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## Food Security Policy Project Research Highlights Myanmar

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### AGRICULTURAL MECHANIZATION IN THE DRY ZONE

Mateusz Filipski, Ben Belton, Joanna Van Asselt

#### INTRODUCTION

This research highlight evaluates the extent of agricultural mechanization in four townships in Myanmar's Dry Zone. It provides evidence that rapid mechanization is underway. Mechanical land preparation is now commonplace, due to thriving machine rental markets, falling equipment prices, and better financing options. The mechanization of harvesting and threshing is also occurring, but is concentrated in rice. These findings suggest that Dry Zone agriculture is at a technological crossroads.

Data analyzed originates from the Rural Economy and Agriculture Dry Zone (READZ) survey, conducted in April and May 2017. The survey was designed to generate a detailed picture of the Dry Zone's rural economy, including livelihoods, cropping systems, and farming practices. 1578 rural households were interviewed in the townships of Budalin, Myittha, Magway and Pwintbyu. These townships were selected purposively to ensure coverage of the major Dry Zone crops and farming systems.

Enumeration areas and households were drawn at random using the sample frame of the national census, making the data statistically representative of rural areas of the four townships. Most results presented here are derived from an analysis of detailed plot- and crop-level data on machinery use and ownership, collected from these households.

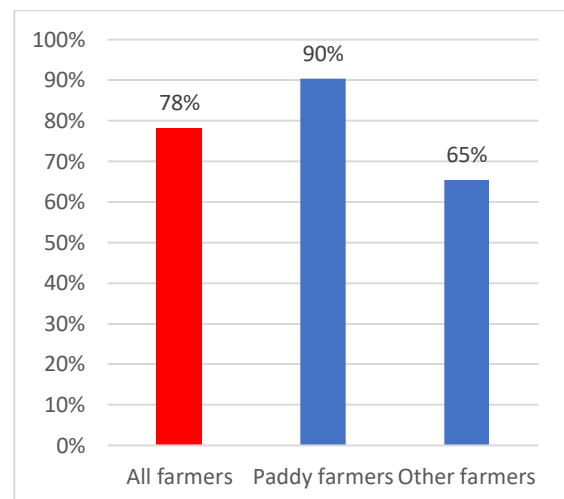
#### KEY FINDINGS

##### Dry Zone mechanization is well under way

Most farmers in the Dry Zone already use agricultural machinery. Amongst all farmers, 78% percent used either a tractor, combine harvester, or a mechanized thresher at

least once during the production process over the past 12 months, for land preparation, harvesting or threshing (i.e. excluding transportation and irrigation) (Figure 1). For farmers growing paddy, this percentage increased to 90%. But even among farmers who did not grow any paddy, 65% reported having used machinery in the year prior to the survey.

Figure 1: Share of farmers who used machinery for agriculture at any point in the past 12 months, by type



Note: excludes mechanized transport of agricultural goods

The most commonly used type of machine is a four-wheel tractor (4WT), used by nearly 50% of farmers in the past year. Threshers and two-wheel tractors (2WT) follow, used by about a third of farmers each. Only 11% of farmers used a combine harvester (Figure 2).

