (Gebre et al. 2021), while in India, the adoption of STRV benefited differentially socially disadvantaged groups that have lower consumption expenditures and smaller landholdings (Dar et al. 2013). Likewise, the uptake of IBLI is associated with a reduced child labor among households with low savings and small herd (Son 2025) and with helping the poor to escape the poverty traps (Noritomo & Takahashi 2020).

Younger household heads seem to be less likely to adopt AFPs in Bangladesh and DT maize in Ethiopia. Likewise, the adoption of IBLI and DT maize is more likely to happen among less educated household heads (Table 2). Furthermore, impacts generated by STRV and DTM in India and Nigeria respectively were reported to across locations and stress conditions faced by these crops (Martey et al 2020; Wossen et al 2017).

4. Takeaways and Lessons Learned

In this document we report on selected ROI-Feasible CGIAR innovations — in other words, innovation cases where it has been possible to combine data on their widespread adoption, estimates of the impacts on farmer outcomes, and costs to CGIAR. As can be seen, these estimations of ROI require us to make assumptions at various points where particular information may be unknowable or missing, and this makes the estimates inherently uncertain. The sensitivity analysis accompanying each estimation attempts to communicate this uncertainty.

The study finds that all four innovations likely generate positive returns. Three of these four innovations qualify as “big wins” of the system, which are rare in Agricultural Research for

Development (AR4D), but can help make the business case for investment in CGIAR and justify support from donors.

As we highlight in the document, ROI estimation is not always appropriate for all CGIAR innovations. To the extent that AR4D makes multi-faceted contributions to the Sustainable Development Goals (SDG) and can support progress toward multiple objectives, the ROI calculation becomes complex. The returns on investment in policy influence activities or creation and maintenance of global public goods may not be amenable to quantification.

Even when it is appropriate, the estimation is only feasible if it is possible to access reliable information on and estimates of the costs of developing the innovation, its adoption by beneficiaries, and the impacts of adoption on the outcomes of interest. Partial availability or unavailability of any of these pieces of information would make it infeasible to estimate the ROI. As has been noted above, although SPIA identified 14 showcase successes, only four were ROI-Feasible in the end.

While adoption estimates were available for the majority of the selected innovations, there were gaps in rigorous impact estimates of some innovations, as well as some limitations for calculating the level of investment on the development and dissemination of other innovations. Moving forward, CGIAR centers and programs should develop a robust system to track investments and costs and link them to specific innovations, group of innovations and programs.

It's also important to note that focusing only on ROI as a measure of impact will necessarily miss some valuable and important innovations and will fall short in documenting the contributions of CGIAR research to each of the five impact areas. SPIA advises that impact assessment for CGIAR acknowledge that returns to investment in AR4D are likely to be highly skewed, and that the large returns to some "big win" investments alone can exceed the total investment in the system. To the extent that the big wins can only be identified after the fact, this can be a case for investing more broadly. However, as a learning organization, CGIAR can also benefit from insights about what caused seemingly promising innovations to fail. While it is difficult to predict big wins at the moment of investment, they can be sufficient to justify (ex-post) the entire investment in the system, potentially over many years. Only quantifying the benefits of a few innovations will provide a conservative (lower-bound) estimate under relatively weak assumptions. As such it explicitly acknowledges that there are likely also many smaller wins and wins for which benefits can be harder to quantify.

Finally, it is important to highlight that the four cases examined here are different along multiple dimensions. The countries where the innovations are being studied differ in their stage in the path to development, their institutions and infrastructure. The same ROI per dollar invested may create much larger positive benefit in countries with lower standards of living, where households have fewer alternatives to agriculture. Also, the economic gains from technologies that mitigate risk (three of the four cases we study) are triggered at exactly the time when households are especially vulnerable. The benefits of such technologies on household welfare likely exceed the average return we have estimated above. For these reasons, we caution against comparisons of the ROI estimates across the four cases.

References

Alemu, S., Ambel, A., Khanal, A., Kosmowski, F., Stevenson, J., Taye, L., Tsegay, A., Macours, K. (2024). SPIA Ethiopia Report 2024: Building Resilience to Shocks. Rome: Standing Panel on Impact Assessment (SPIA).

Alston JM, Norton G, Pardey PG. 1995. Science Under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting. Ithaca, NY: Cornell Univ. Press

Anumalla, M., Singh, U. M., Verma, G., Verma, R. P., Dixit, S., Venkateshwarlu, C., & Kumar, A. (2025). Future flooding-tolerant rice germplasm: Resilience afforded beyond SUB1A gene. The Plant Genome, 18(1), e70040. https://doi.org/10.1002/tpg2.70040

Araus JL, Serret MD, Edmeades GO. (2012). Phenotyping maize for adaptation to drought. Front Physiol. 2012 Aug 10;3:305. doi: 10.3389/fphys.2012.00305. PMID: 22934056; PMCID: PMC3429076.

