CGIAR Standing Panel on Impact Assessment (SPIA) Summary of Evidence from 2019-2024 SPIA Workplan

Causal Impact Studies

Purpose

This document sets out to share insights from the independent evidence on impact and reach generated as part of the SPIA workplan 2019-2024 (approved by SC decision Nr. SC/M7/DP7). The document includes 4 SPIA Briefing Notes highlighting insights related to:

- Climate Change Adaptation and Mitigation
- Environmental Externalities
- Targeting of Agricultural Technologies
- CGIAR Research on Mechanization
- SPIA Country-Level Studies

Note that evidence from the SPIA Country-Level Studies is preliminary and subject to change. Final numbers will be made available in full-length country study reports to be published in December 2024.

Action Requested

The System Council is requested to read and reflect on the document ahead of the SPIA Side Event on 10 December.

Document category: Working document of the System Council. There is no restriction on the circulation of this document

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SPIA Briefing Note: Climate Change Mitigation and Adaptation

CGIAR Standing Panel on Impact Assessment

November 2024

Smallholder farmers in the Global South face unique challenges due to climate change, with increasing temperatures, erratic rainfall, and extreme weather events significantly impacting their livelihoods. These farmers, who often rely on rain-fed agriculture, are particularly vulnerable to climate variability, which exacerbates soil degradation, water scarcity, and crop failure. Researchers across CGIAR have long been developing and testing innovations that aim to help smallholder farmers adapt to climate change, be it through the prism of breeding innovations, or from the standpoint of new agronomic and natural resource management practices. Since at least the inception of the Climate Change, Adaptation and Food Security (CCAFS) CGIAR Research Program (2009-2021), CGIAR has also sought to design and test integrated bundles of biophysical and social or policy innovations related to climate change adaptation and mitigation.

Breeding new crop varieties for tolerance to drought, submergence, heat, or salinity (together referred to as "stress tolerance") is a core CGIAR approach to climate change adaptation. Through the SPIA Country Study portfolio we are learning about the dissemination and adoption of these stress tolerant varieties in key geographies. We take plant samples from farmers' fields and DNA fingerprint them to identify the varieties that farmers are growing. For example, in Ethiopia in 2018/19, we estimated that 23.7% of maize-growing households were growing CGIAR-related **drought-tolerant maize varieties** (SPIA Ethiopia Country Study, 2020). When we re-sampled in 2021/22, following a three-year period of repeated droughts, COVID-19 and a protracted civil conflict, we found that this number had increased to 39.6% of maize-growing households, representing an estimated 2.6 million households (SPIA Ethiopia Country Study, 2024). In Ethiopia, the government is arguably the central player fostering agricultural development, so we might characterize this story of successful rapid diffusion of drought-tolerant maize varieties as being largely supply-driven.

Absent a strong supply push from the state as in Ethiopia, farmers are likely to seek out and adopt new innovations only if they are convinced of their benefits. The study by Boucher et al (2024) shows the challenges associated with learning about the properties of new crop varieties. Stress tolerant varieties will only demonstrate their benefits in response to quite specific extreme weather events. The authors test whether this scaling challenge can be addressed by bundling stress-tolerant seed varieties with insurance that covers climate-related damages that the seeds do not protect against. Through a randomized controlled trial in Mozambique and Tanzania, they evaluate a combined offer of drought-tolerant maize seeds and a satellite-based index insurance product. They find that compared to drought-tolerant seeds alone, this bundled innovation protects crop yields against mid-season drought and also mitigates the long-term drop in productivity that drought typically causes. Importantly, this innovation influenced the reach of the product as well, but in a nuanced fashion -- farmers who experienced a drought shock and observed the protection provided by the bundled intervention were more likely to increase their investment in these innovations in subsequent years. By contrast, farmers who did not experience a shock were less likely to invest in these climate risk management innovations.

Submergence tolerance in rice has emerged as a key trait of CGIAR interest, particularly following the results of the seminal study by Emerick et al (2016). Their randomized control trial in India examined the impacts of Swarna *Sub1*, a rice variety developed by IRRI by using marker-assisted backcrossing of the *Sub1* gene into the popular Indian variety Swarna. The study demonstrates that the presence of the *Sub1* gene has a positive impact not only through preventing yield losses during flooding, but also through additional farm investments in normal years when farmers know that they are protected through the *Sub1* trait.

Several recent evidence streams provide additional insight and nuance. Michler et al (2024) used three waves of household panel data to examine the impact of stress-tolerant varieties at a larger scale (and for Bangladesh rather than India). To compensate for the relative unavailability of data, the authors relied on machine learning and Earth Observation data to construct detailed maps of both rice area and floods, which were then merged with administrative data about dissemination of submergence tolerant rice varieties. They were unable to replicate the positive results reported by Emerick et al (2016). Possible reasons include insufficient adoption, or insufficient instances of flooding of exactly the right type, to detect a positive signal.[1]

Kretzschmar et al (2018) carried out DNA fingerprinting of farmers' rice seeds in Bangladesh in 2014, finding that the two submergence tolerant rice varieties (BRRI Dhan 51 and BRRI Dhan 52)[2] bred for the *Aman* season were being grown by a modest 6.6% of farmers (BRRI Dhan 51 at 1.4% and BRRI Dhan 52 at 5.2%). Ten years later, the SPIA Bangladesh Country Study (2024)'s farmer recall data[3] find a similar estimate of 6.7% for the *Aman* season 2023.[4] Despite concerns about farmers' accuracy at identifying the exact crop variety, taken at face value this suggests that the spread of submergence tolerant varieties has stalled in Bangladesh. These modest levels of adoption provide a simple explanation for the inability to detect benefits of *Sub1* with aggregated remote sensing data.