Figure 2: Share of farmers having used agricultural machinery, by machine type

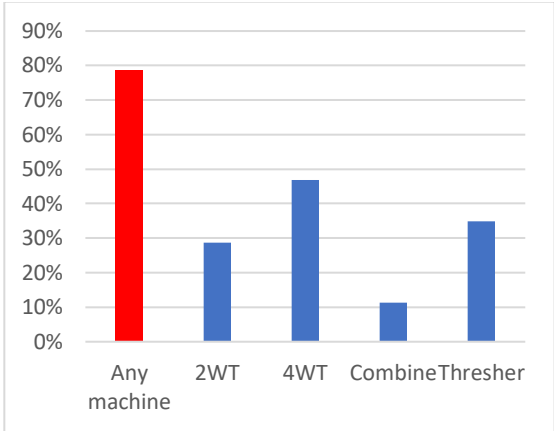
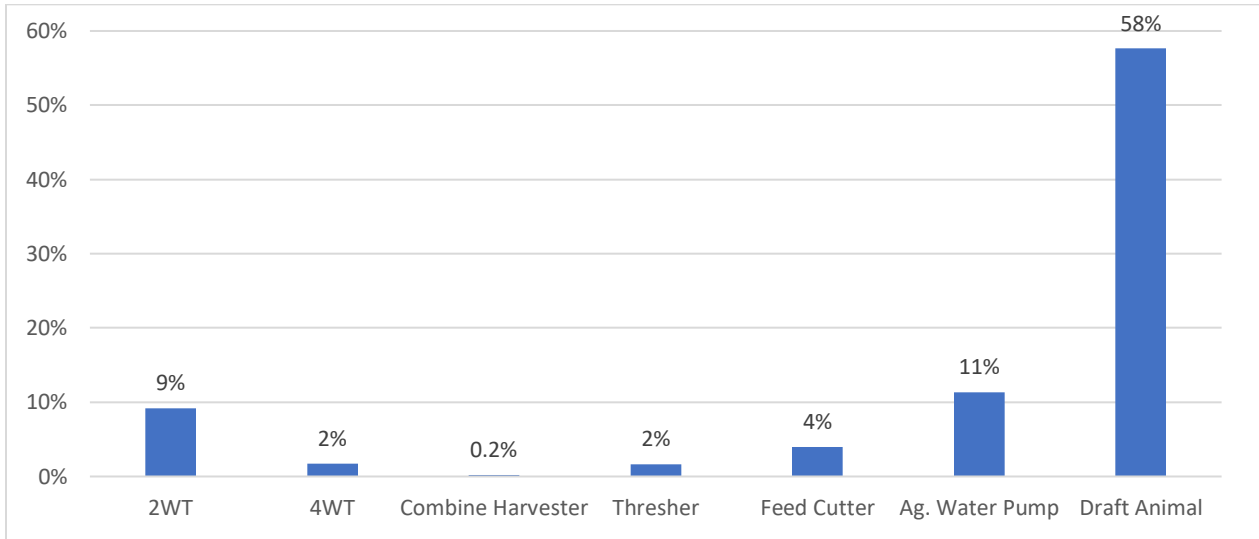


Figure 3: Share of ownership among farmers in the sample



### Rental markets play a key enabling role

Use of rented machinery is much more common than use of own machinery. Nearly 90% of all machinery used was rented. This percentage falls for larger farmers, but not dramatically: Seventy-eight percent of machinery used by the largest third of farms in the sample was rented.