Bairagi S, Bhandari H, Das SK, Mohanty S. (2021). Flood-tolerant rice improves climate resilience, profitability, and household consumption in Bangladesh. Food Policy 105:102183

Barrett, Christopher B., Nathaniel Jensen, Karlijn Morsink, Yuma Noritomo, Hyuk Harry Son, Rupsha Banerjee, Nils Teufel. (2025). Long-run Effects of Catastrophic Drought Insurance. Draft Paper.

Boucher, S. R., Carter, M. R., Flatnes, J. E., Lybbert, T. J., Malacarne, J., Marenya, P. and Paul, L. (2024). Bundling stress tolerant seeds and insurance for more resilient and productive small-scale agriculture. The Economic Journal, 134 (August), 2321–2350 https://doi.org/10.1093/ej/ueae012.

Brown, B., Krupnik, T., Murshed, S., et al. (2024). Irrigation in Bangladesh: Opportunities and Constraints. Unpublished report.

Chantarat, S., Mude, A. G., Barrett, C. B., & Carter, M. R. (2013). Designing Index-Based Livestock Insurance for managing asset risk in Northern Kenya. Journal of Risk and Insurance, 80(1), 205–237. https://doi.org/10.1111/j.1539-6975.2012.01463.x

CIMMYT (n.d.). Drought-Tolerant Maize for Africa (DTMA). (Accessed, October 1, 2025) https://www.cimmyt.org/projects/drought-tolerant-maize-for-africa-dtma/?utm_source=chatgpt.com

Dar MH, de Janvry A, Emerick K, Raitzer D, Sadoulet E. (2013). Flood-tolerant rice reduces yield variability and raises expected yield, differentially benefiting socially disadvantaged groups. Scientific Reports 3:3315.

Emerick, K., de Janvry, A., Sadoulet, E., & Dar, M. H. (2016). Technological innovations, downside risk, and the modernization of agriculture. American Economic Review, 106(6), 1537–1561.

Evans, D. K., & Yuan, F. (2019). The economic returns to interventions that increase learning. World Bank Policy Research Working Paper No. 8752.

https://doi.org/10.1596/1813-9450-8752

Fisher, M., Abate, T., Lunduka, R., Asnake, W., Alemayehu, Y. and Madulu, R. B. (2015). Drought-Tolerant Maize for farmer adaptation to drought in sub-Saharan Africa: determinants of adoption in Eastern and Southern Africa. Climatic Change 133(2):283–299.

Fuglie K. 2018. R&D capital, R&D spillovers, and productivity growth in world agriculture. Appl. Econ. Perspective. Policy 40(3):421–44.

Gebre, G. G., Mawia, H., Makumbi, D., & Rahut, D. B. (2021). The impact of adopting stress-tolerant maize on maize yield, maize income, and food security in Tanzania. Food and Energy Security, 10, e313. https://doi.org/10.1002/fes3.313

Gollin D, Udry C. 2021. Heterogeneity, measurement error, and misallocation: evidence from African agriculture. J. Political Econ. 129(1). https://doi.org/10.1086/711369.

Griliches Z. 1957. Hybrid corn: an exploration in the economics of technological change. Econometrica 25(4):501–22.

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) (2023). Analyses of socio-economic and environmental effects of agroecological practices: A methodological guidance.

Hurley TM, Pardey PG, Rao X, Andrade RS. 2016. Returns to food and agricultural R&D investments worldwide, 1958–2015. Brief., InSTePP, St. Paul, MN.

Islam, Z., Hardy, B., & Siddique, M. A. (2018). Adoption and diffusion of Sub1 rice varieties in Bangladesh. International Rice Research Institute (IRRI) Reports.

Ismail, A. M., Singh, U. S., Singh, S., Dar, M. H., & Mackill, D. J. (2013). The contribution of submergence-tolerant (Sub1) rice varieties to food security in flood-prone rainfed lowland areas in Asia. Field Crops Research, 152, 83–93.

Janzen, S.A., and M.R. Carter. (2019). After the drought: The impact of microinsurance on consumption smoothing and asset protection. American Journal of Agricultural Economics 101:651–671.

Jensen, N. D., Barrett, C. B., & Mude, A. G. (2017). Cash transfers and index insurance: A comparative impact analysis from northern Kenya. Journal of Development Economics, 129, 14–28. https://doi.org/10.1016/j.jdeveco.2017.08.002

Jensen, N. D., C. B. Barrett, and A. G. Mude. (2016). Index Insurance Quality and Basis Risk: Evidence from Northern Kenya. American Journal of Agricultural Economics, 98: 1450–69.

Jensen, Nathaniel D., Francesco P. Fava, Andrew G. Mude, and Christopher B. Barrett et al. (2024). Escaping Poverty Traps and Unlocking Prosperity in the Face of Climate Risk: Lessons from Index-Based Livestock Insurance. Cambridge: Cambridge University Press. DOI: 10.1017/9781009558280

Kostandini, G., Roberto, L. R. and Abdoulaye, T. (2013). Potential impacts of increasing average yields and reducing maize yield variability in Africa. Food Policy 43(December): 213–226.