In the Vietnam country study, we were able to collect DNA fingerprinting data at a large scale to identify the presence of the *Sub1* gene. Alleles associated with *Sub1* were found in 1.3% of the sample (equivalent to approx. 100,000 households), but importantly, only in rice samples whose genetic heritage could not be identified. Since the *Sub1* gene was originally discovered in a landrace, this suggests that the modest presence of submergence tolerant rice in Vietnam is unrelated to the breeding program.

Taken together, these somewhat sobering findings on submergence tolerance raise questions about the long-term impacts of the breeding efforts, absent either a bundled approach to roll-out, or a major supply-side push from government.

The agronomic practice of **Alternate Wetting and Drying (AWD)** of rice paddies has the potential to significantly reduce GHG emissions from rice. It has been a centerpiece of CGIAR research efforts in climate mitigation. For example, in 2011, CCAFS (2011) forecast that AWD "looks set to be rolled out across 3.2 million hectares in Vietnam". Over the past decade, eight Vietnamese governmental decrees have promoted AWD implementation, and since 2016, AWD has been recognized as central to the country's Nationally Determined Contributions (NDC) under the Paris agreement.

Despite this, scaling the approach has been a challenge. In the SPIA Vietnam Country Study (2024) we estimate between 3.3% (if we consider two dry downs of five or more days) and 5.4% (if we consider one dry down) of rice-growing households adopt

[1] It is very challenging to detect the impacts of innovations like submergence tolerance when working with the Earth Observation products that were available for 2010 onwards (when the rice varieties were being rolled out). This data constraint is an additional possible explanation for the null result.

[2] The international names for these varieties are Swarna_Sub1 and BR11_Sub1.

[3] We could only carry out DNA fingerprinting of rice during the *Boro* 2024 season, which is mostly irrigated and for which stress tolerance is a less relevant focus.

[4] The two varieties had switched positions in relative popularity almost perfectly (BRRI Dhan 51 at 5.5%, BRRI Dhan 52 at 1.2%).

AWD[5]. The corresponding estimated reach of AWD in Vietnam is between 249,300 households (two dry downs) and 408,700 households (only one dry-down). In the SPIA Bangladesh Country Study (2024), over 25% (corresponding to an upper bound estimate of approximately 2.8 million households) of rice-growing households report drying their rice plots between irrigation cycles during the *Boro* season. Importantly however, 33.9% of these plots belonged to households reporting water shortages in the past three *Boro* seasons – suggesting the fields had dried naturally and not through intentional AWD application. Moreover, less than 1% of farmers in Bangladesh were adopting AWD with the intended method of using a perforated PVC pipe. This may indicate that the correct estimate of AWD adoption in a water-abundant context is even smaller.

Indeed, Chakravorty et al (2023) show that when irrigation water is abundant, large-scale adoption of AWD is hampered by a lack of private incentives. In their village-level randomized trial in Bangladesh, training about AWD along with provision of perforated pipes had no significant effects on water use and farm-level profits on average. Instead, measurable water savings occurred only in villages where farmers pay a volumetric (marginal) price for water. In a follow-up study, farmers who were randomly selected to receive debit cards that converted their billing from per-acre to per-hour of water use adopted AWD at higher rates. This shows the potential for innovations that align private incentives with the public good.

Another example of policy-related innovations to address climate change comes from work on **climate-smart mapping and adaptation planning** (CS-MAPS), featured in the SPIA Vietnam Country Study (2024). During the period 2016–2021, CCAFS researchers developed and tested a participatory approach that integrated scientific evidence about climate risks with local knowledge about relevant land use and infrastructure to develop adaptive interventions.

In 2023, SPIA collected these scenario maps for all 41 provinces across four regions in Vietnam that have created location-, risk-, and season-specific climate change adaptation plans. A phone survey of provincial officials and qualitative content analysis of the annual/ seasonal agricultural plans they developed, helped to understand how CS-MAPs influence the government's recommendations to farmers when extreme weather is predicted. Using data from the Vietnam Household Living Standards Survey (VHLSS), we find that in an extreme year, 171,561 households (approximately 27.4% of all rice-growing households in the Mekong Delta) planted rice on the extreme-year planting date recommended for their district by the CS-MAP.

Index-based livestock insurance (IBLI)[6] supports pastoralists' adaptation to climate change. Barrett et al (2023) examine the long-term effects of a randomized roll-out of IBLI in pastoral areas of Northern Kenya and Southern Ethiopia. The roll-out involved the distribution of discount coupons to help pay the insurance premium to 1,439 pastoralists across Marsabit County in Kenya (2009) and Borana Zone in Ethiopia (2012). Some ten years after the original study the authors find that adoption of IBLI had increased the share of large animals herded at the expense of small animals (particularly goats). While there was no observable change in the total value of productive assets, they find large, albeit imprecisely estimated, increases in income from livestock and crops. Remarkably, this shift in the households' production strategy is closely linked to an observed major increase in household members' education levels. As small animals, traditionally herded by children, are displaced by larger animals, child labor becomes less productive at the margin which provides a further incentive for households to send their children to school.

Across the portfolio of innovations reviewed in this brief, a recurring theme is the value of having multiple waves of data on the same innovation collected over time to help understand the dynamics of change. The studies also highlight the importance of experimental impact evaluations in both studying complex combinations of innovations and in creating space to uncover unanticipated causal pathways.

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[5] The AWD practice recommends that farmers dry the surface of their fields, and only reirrigate when the water level drops 15 cm below the surface. The water level can be monitored using a simple plastic pipe bedded in the soil. SPIA's country studies both in Vietnam and Bangladesh find minimal adoption of this plastic pipe. However, AWD advocates argue that the use of this pipe is not a necessary condition for adoption of AWD, as experienced farmers learn to judge the patterns of drying on the soil surface without it. Hence the focus on collecting data about actual patterns of drying.