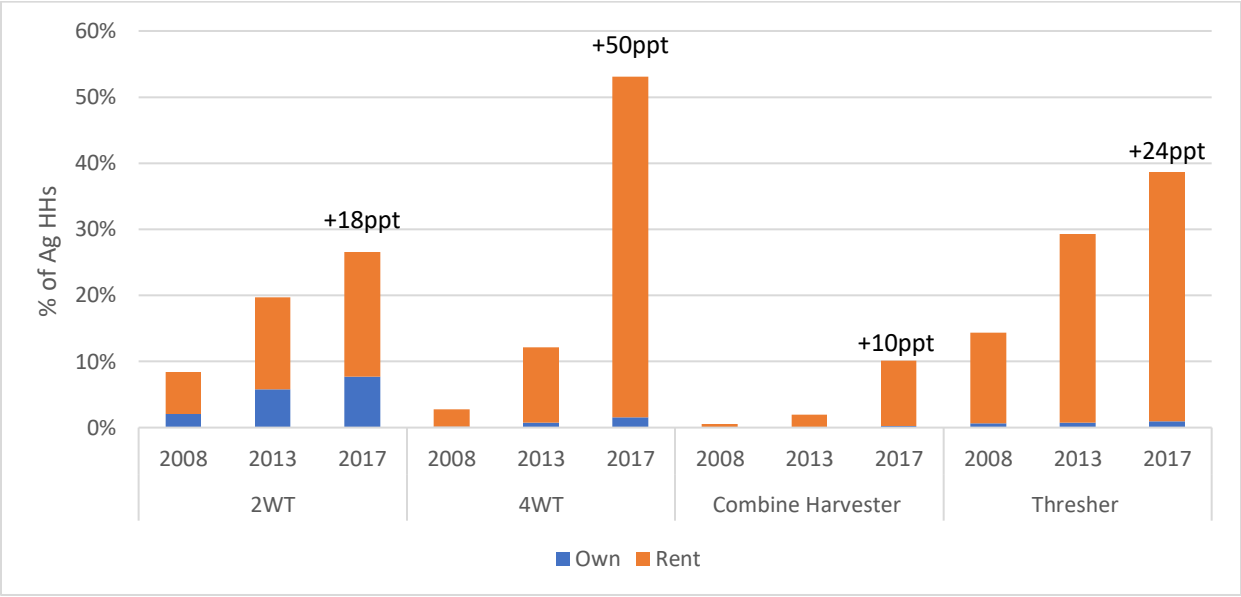
### Ownership of machines is limited

Although the use of machines is widespread, rates of ownership remain low. Only 9% of all farmers in the sample owned a two wheel tractor, and less than 2% owned a four wheel tractor (Figure 3). Animal power remains important. Fifty-eight percent of farmers owned a draft animal (ox or water buffalo). Ownership of machines is related to landholding size: less than two percent of famers in the smallest landholding tercile (the smallest third of farms) owned a tractor, compared to 16% in the largest tercile. However, rental markets enable farms to mechanize whether or not they own machinery.

Figure 4 breaks down trends in machinery use over the past ten years by machine type and ownership status. Over a ten-year period, the use of two-wheel tractors increased threefold, from use by 9% of farm households to 27%. The growth in four-wheel tractors was even

more spectacular, rising from 3% of households in 2007 to 53% in 2017. Combine harvesting and threshing also increased very rapidly over the period. Crucially, as the figure shows, these increases in machinery use have been driven almost entirely by rentals.

Figure 4: Share of farmers using different types of machinery, by year and ownership status



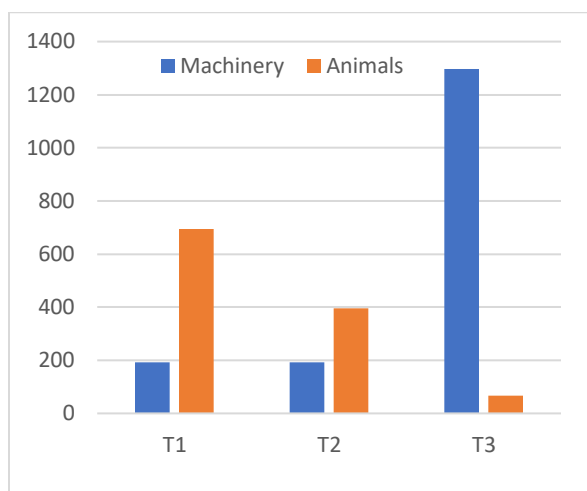
Note: +NNppt = percentage point change over ten years.

From the supply side, farmers who own machines often provide machine rental services in order to generate income. Just over 1% of all households in the sample (including some of whom were not farmers) earned income from providing agricultural machinery rental services. This is similar to the share of households who derived an income from renting out draft animals (1.2%).

These activities are seasonal, but lucrative. Figure 5 shows that machinery rentals are primarily an activity

engaged in by larger farm households, while animal draft power services are primarily a way for households with smaller landholdings to supplement income. The monetary value of revenues mirrors that pattern: the rental of animal services generates about USD \$400 per year in revenue (\$350 of profit), while the average four-wheel tractors rental generates USD \$2500 in revenue per year (\$1500 profit).

Figure 5: Number of farmers engaging in rentals of machinery or draft animal services.



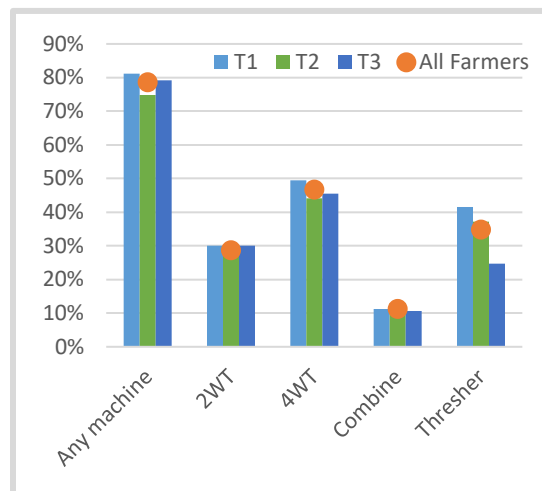
Note: Numbers are population-weighted.

### The mechanization revolution is scale-neutral

A remarkable consequence of thriving rental markets is that machine use is virtually independent of landhold-ing size. Small farmers (defined here as those in the first landholding tercile) are almost as likely to use machines as medium or large farmers, with 80%, 73% and 81% of farmers in each tercile, respectively, using machinery of any kind.