Krishna, Vijesh V., Maximina A. Lantican, B.M. Prasanna, Kevin Pixley, Tahirou Abdoulaye, Abebe Menkir, Marianne Bänziger, Olaf Erenstein. (2023). Impact of CGIAR maize germplasm in Sub-Saharan Africa. Field Crops Research, Volume 290, 2023, 108756, https://doi.org/10.1016/j.fcr.2022.108756

Krupnik, T. J., et al. (2015). Energetic, Hydraulic and Economic Efficiency of Axial Flow and Centrifugal Pumps for Surface Water Irrigation in Bangladesh. Journal of Irrigation and Drainage Engineering (2015). DOI: 10.1002/ird.1940

Lunduka, R., Mateva, K. I., Magorokosho, C. and Manjeru, P. (2019). Impact of adoption of Drought-Tolerant Maize varieties on total maize production in South Eastern Zimbabwe. Climate and Development 11(1): 35–46.

Mackill, D. J., Ismail, A. M., Singh, U. S., Labios, R. V., & Paris, T. R. (2012). Development and rapid adoption of submergence-tolerant (Sub1) rice varieties. Advances in Agronomy, 115, 299–352.

Martey, E., Etwire, P. M. and Kuwornu, J. K. (2020). Economic impacts of smallholder farmers' adoption of Drought-Tolerant Maize varieties. Land Use Policy 94(May): 104524.

McEwan, P. J. (2015). Improving learning in primary schools of developing countries: A meta-analysis of randomized experiments. Review of Educational Research, 85(3), 353–394. https://doi.org/10.3102/0034654314553127

McIntosh, C., & Sarris, A. (2022). Returns on Investment in Rural Development: A Meta-Analysis. World Bank Working Paper.

McMillen MS, Mahama AA, Sibiya J, Lübberstedt T, Suza WP. (2022). Improving drought tolerance in maize: Tools and techniques. Front Genet. 2022 Oct 28;13:1001001. doi: 10.3389/fgene.2022.1001001. PMID: 36386797; PMCID: PMC9651916.

Michler, Jeffrey, Dewan Abdullah Al Rafi, Jonathan Giezendanner, Anna Josephson, Valerien O. Pede, and Elizabeth Tellman. (2025). Impact Evaluations in Data Poor Settings: The Case of Stress-Tolerant Rice Varieties in Bangladesh. Draft Paper.

Mincer, J. (1974). Schooling, experience, and earnings. New York: Columbia University Press for the National Bureau of Economic Research.

Mottaleb, Khondoker A. (2018). Perception and adoption of a new agricultural technology: Evidence from a developing country. Technology in Society, Volume 55, 2018, Pages 126-135. https://doi.org/10.1016/j.techsoc.2018.07.007.

Mude, A., Chantarat, S., Barrett, C.B., Carter, M., Ikegami, M. and McPeak, J. 2011. Insuring against drought-related livestock mortality: Piloting Index-Based Livestock Insurance in northern Kenya.IN: International Livestock Research Institute. 2011. Towards priority actions for market development for African farmers. Proceedings of an international conference, Nairobi, Kenya, 13-15 May 2009. Nairobi: AGRA and ILRI: 175-188. https://hdl.handle.net/10568/16493

Noritomo, Y., & Takahashi, K. (2020). Can Insurance Payouts Prevent a Poverty Trap? Evidence from Randomised Experiments in Northern Kenya. The Journal of Development Studies, 56(11), 2079–2096. https://doi.org/10.1080/00220388.2020.1736281

Paul, L.A. (2021). 'Heterogeneous and conditional returns from DT maize for farmers in Southern Africa', European Revie w of Agricultural Economics, vol. 48(5), pp. 1224–48.

Psacharopoulos, G., & Patrinos, H. A. (2018). Returns to investment in education: A decennial review of the global literature. World Bank Policy Research Working Paper No. 8402. https://doi.org/10.1596/1813-9450-8402

Raitzer DA, Kelley TG. 2008. Assessing the contribution of impact assessment to donor decisions for international agricultural research. Res. Eval. 17:187–99

Rao X, Hurley TM, Pardey PG. 2020. Recalibrating the reported returns to agricultural R&D: What if we all heeded Griliches? Aust. J. Agric. Resource. Economics. 64(3):977–1001

Sakketa, Tekalign Gutu, Dan Maggio, John McPeak. (2025). The protective role of index insurance in the experience of violent conflict: Evidence from Ethiopia, Journal of Development Economics, Volume 174, 2025, 103445, https://doi.org/10.1016/j.jdeveco.2024.103445.