[6] IBLI is also the focus of the study by Wilcox et al (2024), featured in the environmental impacts brief, showing that there are no observed negative environmental impacts on rangeland health from the IBLI roll-out.

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Photo credit: Michael Major/Crop Trust

SPIA Briefing Note: Environmental Externalities of Agricultural Intensification

CGIAR Standing Panel on Impact Assessment

November 2024

Increasing agricultural productivity is important for CGIAR, as it is central to the achievement of a range of development outcomes, which may arise through crop or commodity-specific causal pathways. These potential pathways include raising farmer incomes, lowering food prices for consumers, changing employment shares, altering land use patterns, creating demand for processing services, and more. The process of agricultural intensification can take several complementary forms, but there is typically an association with the adoption of new agricultural innovations wherein farmers increase their productivity[1] through the use of new inputs, higher cropping intensity (i.e., two or more crops) per unit of land, and/or shift to higher-value crops. These processes of change may alter the environmental damages from agriculture, both directly (e.g., pollution from more use of inputs) or indirectly (e.g., increased productivity can lead to more ("Jevons' paradox") or less ("Borlaug hypothesis") land conversion at the margin). Understanding these direct and indirect effects is important for designing agricultural policies and interventions in ways that consider potential tradeoffs and minimize negative consequences.

In a recent literature review, commissioned by SPIA, Garcia (2020) identified the following gaps:

1. a lack of rigorous causal evidence on direct environmental impacts of specific agricultural innovations
2. insufficient evidence on competing land conversion hypotheses (Borlaug hypothesis vs. Jevons paradox)
3. open questions about the contextual conditions and mechanisms through which agricultural intensification impacts the environment

To support research addressing these gaps in the literature, SPIA issued a joint call for proposals with the Environmental Markets Lab (emLab) at UC Santa Barbara in 2019. Four impact assessment studies were commissioned under this call. Two studies offer valuable insights on the prospects for what is sometimes referred to as "sustainable intensification" (Godfray and Garnett, 2012; Cassman and Grassini, 2020) in which innovations are introduced to farmers that are designed to have positive environmental externalities, thereby addressing existing environmental concerns related to agricultural production.

Krishna et al. (2024) aimed to estimate the impact on air quality of the adoption of the Happy Seeder technology – an implement fitted to the back of tractors that allow farmers to plant wheat into fields with rice straw left intact (i.e., not burned, as conventional practice). During the period of their study

[1] Productivity can be framed in terms of output per unit of land; or, output per some other constraining factor such as labor; or, across an index of all factors of production as in Total Factor Productivity estimation.

fieldwork (i.e., 2000–2022) the Punjab government heavily subsidized a different machine (the "Super Seeder") that is similar but that produces a shallow tillage in the field. The Super Seeder was produced with no known CGIAR research contribution. Owing to the lower-than-expected adoption of the Happy Seeder, their study instead examines how both zero tillage (with) and shallow tillage (with Super Seeder) adoption affects rice residue burning. Krishna et al. (2024) find zero-tillage adoption averages 17%, and that places with higher adoption also engage in less agricultural burning, though a causal interpretation of this relationship requires further analysis.

A farmer in India uses a tractor fitted with a Happy Seeder. (Photo: Dakshinamurthy Vedachalam/CIMMYT)

Aker and Jack (2023) used a village-level randomized trial in Niger to evaluate a training intervention for constructing *demi-lunes*: half-moon shaped depressions in the soil for concentrating rainwater and reducing soil runoff, thereby helping to rehabilitate degraded land. They find that adoption is responsive to the training intervention, increasing from 4% in the control group to around 95% in the treatment group. They show that rainwater harvesting increases agricultural output per farmer, improves self-reported soil quality and reduces land retirement and recruitment of new land into production. The findings are consistent with a land-sparing result, supporting the Borlaug hypothesis.

Two other studies evaluated the potential indirect environmental impacts of innovations that were not designed with a specific environmental focus. Wilcox et al (2024) examined the long-run ecological impacts of index-based livestock insurance (IBLI) in East Africa, and Abeygunawardane et al (2024) examined the impact on land-use / land-cover change of a program promoting intensification of sorghum and millet in Mali. In both these cases, the environmental impacts of these examples of agricultural intensification are entirely ambiguous, open questions – competing theories, along the lines of Borlaug vs Jevons, could argue for either result in the absence of strong empirical evidence.

Wilcox et al. (2024) investigated IBLI's impact on rangeland health among pastoralists in East Africa. The IBLI insurance protects against drought-related livestock mortality and has been shown to enhance herd productivity and household income. This study was motivated by the concern that increased profitability may lead to higher stocking rates and environmental degradation. The study uses difference in differences analysis with location and time fixed effects, exploiting the quasi-random variation in the timing of roll-out of IBLI. The authors find that IBLI has neutral to slightly positive impacts on various indicators of rangeland health. These results suggest that agricultural intensification through risk reduction can avoid environmental harm, arguably representing another result consistent with the Borlaug hypothesis, and provides valuable insights for scaling IBLI and similar technologies designed to offset increasing variability due to climate change. Scaling decisions for this innovation should also take into account evidence from Barrett et al (2024) that suggests that impacts on herd value and cash income may not endure in the long term.

Abeygunawardane et al. (2024) assessed the land use impacts of a bundled intervention aiming to promote intensification by sorghum and millet farmers in southern Mali, through introduction of improved seeds, seed treatment techniques, and soil and pest management practices. Their study used tree cover as a proxy for land use and focuses on the semi-arid zone. They selected a comparison group through propensity score matching on both pre-program outcomes and time varying covariates and ran a difference in differences analysis with two-way fixed effects. They find a 1.8% decline in tree cover outside cropland and 0.7% within cropland, for treated villages relative to control villages. These results are consistent with the idea of a "rebound" effect, aligning with the Jevons paradox, which raises concerns for similar intensification programs worldwide.