Farmers in all three landholding terciles (T1, T2, T3) were equally likely to have used a two-wheel tractor, a four-wheel tractor, or a combine harvester. One exception is that smaller farms seem somewhat more likely than larger farms to have used a thresher. This overall lack of differentiation in machine use by landholding size is testament to the dynamism and effectiveness of rental markets.

Figure 6: Share of farmers using different machines, by farm size



Note: T1, T2, T3 are landholding terciles, smallest (T1) to largest (T3)

### Machine purchases have risen dramatically

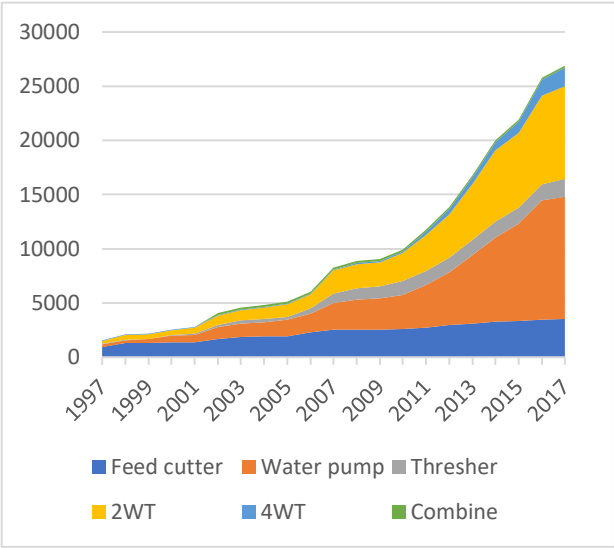
Despite most machines being accessed via the rental market, machine ownership has grown sharply.

Figure 7 plots the number of machines in the sample by year of purchase from 1997 to 2017, including tractors, threshers, combine harvesters, feed cutters (for animal fodder), as well as water pumps for irrigation. In the year 2000, most machines were engine powered feed cutters and water pumps, with only about 400 two-wheel tractors and 60 four-wheel tractors in the whole surveyed area. The total number of agricultural machines in the area barely reached 2,500. Sixteen years later, this number increased tenfold, to nearly 27,000.

Growth was driven primarily by purchases of small machinery, with more and more households purchasing water pumps and two-wheel tractors, of which there were 11,000 and 8,500, respectively, at the time of survey. Purchases of feed cutters and threshers grew modestly but consistently.

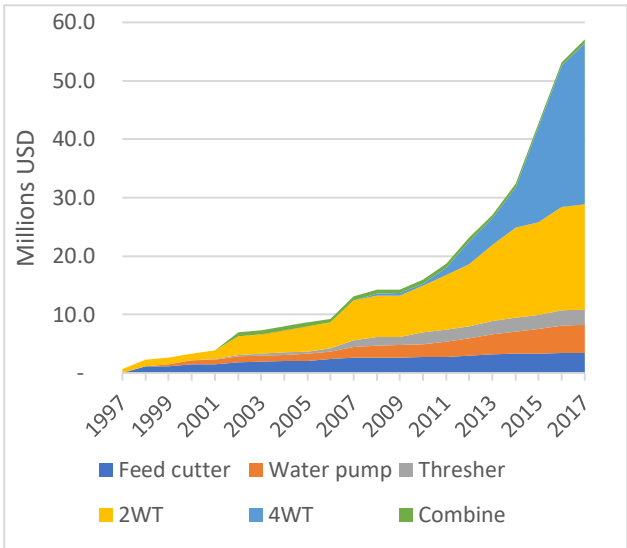
Ownership of large machinery remains rare in absolute terms, but recent growth has been very rapid. Farmers in our sample area owned 1700 four-wheel tractors in 2017. More than half of these large machines were purchased within the past three years. While the number of large machines remains low, these purchases represent a huge increase in total mechanical power in the area. Figure 8

Figure 7: Total number of machines purchased, by year



illustrates this by plotting the monetary value of machines owned by households in the sample over time. In value terms, four-wheel tractors are the dominant category today – a shift that occurred almost entirely after 2014. The dominance of two-wheel and four-wheel tractors in Figure 8 illustrates the rapid shift towards mechanized traction in the Dry Zone.