Santos Valle, S., Qureshi, A.S., Islam, M.S., Hossain, M.A, Gathala, M.K., and Krupnik, T.J., 2014. Axial flow pumps can reduce energy use and costs for low-lift surface water irrigation in Bangladesh. Cereal Systems Initiative for South Asia Mechanization and Irrigation (CSISA-MI) Project, Research Report No. 1., Dhaka, Bangladesh: CIMMYT.

Santos, P., & Vallée, D. (2014). Sustainability and Market Dynamics in Irrigation Technology Adoption. IFPRI Discussion Paper.

Shah, T., Bhatt, S., Shah, R. K., & Talati, J. (2008). Groundwater governance through electricity supply management: Assessing an innovative intervention in Gujarat, western India. Volume 95, Issue 11, November 2008, Pages 1233-1242. https://doi.org/10.1016/j.agwat.2008.04.00

Shikuku, K. M., Ochenje, I. (2025). Impact of index insurance on downside income risk: Evidence from northern Kenya. Appl Econ Perspect Policy. 2025;1–29. https://doi.org/10.1002/aepp.13497.

Shively, G. (2012) An Overview of Benefit – Cost Analysis. Purdue University, West Lafayete

Simtowe, Franklin, Emily Amondo, Paswel Marenya, Dil Rahut, Kai Sonder, Olaf Erenstein. (2019). Impacts of Drought-Tolerant Maize varieties on productivity, risk, and resource use: Evidence from Uganda. Land Use Policy, Volume 88, 2019, 104091, https://doi.org/10.1016/j.landusepol.2019.104091.

Singh US, Dar MH, Singh S, Zaidi NW, Bari MA, Mackill DJ, Collard BCY, Singh VN, Singh JP, Reddy JN, Singh RK, Ismail AM. (2013). Field performance, dissemination, impact and tracking of submergence tolerant (Sub1) rice varieties in South Asia. SABRAO Journal of Breeding and Genetics. 2013; 45:112–131.

Singla, S., Ul-Islam, T,. Hassan, F., Monteiro, I., Stevenson, J., Emerick, K. (2025). SPIA Bangladesh Study 2025: Updating the Green Revolution. Rome. Standing Panel on Impact Assessment (SPIA).

Son, Hyuk Harry, Reducing Child Labor Through Risk Management: Short-Term Behavioral Effects of Index Insurance in East Africa. Available at SSRN: https://ssrn.com/abstract=5354091 or http://dx.doi.org/10.2139/ssrn.5354091

Standing Panel on Impact Assessment (SPIA) (2024). SPIA briefing notes: Targeting of Agricultural Technologies, Climate Change Mitigation and Adaptation, Environmental Externalities of Agricultural Intensification, CGIAR Research on Mechanization, SPIA country studies

Tafere, K., C.B. Barrett, E. Lentz. (2019). Insuring well-being? Buyer's remorse and peace of mind effects from insurance. Am. J. Agric. Econ., 101 (3) (2019), pp. 627-650 https://onlinelibrary.wiley.com/doi/pdf/10.1093/ajae/aay087.3

Anne G. Timu, Christopher R. Gustafson, Taro Mieno (2023) The gendered impacts of index-insurance on food-consumption: Evidence from southern Ethiopia, Climate Services, Volume 30, 2023, 100355,

Tiwari, S., Takeshima, H., & Diao, X. (2019). Mechanization and Agricultural Transformation in Bangladesh. IFPRI Discussion Paper 01824.

Walker, T. and J. Alwang (eds.). (2015). Crop Improvement, Adoption, and Impact of Improved Varieties in Food Crops in Sub-Saharan Africa. Wallingford, U.K.: CGIAR-CABI.

Winrock International (2016). CSISA-MI Annual Report. https://csisa.org/wp-content/uploads/sites/2/2014/06/CSISA-MI-Annual-Report-2016.pdf (Accessed, July 2025)

Wossen , T. , Abdoulaye, T., Alene, A., Feleke, S., Menkir, A. and Manyong, V. (2017). Measuring the impacts of adaptation strategies to drought stress: The case of Drought-Tolerant Maize varieties, Journal of Environmental Management , vol. 203, pp. 106–13.

Xu, K., Xu, X., Fukao, T., Canlas, P., Maghirang-Rodriguez, R., Heuer, S., … & Mackill, D. J. (2006). Sub1A is an ethylene-response-factor-like gene that confers submergence tolerance to rice. Nature, 442(7103), 705–708. doi: 10.1038/nature04920.