In conclusion, the findings demonstrate that the adoption of agricultural innovations at scale can produce positive environmental externalities (or reduce negative ones) consistent with the principal of sustainable intensification, but that this is innovation- and location-specific. The implication of such context-specificity is that agricultural researchers should try to anticipate the range of possible causal pathways but should also remain open to surprises. It also highlights the value of further work to more systematically explore the conditions that give rise to environmental benefits.

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SPIA Briefing Note: Targeting of Agricultural Technologies

CGIAR Standing Panel on Impact Assessment

November 2024

The collaborative work of CGIAR and its partners across different regions has yielded several agricultural innovations with great potential to benefit farmers in the Global South, by increasing farm productivity, improving resilience or reducing costs or environmental spillovers. One of the key assumptions to materialize these potential impacts is to reach the right end users of these innovations. However, emerging evidence from the 2019-2024 SPIA portfolio on the reach and impacts of CGIAR research and innovations have identified some challenges not only in achieving and sustaining large-scale adoption of innovations but also in reaching farmers that can benefit the most from the technology in question.

Early evidence from the SPIA country-level study in Vietnam showed interesting patterns in adoption of rice varieties with salinity-tolerant traits, with high adoption in some coastal areas but also in less vulnerable areas in the mountains in the north. While, at first sight, this might look like the technology is poorly targeted, we cannot exclude other explanations for this adoption pattern. For example, the salinity tolerance trait could be bundled together with other attributes that are useful for farmers in the mountains. This highlights the complexity in drawing conclusions on targeting based on adoption figures.

For submergence tolerant rice varieties, there is clearer evidence on poor targeting. For example, Yamano et al. (2016) show that in four states in eastern India, the submergence tolerant variety Swarna-Sub1 was poorly targeted to submergence-prone areas, with only a marginally higher adoption rate among farmers who experienced short-duration submergence (3.6%) compared to the overall adoption rate of 3.4%.

In a more recent study, Dar et al. (2022) make a similar observation. In their control group, they find that adoption is negatively correlated with flood risk. However, the main finding of their study shows a promising solution to this targeting problem. They conduct an experiment in Odisha, India, comparing traditional public-sector extension services with and an agrodealer based approach to increase adoption of Swarna-Sub1. The latter approach included distribution of seed minikits and informational pamphlets directly to agrodealers. They find that compared to the traditional approach, the private-sector partnership approach increased farmer-level adoption by over 50 percent. Importantly, they also find that adoption increased the most among farmers in more floodprone areas, indicating that private-sector partnerships can be efficient in targeting new technologies to the farmers that are likely to benefit the most.

In evaluating labor impacts of both supply-side and demand-side of small-scale mechanization in Ethiopia through a randomized control trial, Godlonton et al. (2024) found that subsidy vouchers to encourage demand for mechanized services are more impactful among female-headed households.

This could indicate that females would like to mechanize, but since they face tighter liquidity constraints, they cannot do so without larger subsidies. While the study does not find evidence of changes to adult farm labor, it suggests reductions in child farm labor. These reductions are larger in female-headed households, implying that that the dissemination of 2WTs at scale may achieve positive impacts on child farm labor by explicitly targeting female-headed households.

In a related study, Teufel et al. (2024) study factors in last-mile delivery of an underutilized vaccine, the Infection-and-Treatment-Method (ITM), in Kenyan dairy systems. Aiming at overcoming barriers to access to the vaccine by improving farmer coordination (the vaccine requires 40 animals to be vaccinated at one event) and liquidity constraints, the project implementation conducted active mobilization of the target population through direct phone calls. However, the intervention was unsuccessful in getting enough pastoralist to participate in the vaccination program, making it unviable. However, despite mobilization through direct phone calls, they were unsuccessful in getting enough farmers to participate in their vaccination program to provide basis for analysis. Regardless, the study brought some learnings about the complexity of the targeted value chain and the willingness of local partners to invest own time and financial resources in a foreign-funded project.

Overall, this ongoing body of work shows that technologies do not always get to the farmers that are projected to have the highest returns. This could be salt tolerant varieties for farmers in coastal areas, flood-tolerant varieties for flood-prone farmers, or mechanization services for females. The body of evidence shows the importance of not only testing interventions to boost adoption, but considering whether the interventions increase adoption the most for high-return farmers.

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SPIA Briefing Note: CGIAR Research on Mechanization

CGIAR
Standing Panel on Impact Assessment

November 2024

The displacement of agricultural labor by mechanization has been central to economic growth and structural transformation in countries around the world as it increases agricultural productivity and frees labor for more remunerative sectors. CGIAR has a long-standing research agenda on mechanization focused on how this secular trend towards greater mechanization can be reconciled with the needs and constraints of smallholder farmers and be better integrated with new genetic or agronomic innovations coming from CGIAR research.

Adoption Evidence

In Bangladesh, CGIAR efforts under the long-standing **Cereal Systems Initiative for South Asia** (CSISA, 2009 to present, CIMMYT, IRRI and IFPRI) has aimed to facilitate the process of mechanization by smallholders in a way that is consistent with adoption of sustainable intensification practices. The model of mechanization as a service is central here – Bangladesh is a leader in this regard, with many more farmers benefiting from rental services for specific machines than owning them. CGIAR has focused on promoting axial flow pumps for surface water irrigation (particularly in the USAID Feed the Future zone of influence); power tillers and tractors using attachments for seeding rice, jute, and maize; and the use of mechanical reapers. In the SPIA Bangladesh Country Study (2024) we collected data on the extent of adoption of these innovations and compared our estimates to two prior rounds of data collected from the same sample of households in the BIHS rounds in 2015 and 2018.