Figure 8: Total value of machinery, by year of purchase

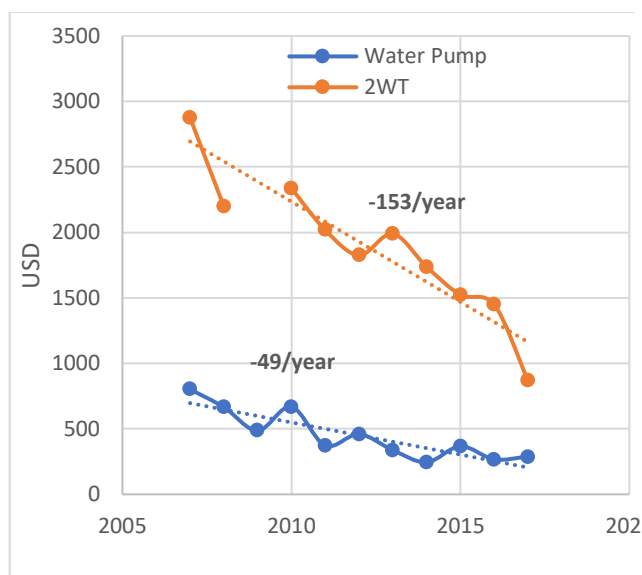


### Drivers of mechanization

One of the primary drivers of mechanization is the rising scarcity and cost of labor, which incentivizes farmers to replace labor with machines. Our data shows that real wages (adjusted for inflation) increased by more than a third over the period 2012 to 2016. This increase is partly due to out-migration of the labor force in search of more remunerative work opportunities, most importantly in Myanmar’s growing cities, and to a lesser extent abroad. Among all households in the sample, 43% had at least one member who had ever migrated in search of work, most of whom had left within the past five years.

In parallel, over the same period machines have become more affordable, in part due to an increased supply of machinery at competitive prices from neighboring China and Thailand. Figure 9 shows the dramatic drop in the cost of water pumps and two-wheel tractors in the past 10 years (converted to current prices). The cost of a water pump for irrigation dropped from the equivalent of \$800 ten years ago to less than \$300 today, an average reduction of \$50 per year. Even more dramatically, the cost of a two-wheel tractor dropped from nearly \$3000 ten years ago to well below \$1000 today.

Figure 9: Cost of machinery over time (in 2016 USD)



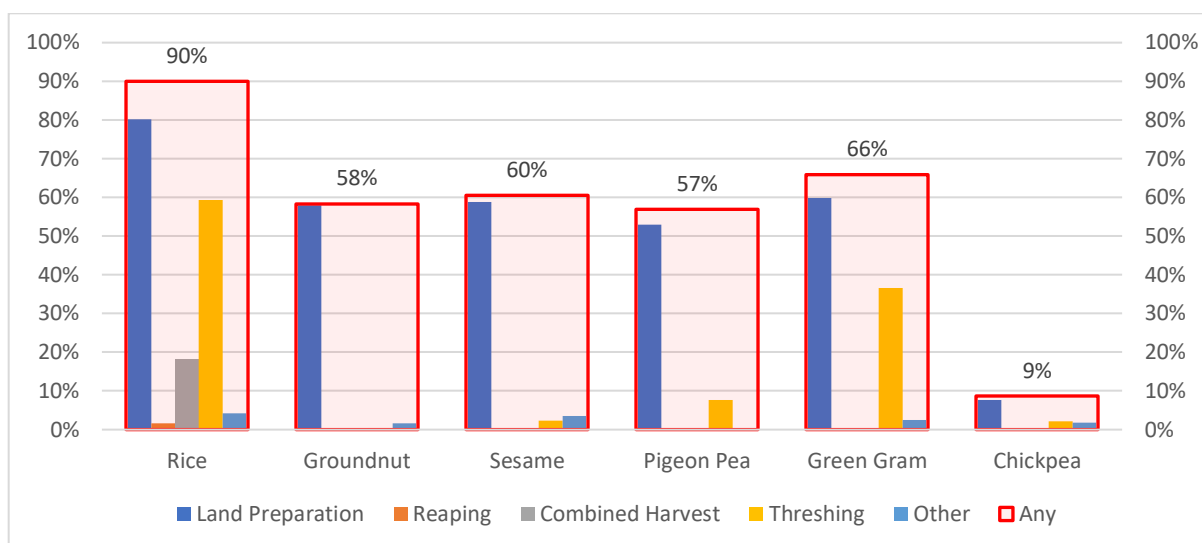
A final important enabling factor for mechanization is access to finance. While in the past farmers could rarely access formal loans, and had to pay the full cost of machines in cash, today they can use a range of financing options for their purchases. The most commonly used are hire-purchase agreements (HP), under which farmers front an initial down payment and pay off the remaining balance over one or more years. More than half of all machine purchases are now made by HP. HP is sometimes offered by machinery dealers, but since 2013 is more commonly provided by banks.