Yamano, T. (2023). Diffusion of Submergence-Tolerant Rice in South Asia. In: Estudillo, J.P., Kijima, Y., Sonobe, T. (eds) Agricultural Development in Asia and Africa. Emerging-Economy State and International Policy Studies. Springer, Singapore. https://doi.org/10.1007/978-981-19-5542-6_4

Annexes

Annex 1. How the ROI Distributions Were Constructed

	IBLI	AFP	FTRV	DT Maize
Investment costs	2010-2025, N (17.68 million, 5%) [Normally distributed with (mean, std. dev.)]	2013-2018, N (4.87 million, 5%)	1993-2025, N (5.73 million, 5%) (includes IRRI global expenditures and Bangladesh-specific share)	2006-2004, N (20.96 million, 5%) (includes DT Maize research & dissemination programs, e.g. DTMA and STMA)
Impacts	**Short-term:** N(1345, 5%) Simulation randomly draws: 50-50 change of drawing one or the other estimate. **Long-term:** N(3646, 5%) Product of fixed adoption effect and estimated additional adoption years (negative benefits possible)	Crop (rice, maize, wheat, others) shares N (0.038, 5%) distributed, std. dev. 5% (no negative shares set) Fuel cost savings N (21, 5%) from different scenarios (capital/fixed costs, pump prototypes, head type, level of water use). Adjustment factor N (0.465, 0.173) to ensure simulated value <1	Benefits under observed Goldilocks flood conditions. Impacted rice area bounds N (112,674, 92,268) from two survey estimates. Simulation randomly draws: 50-50 chance of drawing one or the other estimate. Seeding rate N (32, 5%) Increased rice yields N (7.41, 5%)	Drought-impacted area, adoption, maize yield and market price production lifts randomly N (192.2, 57.2) for mid-term effects and N (42.8, 82.1) for long-term effects, and N (54.8, 38.3) in a normal year. Given maize yields in Ethioopia are 10 times higher, used a conversion factor of N (0.5, 0.13). 95% of simulated values fall between 0.25 and 0.75.
Adoption	N (28,983, 5%)	N (1.6 million, 5%)	N (670,000, 5%)	N (2.6 million, 5%)
Monetary values	All values expressed in 2022 US dollars (using CPI)			
Simulation	100,000 simulation draws			

Annex 2.1 Benefit Estimation and Cost Data Used for IBLI

2.1.A. Benefits

The ROI analysis focuses on the two benefits for which there is rigorous, long-term evidence and a clear monetization pathway, both of which are observed only among households that purchased IBLI under the early micro-level commercial model.[6] These include:

[6] After the micro-level commercial model, IBLI further developed into meso- and macro-level public–private and government-led programs, laying the foundation for large-scale public-private partnerships (PPP) such as Kenya Livestock Insurance Program (KLIP), Satellite Index Insurance for Pastoralists in Ethiopia (SIIPE), and the regional World Bank–supported De-Risking, Inclusion, and Value Enhancement of Pastoral Economies (DRIVE) program.

1. Educational gains that lead to increased lifetime earnings: Barrett et al. (2025) estimate that households that purchased IBLI at least once experienced on average a 7.3-year increase (standard error 3.704 from Barrett et al. 2024) in total school attainment over a decade among members who were school-aged at the time of the initial purchase, potentially translating into significant lifetime income gains. Although Barrett et al. do not provide estimates of the income gains, one can apply Mincerian estimates of the returns to education for Sub-Saharan Africa (mean: 12.4% from Montenegro and Patrinos 2014) and use the average income in Kenya (mean: USD 234 per adult-equivalent, assumed standard error 5%) to estimate the present value benefit per household attributable to education-induced lifetime earnings gains.

   The benefit is treated as a one-time, long-term gain per household that participates in IBLI at least once. It is not annualized, since the estimated income effects are already discounted to present value and accrue across the adult working lives of insured children. We do not subtract household-level education costs (e.g., tuition, school uniforms, transport) from this benefit figure on the grounds that the Mincerian returns we apply capture net income gains conditional on typical household co-investments in education, even if those costs are not explicitly deducted.

2. Short-term income gains: Participation in IBLI reduced the risk of income loss during a drought and increased average household income (Shikuku et al. 2025; Jensen et al. 2017; Jensen et al. 2016). We rely on two alternative estimates of the short-term income benefits of IBLI purchase, from Jensen et al. (2017) who estimate KES 275.3 (standard error 101.9) per Adult Equivalent (AE) per cumulative livestock units insured, to Shikuku & Ochenje (2025) who estimate an income effect of 0.97 (standard error: 0.24) Evidence indicates that passive coverage through meso- or macro-level programs such as KLIP or SIIPE does not produce these impacts. According to Barrett et al. 2024, the lack of observed long-term impacts of IBLI may suggest the need for complementary interventions to help relieve the continuing severe poverty that afflicts many pastoralist households, which were not addressed in the meso-/macro-level programs.Both estimates were converted to constant 2022 USD using Kenya CPI data and the 2022 exchange rate.

   Extending Kenyan income impact estimates to Ethiopia: The income effect estimates from Jensen et al. (2017) and Shikuku & Ochenje (2025) are based on Kenyan households. To extrapolate the estimates to the Ethiopian context, we rely on the fact that the Barrett et al. (2025) study is in both countries. In their work, the Kenyan household income is 84% of the average household income in the pooled sample. Assuming that the income effect translates linearly, we estimate that the income effect in the pooled Kenyan-Ethiopian sample would be 84% (fixed value) of that in Kenya.