Two-wheel tillers have fallen since 2018 coinciding with a steady trend in adoption of four-wheeled power tillers (Figure 1). Indeed, when we look at the panel

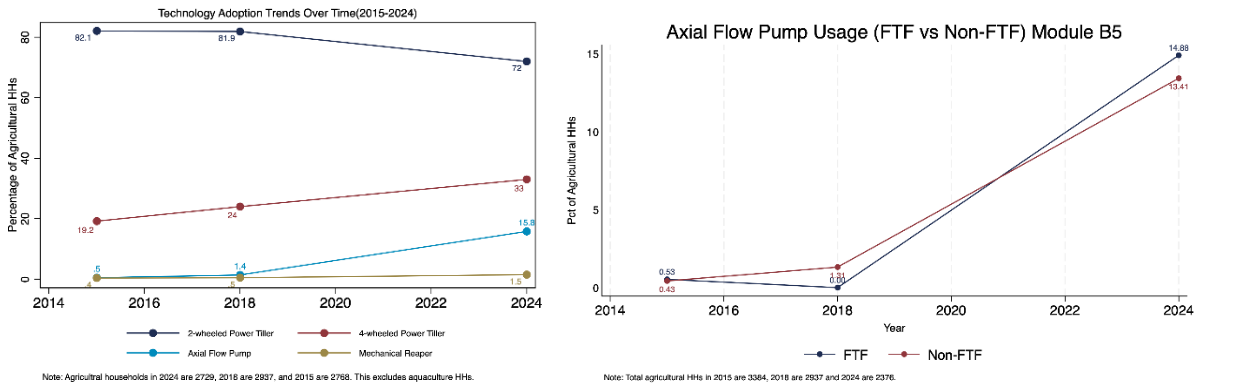

Figure 1. Adoption rates of pumps and tillers.

data on those specific farmers that disadopted two-wheel tillers between 2018 and 2024, most of them had moved to four-wheel tillers. Most strikingly, axial flow pumps have rapidly diffused (a ten-fold increase over six years, albeit from a low base) to reach 16% of agricultural households. We estimate that this corresponds to an upper bound reach of 1.65 million households in 2024. We see more rapid take-up in the FTF zone vs other parts of the country, suggesting that this secular trend may have been slightly boosted by CSISA activities. All these machines are rented at rates of 90% or above, with only a small minority of farmers owning their own.

In the SPIA Ethiopia Country Study (2024), we examine the trend in the adoption of **two-wheel tractors (2WTs)** (Figure 2). CGIAR research on has focused both on the agronomic rationale for 2WTs in Ethiopia (e.g., Baudron et al., 2015) and on the business models for promoting them, the latter as part of the long-run Africa Rising program (2011-2023). The Bangladesh model of a large market for mechanization services was part of the inspiration for the approaches used by CGIAR in Ethiopia. Berhane et al (2017) suggest that mechanization is rapidly increasing, but from a very low base. Using ESPS data from 2013/14, they showed that land preparation was dominated by the use of either livestock or hand hoes, with tractors of any kinds representing only approximately 1% of plots. We are interested to what extent CGIAR-related efforts supported the shift towards land preparation using 2WTs at scale.

SPIA designed and included a visual aid for 2WTs in the community survey in the ESPS 5 2021/22 survey round, finding that 4.3% of enumeration areas report their communities (see blue diamonds on the left panel below). These enumeration areas are typically far from the project sites "intervention areas" of the Africa Rising program (orange dots). By contrast, we see more widespread adoption of 4WTs (blue diamonds, left panel below) and this is happening slightly closer to intervention areas. These descriptive findings suggest that in places where farmers are ready to shift to mechanization, they have shifted immediately to 4WTs and are seemingly being supplied by a combination of private markets and government action.

Finally, **laser land-leveling** (LLL) is a mechanized form of land preparation, available through custom hire services, which can prepare rice paddies in such a way that allows for a more uniform water depth across the plot. LLL is synergistic with the agronomic practice of alternate wetting and drying (AWD) – promoted by IRRI due to its potential for reducing GHG emissions from rice production. In the SPIA Vietnam Country Study (2024), we estimate that adoption of LLL in 2023 was 5.4% of rice-growing households,

