



Photo credit: Michael Major/Crop Trust

# SPIA Briefing Note: CGIAR Research on Mechanization



Standing  
Panel on  
Impact  
Assessment

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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

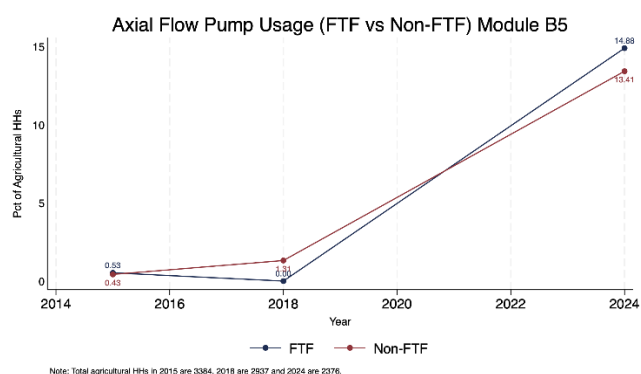
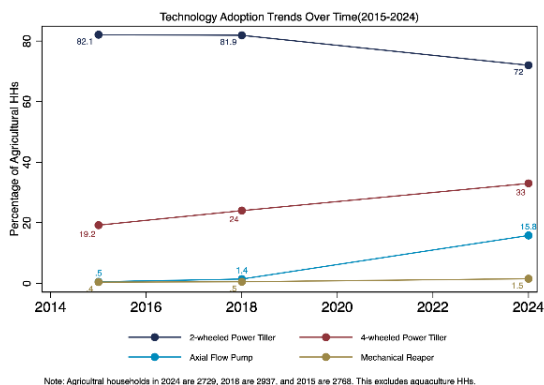


Figure 1. Adoption rates of pumps and tillers.

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

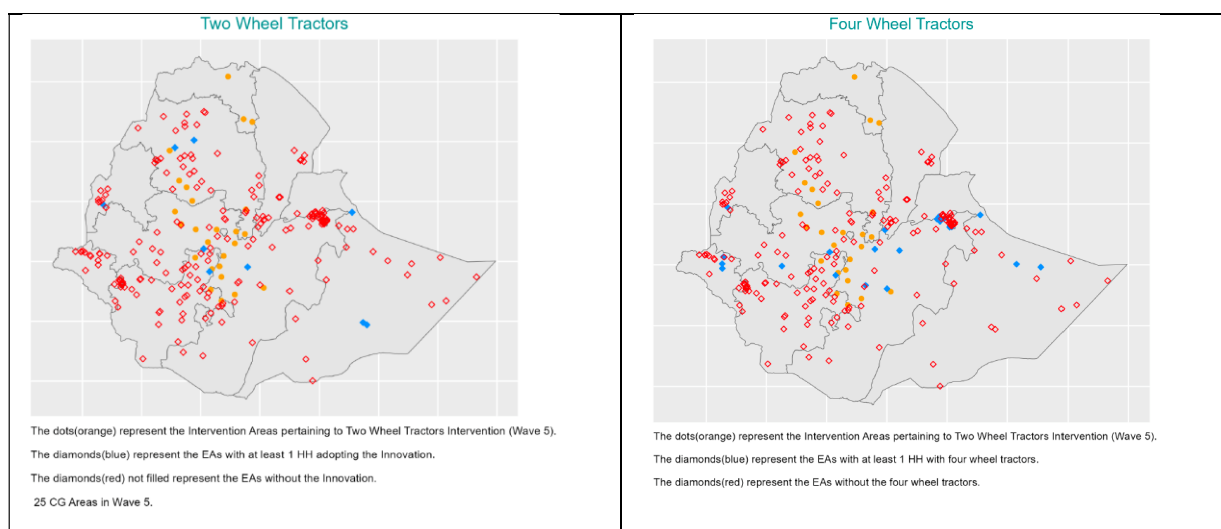


Figure 2. Patterns of adoption of two- and four-wheel tractors in 2021/22 data (ESPS wave 5, SPIA Ethiopia Country Study, 2024)

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<sup>1</sup>.

## 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)**<sup>2</sup>. 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: IIRI

<sup>1</sup> We expand more on this relationship in the climate change brief, and the study by Chakravorty et al (2023) in particular.

<sup>2</sup> 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.

## References

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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