   This yielded a pooled per-household income effect of USD 1481 (average upper bound) and USD 1209 (average lower bound). Taking an average of these two simulated bounds—given them equal weight—provides an average simulated value of USD 1345, which we use as the per-household income benefit observed during the 2009–2012 period ("short-term"), in contrast to the long-term education effects discussed above.

Multiplying this per household income gain by the estimated number of adopting households (described below) produces total income benefits for each of a set of years. These estimates are adjusted for inflation to obtain the benefit stream in 2022 USD . The aggregated income benefits are combined with long-term education benefits to estimate the overall ROI.

2.1.B. Adoption

Jensen et al. (2024, p. 49) estimate that a total of 43,931 policies were sold in Kenya and Ethiopia between 2010 and 2020. Assuming one policy per household and no repeat purchases, this figure represents the maximum cumulative number of unique beneficiary households. However, Jensen et al. (2024) note that using a methodology that avoids double-counting across insurance units and seasons yields a total of 16,158 unique policy sales. Finally, based on data in Barrett et al. (2025) (see their Figure 3), one can calculate that, conditional on ever purchasing IBLI, households purchase 1.64 policies on average. Using this conditional average to adjust the total number of policies sold (43,931), we estimate that on average 26,861 unique households may have benefited from IBLI. To reflect this uncertainty about the number of beneficiary households, in our sensitivity analysis we represent this with a normal distribution with a mean of 30044.5 and a standard deviation of 7087.5 (where 95% of the simulated values are within the upper and lower bounds).

2.1.C. Research and dissemination costs

ILRI provided annual cost data covering 29 IBLI-related projects implemented between 2010 and 2027. These budgets include expenditures for research, product design, pilot testing, extension, and delivery support.

To estimate the cost of IBLI specifically in Kenya and Ethiopia, we counted 100% of the costs of projects focused solely on these countries. For regional projects, it is unclear how to apportion costs. After discussion with ILRI, an estimate of 20% was considered reasonable if the project targeted Africa broadly, and 40% if it focused specifically on East Africa or the Horn of Africa. Accordingly, we used a distribution of apportionment fractions, with a mean of 19,468,239 and a standard deviation of 973,412 (5% of the mean).

Although the estimated benefits are measured only through 2021, we adopt a conservative approach by including all committed project expenditures through 2025.

Annex 2.2 Benefit estimation and cost data used for axial flow pumps

2.2.A. Benefits

The estimated benefits of axial flow pumps (AFPs) focus on net fuel cost savings per hectare from switching from conventional centrifugal (CEN) pumps to AFPs. This estimate is based on engineering and controlled field trial that models fuel and cost efficiencies under different crop, lift height, and water use scenarios (Krupnick et al. 2015). In each round of the sensitivity analysis, we randomly sample from different scenarios (with equal probabilities) mentioned in the paper to calculate the benefit, and thus we will only report the average below. Given this potential overestimation of the AFP impacts, the per-hectare benefits were scaled by 0.465 (standard deviation 0.173) corresponding to the observed ratio of actual (on-farm) to potential (experimental) yield benefits from irrigated rice in Bangladesh, as reported in the Global Yield Gap Atlas (https://www.yieldgap.org/).

Average fuel cost savings reported by Krupnick et al. 2015 varied by crop (Boro rice USD 37, wheat USD 10, and maize USD 16, all expressed in 2013 USD) and did not account for incremental costs associated with AFP ownership (first Year capital cost and fixed cost) that were estimated at USD 131 for four years using cost data from Krupnick et al. 2015. Average fuel cost saving did not account for variable costs of the pumps either, therefore an estimate of the difference between operating costs and fuel and capital costs was used.

This net benefit is converted to 2022 USD using the inflation adjustment factor and then multiplied by the estimated AFP adoption area (by crop and year) to produce total annual gross benefits to AFP owners. We therefore used respective average net benefits for rice, maize, wheat and other (mainly vegetables) of USD 31, USD 7, USD 12 and USD 17 (average of rice, maize and wheat).

2.2.B. Adoption

Adoption data for AFP comes from the 2024 Bangladesh Integrated Household Survey (BIHS) Round 4, conducted by SPIA and detailed in Singla et al. (2025). The survey included a dedicated irrigation module at the plot, season, and crop level, capturing detailed information on irrigation status, equipment used, and ownership status (owned vs. rented). To minimize misreporting and enhance identification accuracy, enumerators used visual aid with images of different irrigation technologies, enabling farmers to correctly recognize and report the equipment they used. It was hoped that this approach would reduce the likelihood of measurement error in identifying AFP use.