Photo 1. Laser land leveling. Photo: IRRI

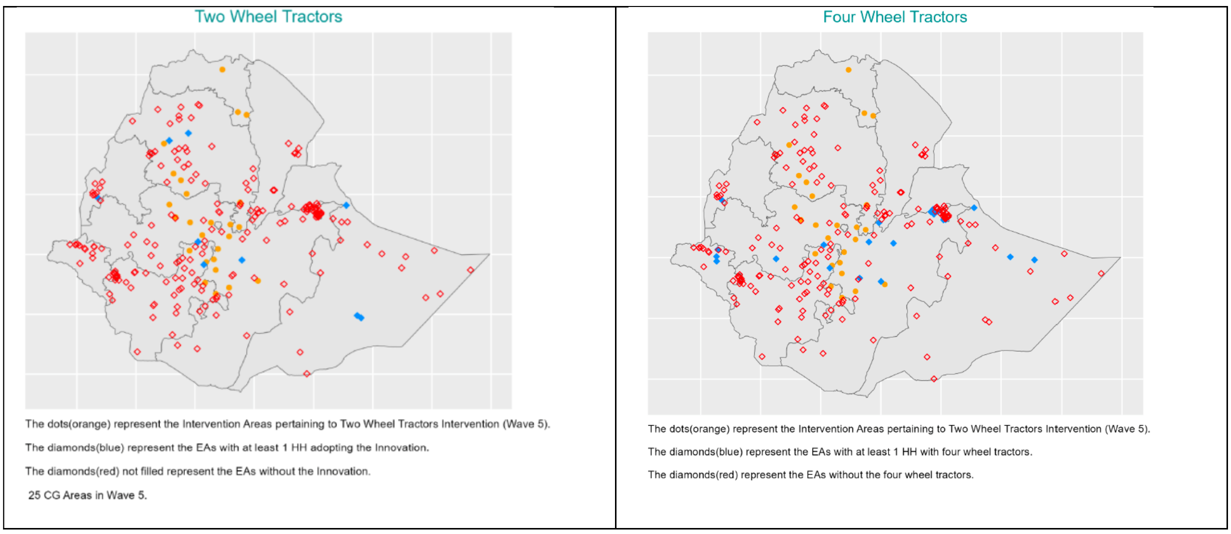

Figure 2. Patterns of adoption of two- and four-wheel tractors in 2021/22 data (ESPS wave 5, SPIA Ethiopia Country Study, 2024)

having 2WTs being used by at least one household in

representing a little over 400,000 households. We estimate the same adoption share (5.4%) of rice-growing households were adopting AWD in 2023. While there is a good degree of joint adoption of these two practices, many farms only adopt one of the two and the geographic distribution of the two innovations are different – the estimates being so similar is a statistical fluke. However, the low level of demand for LLL is indicative of a lack of incentives for optimizing irrigation water use in a manner consistent with low levels of AWD adoption[1].

Impact Evidence

Our first causal impact study in this brief continues with 2WTs in Ethiopia. Godlonton et al (2024) investigate the low take-up of 2WTs purchased and disseminated by the government by local entrepreneurs for their own use or for hire-services. They ask whether a demand or supply-side intervention would work best in stimulating mechanization service use. Interventions were randomized with mechanization service providers (supply side, training and information provision) and/or smallholders (demand side, vouchers to stimulate demand for service use) in a three-stage randomized trial.

Among service providers they find suggestive (but imprecise) impacts of the training workshop on firm survival, service diversification, and changes to pricing strategies. Among smallholder households, vouchers are more impactful among female-headed households. There is little evidence of changes to adult farm labor, but using female reports, they find evidence of reductions in child farm labor that are larger in female-headed households. This study shows that it is possible to induce demand for 2WTs using subsidies, and that this can have positive social sufficient to sustain long-term adoption in the face of competition from 4WTs.

Taken together, these insights on 2WTs in Ethiopia raise questions about the effectiveness of action research on small mechanization. The adoption of mechanization equipment seems to be driven by factors outside the influence of agricultural researchers, notably competitive market forces. Much of the interest in promoting 2WTs in Ethiopia comes from the long-held goal of CIMMYT and partners to promote conservation agriculture in the country. In this light, adoption of 2WTs is seen as a complement to the adoption of soil conservation practices such as zero or minimum tillage and the maintenance of crop residues on the soil after harvest (Baudron et al, 2015). The same interest in synergies between mechanization and CGIAR innovations can be seen in other empirical studies.

Nedumaran et al (2024) examine the impact of **machine-harvestable chickpea varieties** (MHCPs) developed by ICRISAT. Traditionally, chickpeas grow low to the ground and are manually harvested and threshed, mostly by women. With the wage rate and competition for hired labor rising owing to economic growth in India, farmers have been requesting a variety that stood taller so they could be mechanically harvested. Between 2016 and 2022, ICRISAT and their national agricultural research partners released five MHCPs.

The authors randomized the provision of free MHCPs seed to farmers in Andhra Pradesh. Results show that almost 30% of farmers in the treatment groups used combined harvesters, compared to 17% in the control group. The results show that the proportion of female workers engaged in chickpea harvesting and threshing falls in the treatment villages. The long-run implications of this female labor displacement are yet to be seen, but there is suggestive evidence from the study that women find work outside their village.

Gulati et al (2024) also provide further evidence on the gendered aspects of a technology that saves women's labor: **mechanical rice transplanting (MRT)**[2]. Traditionally, rice planting uses a lot of women's labor, whereas MRT can be adopted through a custom hire service and can massively (by a factor of approximately 25 times) reduce the labor input required to transplant an acre of rice field. The authors elicit demand for MRT from women and men separately, and both from those who provide transplanting labor from their family vs hiring it in.

Photo 2. Mechanical rice transplanting. Photo: IRRI

[1] We expand more on this relationship in the climate change brief, and the study by Chakravorty et al (2023) in particular.
[2] This is not a CGIAR-related innovation but the research about gendered impacts was carried out in collaboration with IFPRI so we include it here as it adds richness to this discussion of the intersection of mechanization, labor and gender.

They find that women value MRT more than men, particularly when the women are the ones responsible for transplanting. However, men's preferences dominate the aggregate household willingness to pay for the service. This implies that improvements in women's bargaining power outside the narrow confines of decisions about transplanting will likely be necessary for adoption of the technology to become widespread in this setting.

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*SPIA Bangladesh Country Study (2024)

*SPIA Ethiopia Country Study (2024)

*SPIA Vietnam Country Study (2024)

*study conducted under the 2019-2024 workplan

Photo credit: Michael Major/Crop Trust

SPIA Country Studies

Standing Panel on Impact Assessment

November 2024

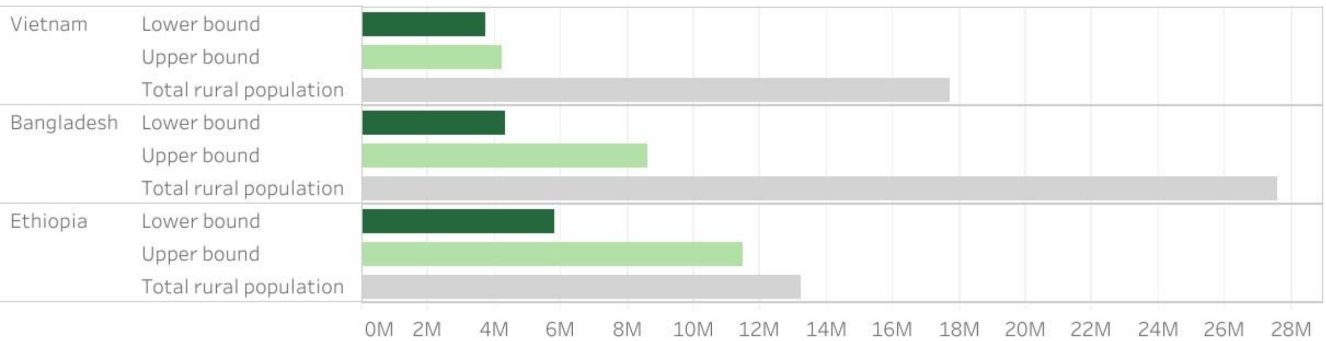
CGIAR research effort is not spread uniformly across the globe but is concentrated in several high-priority countries. In 2020, with our report on Ethiopia (Kosmoski et al, 2020) SPIA launched the first in a series of country-level studies in which we rigorously estimate the reach of CGIAR in these high-priority countries. Here, we report on the first reach estimates for CGIAR in **Vietnam** and **Bangladesh** and provide a second round of data collection in **Ethiopia** that helps us study the dynamics of change during a turbulent period for the country. Full details are provided in the published full study reports, but here we provide an overview.

In aggregate, we estimate that **13.8 million** households[1] were being reached by CGIAR-related innovations in the reference year[2] for these three priority countries (Figure 1).

Vietnam

Data were collected within the Vietnam Household Living Standards Survey (VHLSS), a large nationally representative survey of 47,000 households, run by the General Statistics Office (GSO). We estimate a lower bound of **3.7 million households** and an upper bound of **4.2 million households** being reached by CGIAR (Figure 2). The difference is driven by laser land-levelling (an agronomic technology that CGIAR

Figure 1. Estimated number of households reached by CGIAR, by country



Note: The bar "Total rural population" for Ethiopia applies to the population in 2018/19 (excluding Tigray). We use the World Bank LSMS statistical weights to compensate for conflict-related attrition in regions other than Tigray.

[1] Sum of the lower bound estimates across all three countries

[2] Varying between 2021/22 and 2024

has promoted, among other contributing factors to its adoption) and CS-MAPS (where climate adaptation recommendations cascade down to farmers from localized, season-specific recommendations about planting). We should note that reach is widespread across the country, allaying a possible fear of clustering of adoption among the more intensive delta regions of the country. Fully half of the estimated reach is due to adoption of improved rice varieties.

Other aspects of mechanization not listed above (e.g., adoption of combine harvesters, mini combine harvesters, balers) have been subjected to some degree of CGIAR research, but the positive secular trend in adoption of these machines makes it inappropriate to include these even in the upper bound estimates. Regardless, we did collected data about their adoption, estimating that over 5.5 million households in Vietnam use full-size combine harvesters whereas approximately 0.8 million households use mini combine harvesters suited to smaller or irregular plots.

Bangladesh

Data were collected in 2024 using the Bangladesh Integrated Household Survey (BIHS) sample of 5,554 households. Owing to joint adoption by some households, we can't simply sum up across these innovations to get the total number of households reached by CGIAR as a whole – we would be double-counting certain households. We estimate a lower bound reach of **4.3 million households** and an upper bound of **8.6 million households** (Figure 3). The difference between the lower and upper bound estimates relates to different innovations (including specific rice varieties within each season) having different strengths of attribution to CGIAR's research. In the case of Alternate Wetting and Drying, this difference is particularly striking, with zero households (lower bound estimate) using the "Safe AWD pipe" distributed to households, but almost 3 million practicing some form of drying of the plot during the growing season.[3]