Adoption of axial flow pumps (AFPs) in Bangladesh in 2023 reached 12.6% of rural households, and increase from 0.5% and 1.4% reported in previous rounds of BIHS (2015 and 2018 respectively). But given that the ROI calculation requires an estimate of the acreage under the use of AFP, it was translated into 7.63% of the cropland using information collected during the BIHS round 4. From the same survey, the share of total AFP-irrigated area allocated to rice, maize, wheat, and other crops (primarily vegetables) were estimated at 79.5%, 1.9%, 1.7% (with a standard deviation of 5% of the mean for each crop, avoiding negative values) and 17.5% (subtracted from the simulated shares of rice, maize and wheat) respectively.

2.2.C. Research and dissemination costs

CIMMYT provided expenditure data from the CSISA–Mechanization and Irrigation (CSISA–MI) project covering 2013–2018. Total project spending of USD 4 million was evenly distributed across six years and converted to constant 2022 USD , yielding a total of USD 4.87 million (with a standard deviation of 5% of the mean). These expenditures represent public R&D, testing, and demonstration activities. Private-sector manufacturing and user purchase costs are excluded.

Annex 2.3. Benefit Estimation and Cost Data Used for FTRVs

2.3.A. Benefits

The ROI analysis focuses on causal impact estimates of the adoption of flood-tolerant rice varieties (FTRV) on rice yields rigorously estimated by Michler et al. (2025) Using Earth Observation data the authors focused on average vegetation “greenness” or vigor (EVI) within rice areas and evaluated the interaction of district-level FTRV seed supply (in tons, used as a proxy for adoption) and measures of flood occurrence. The authors run thousands of regressions and consistently found that FTRVs provide yield protection within a narrow “Goldilocks” band of moderate floods, indicating that the technology is effective but only under specific, stochastic conditions.

The average impact estimate for this band of Goldilocks flood is 0.0001147 (std. error 0.0000496). This coefficient estimates the impact of the interaction between cumulative FTRV seed (in tons) and flood occurrence, on changes in average EVI associated with an additional ton of seed available in a district during a Goldilocks flood year. In other words, if a Goldilocks flood occurs, each additional ton of cumulative FTRV seed in that district is associated with a 0.0001147 increase in the district’s average EVI, holding other factors constant.

The next step was converting changes in vegetation indices into agronomic yield outcomes. In the absence of context-specific estimates of such a slope for Bangladesh rice systems, we constructed a conversion factor (S) by regressing district-level paddy yields (tons/ha) over time (sourced from the Annual Yearbook of Agricultural Statistics of Bangladesh, various years) on EVI-max values derived from Earth Observation data. The estimate of S = 0.7409494 tons/ha per 1.0 EVI (std. error=0.1694612) indicates that a 0.01 increase in EVI corresponds to an average yield gain of approximately 7.41 kg/ha.

To capture the stochastic nature of FTRV benefits, we filter to the actual district-years in which Goldilocks floods occurred. Benefits are therefore realized only for those districts and years. Across the 20-year EO panel (2002–2021) covering 64 districts in Bangladesh — yielding 1,280 district-year observations —Goldilocks floods were identified only 16 times (about 1.25% of cases). Of these, 15 occurred during 2017–2021, concentrated in just eight districts.

2.3.B. Adoption

The 2024 Bangladesh Integrated Household Survey (BIHS) Round 4 reports an adoption of

7.98% of the total rice acreage with FTRV (Singla et al. 2024). However, using district-level cumulative seed production and distribution data compiled by Michler et al. 2025 that recorded recycling carry-over, this estimate was adjusted. the total adoption area exposed to Goldilocks floods is estimated to be 49,308 ha.

Michler et al. 2025 also provides household-level adoption rates for 2014, 2017 and 2022. Using these estimates and assuming a seed rate of 32 kg/ha, the total FTRV adoption area exposed to Goldilocks floods is estimated at 101,627 ha across the 15 observed flood events between 2017 and 2021.

To reflect this uncertainty about the number of beneficiary households, in our sensitivity analysis we represent this with a normal distribution for each year where 95% of the simulated values are within the upper and lower bounds, avoiding extreme negative values. The upper and lower bounds are [12824, 7345], [41353, 21347], [40822, 17813], [3314, 1407] and [3314, 1406] for 2017~2021 respectively.

2.3.C. Research and dissemination costs

IRRI supplied project-level budget data associated with research and dissemination activities for FTRV. Relevant projects were identified by IRRI by filtering titles using targeted keywords related to flood tolerance (e.g. FTRVs, submergence tolerance in rice, rice submergence tolerance (Sub1 gene), flood resilience, and flood resistance genetic traits). The resulting dataset captures expenditures related to both upstream and downstream activities linked to FTRV research, though it may not represent the complete costs of early-stage varietal development preceding these projects.

These budgets specify both the country focus and time period of each grant, enabling construction of two aggregates: (i) global IRRI expenditures on FTRVs (across all countries), and (ii) the Bangladesh-specific share. For ROI estimation, only the Bangladesh-specific IRRI investments were included, expressed in 2022 USD . This approach ensures comparability with other cases and reflects the CGIAR/IRRI donor contribution only, excluding expenditures by national partners such as BRRI or the Department of Agricultural Extension.