Figure 2. Vietnam: Estimated number of households reached per innovation

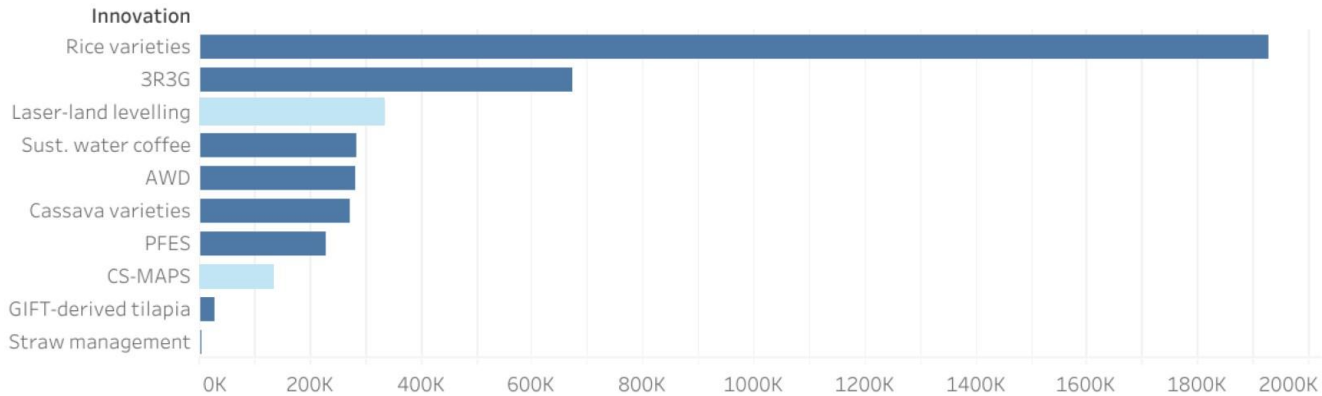
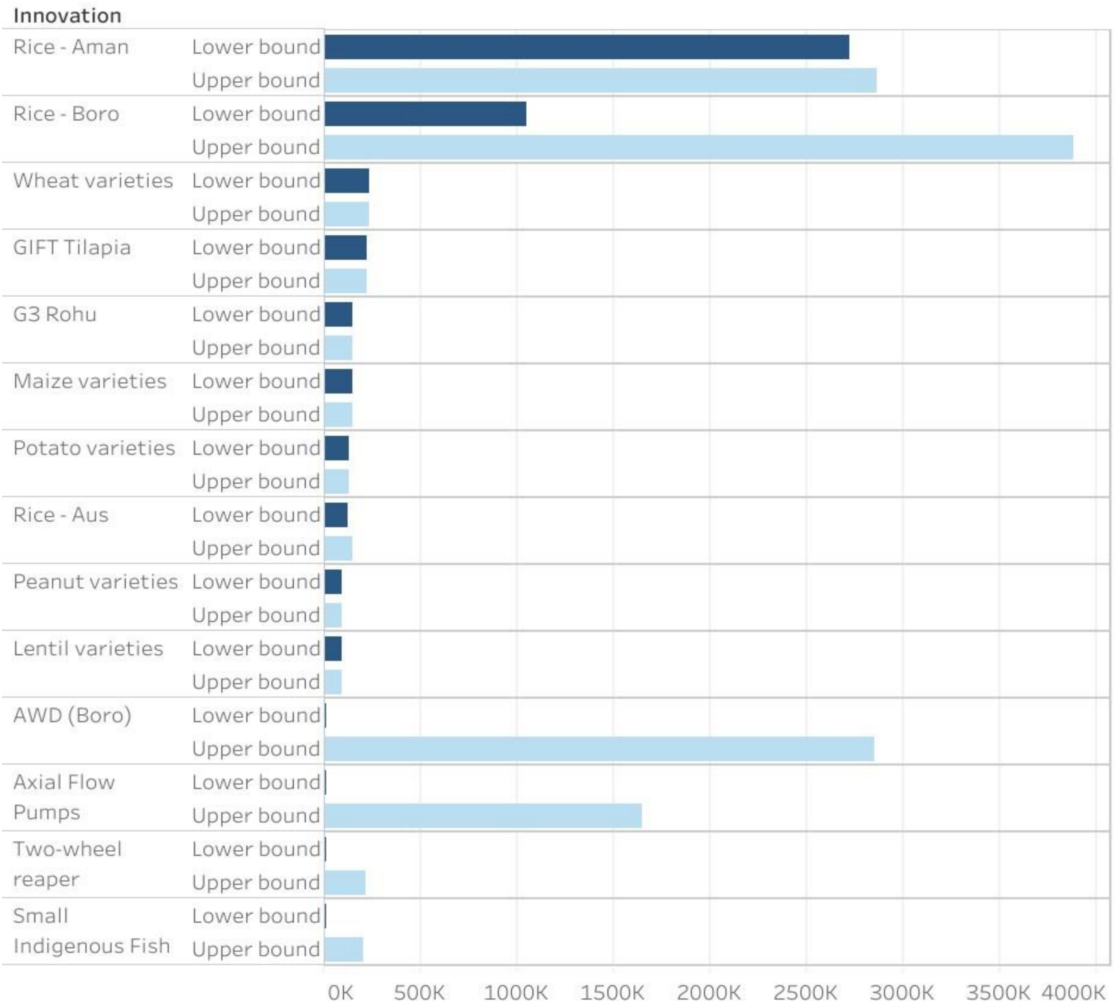


Photo 1. Farmer meeting, Bangladesh. Photo: Michael Major/Crop Trust

[4] The AWD reach figures for Bangladesh are provisional, pending more some final analyses of the data

Figure 3. Bangladesh: Estimated number of households reached per innovation



Ethiopia (2nd edition)

Data were collected in 2021/22, embedded in the fifth wave of the Ethiopia Socioeconomic Panel Survey. We had previously collected comparable data in 2018/19 (ESPS wave 4). Between the two waves of data collection the country was beset by civil conflict across a large part of its territory, suffered severe drought, and confronted the unique challenges posed by the COVID-19 pandemic. Figure 4 shows the estimated reach of CGIAR-related agricultural innovations for **2018/19 (upper, lighter shade bars)** and **2021/22 (lower, darker shaded bars)**. As we can see, despite the numerous challenges outlined above, the estimated reach for several innovations actually increased in the areas of the country where we were able to collect data – notably for forage grasses, crossbred poultry and CGIAR-related maize varieties, particularly drought-tolerant maize.

We estimate from the 2021/22 data a lower bound of **5.8 million households** reached and an upper bound of **11.5 million households**. We should note that the strength of CGIAR's attribution claim for different innovations featured *within this upper bound* does vary across the set, according to how active CGIAR has been in the overall innovation system that promotes adoption of the innovation.

Estimated reach of CGIAR-related agricultural innovations in Ethiopia for 2018/19 (lighter bars) and 2021/22 (darker bars). All data from ESPS 4 (2018/19) and ESPS 5 (2021/22), collected in collaboration with the Ethiopian Statistical Service (ESS, formerly Central Statistical Agency). Green signifies natural resource management, orange signifies crop germplasm improvement, and blue signifies animal agriculture.

Figure 4. Ethiopia: Estimated number of households reached per innovation (millions)