Annex 2.4 Benefit Estimation and Cost Data Used for Drought-Tolerant Maize

2.4.A. Benefits

The ROI analysis focuses on causal impact estimates of the adoption of DT maize on maize yields rigorously estimated by Boucher et al. (2024) for Mozambique and Tanzania. Using two estimation approaches (ANCOVA and DID), the authors decomposed the total impact of DT maize into three effects: mid-season drought (yield losses mitigated in the same season);

lagged effect (DT helps recover from lingering drought damage into the following season); and normal year (effects in non-drought seasons). To avoid setting up multiple scenarios that will introduce further uncertainty in the estimation, we average the estimates of the two estimation approaches.

Boucher et al. (2024) report negative effects in the endline for normal years, but most of them were statistically insignificant. We then focus on the marginally significant increase in normal years, reported by the authors for the mid-season for consistency. The mid-season yield losses mitigated were estimated in 192.2 kg/ha (standard deviation 57.2), while the lingering effect into the next season in 42.8 kg/ha (standard deviation 82.1) and the effect in non-drought season in 54.8 kg/ha (standard deviation 38.3). Given that the average maize yields in Ethiopia (≈3–3.5 t/ha) are much higher than in the RCT control group in Mozambique and Tanzania (~0.399 t/ha), we implement percentage-based lifts by converting the working kg/ha into percentages using the RCT's baseline yield, then apply those % effects to Ethiopia's baseline by zone–year. We use a conversion factor of 0.5 (standard deviation 0.13, 95% values are between 0.25 and 0.75).

To determine if a specific location and year were affected by drought, CHIRPS dekadal rainfall was aggregated to Ethiopia's ADM2 (zone) level. This allowed the detection of the start of season (SOS) and the calculation of total rain over the SOS-anchored mid-season window (SOS+5…+8 dekads). From these we computed MID (mid-season rainfall, mm) and MID_LTA (its long-term average) to classify mid-season drought under the absolute and relative rules. (≈ 40–80 days after planting, aligned with the definition of mid-season used by Boucher et al. 2024). We classify mid-season drought with two rules:

1. Absolute: drought = 1 if MID < 200 mm, aligned with Boucher et al. (2024)'s mid-season definition (≈40–80 DAP).
2. Relative: drought = 1 if MID/MID_LTA ≤ 0.80.

2.4.B. Adoption

Adoption estimates come from the fifth wave of the Ethiopia Socioeconomic Panel Survey (ESPS-5, 2021/22) led by SPIA (Alemu et al., 2024). The survey collected plot-season-crop information, including variety names, and—crucially—used DNA fingerprinting against a reference library (which includes Ethiopian DT releases) to minimize varietal misreporting. We use these DNA-based identifications to estimate the area under DT maize.

The adoption of DT maize varieties in 2021 by region was estimated at 12.6% for Amhara, 27.4% for Oromia, 1.4% for SNNP, 8.6% for Harari and 35.1% for Dire Dawa. The area-weighted national adoption rate in 2021 is about 14%. In 2009, a study on the adoption and impacts of improved varieties in Africa (DIIVA) estimated the adoption of DT maize varieties for the same regions at 0.01%, 0.01%, 0.01%, 0.01%, 0.01% respectively (Walker and Alwang 2015). The mid values for the adoption of DT maize are calculated by interpolation. For each interpolated value, we use 5% of the mean as standard deviation (avoiding negative values).

2.4.C. Research and dissemination costs

CIMMYT provided project-level budget data covering DT maize research and dissemination activities implemented across Ethiopia, Tanzania, and Mozambique. The compilation included both completed and ongoing projects that contributed to the release and adoption of DT maize varieties. For multi-country projects, investments were proportionally allocated to each country based on project location and scope. For projects extending from 2017 to 2025, CIMMYT estimated the breeding and scaling investments, recognizing that some breeding components would not reach the scaling stage within this period.

Based on these criteria, 56 projects from 2006 to 2025 were identified, representing a total investment of approximately USD 48.0 million across the three countries. The subset attributable to Ethiopia were compiled and harmonized across years and expressed in 2022 USD , totalling USD 20.96 million. These estimates capture CGIAR and donor investments in DT maize breeding, testing, and delivery over time. However, it is expected that though it may not represent the complete costs of early-stage varietal development preceding these projects.

Farmers draw groundwater using a portable micro-solar irrigation pump installed by the Rural Development Academy in Kayumer Char, Fulchhari Upazila, Bangladesh. These SIPs, vital for irrigation in newly emerged river islands with minimal electrification, have significantly reduced women's labor in farming, cattle care, and kitchen gardening—boosting resilience and saving time. Credit: Tanmoy Bhaduri/IWMI

Standing
Panel on
Impact
Assessment

CGIAR Advisory Services – SPIA
Alliance of Bioversity International and CIAT
Via di San Domenico,1
00153 Rome, Italy

spia@cgiar.org

https://cas.cgiar.org/spia