### Mechanization is far from complete, and dominated by rice

Despite evidence of significant uptake of agricultural machinery, the Dry Zone is still far from having a fully mechanized rural economy. Production of rice is more fully mechanized than other crops. The large red bars in Figure 10 show that machinery was used on more than 90% of rice plots, but this drops to roughly 60% for the major oilseeds and pulses, and is only 9% for chickpea. In other words, about 40% of farms producing major commercial crops such as sesame and green gram are relying exclusively on human and animal power.

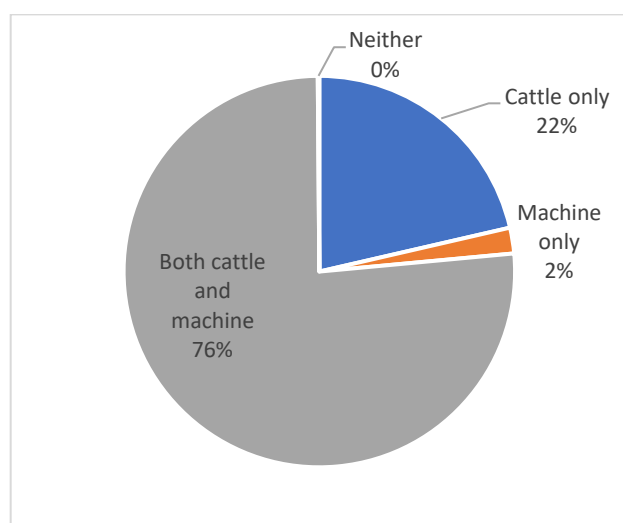
Figure 10 also breaks down machinery use by crop management practice (inside of each red bar). Land preparation is far ahead of other processes in terms of mechanization. For all crops except chickpea, more than 50% of plots used mechanized land preparation. In contrast, only two crops use mechanized threshing to a significant degree: rice (60% of plots) and green gram (40% of plots): for all other crops, mechanized threshing was used in less than 10% of plots. Combine harvesting is used exclusively for rice (20% of plots).

Figure 10: Share of crops being farmed with machinery, overall and by phase of production process.



The use of draft animal power is still widespread. Figure 11 shows that only 2% of farmers are entirely mechanized while less than a quarter of farmers (22%) used only draft animals. The vast majority (76%) use a combination of traditional and modern technology. Further, 70% of farmers used draft animal power to haul their crops to market.

Figure 11: Share of farmers using cattle and machinery on the farm



## CONCLUSIONS

Our analysis reveals the following main conclusions:

- 1) Agricultural mechanization is advancing rapidly in the Dry Zone. Already, a majority of farmers use some form of mechanized power for crop production. But the mechanization process is far from complete. Machinery is used mainly for land preparation. Harvesting and threshing are performed manually for most crops, and even in paddy cultivation these processes are only partially mechanized. This appears due in part to a lack of locally adapted machinery and attachment designs.

Particularly for non-rice crops, farmers do not have access to machinery for use in all stages of the production process. Threshers and combine harvesters, need screens precisely engineered for each crop. Even for a given crop, not all varieties can be reaped and threshed mechanically (due to issues of height consistency, stem rigidity, and grain/glume/husk characteristics), and high levels of seed purity are needed to maximize the efficiency of mechanized harvesting.

Figure 10 suggests that, when it comes to reaping and threshing of non-rice crops, currently available machines are not adapted to the currently predominant crop varieties (and vice-versa). The advancement of mechanization in the Dry Zone will likely depend on a process of mutual adaptation of the machinery, varieties and seed quality employed.

- 2) Machine use has spread rapidly due to a thriving rental market, making adoption of machinery scale neutral at the point of use. This has enabled small-holder farmers to benefit from mechanical technology, while generating income for those who have invested in equipment.

- 3) Though relatively few households own machinery, purchases have accelerated over the past few years. This reflects the combined effect of rising labor costs and labor shortages, making mechanization an increasingly cost-effective option. The availability of hire purchase financing and the falling real price of machines has also boosted machinery sales.



## ABOUT THE AUTHORS

**Mateusz Filipski** is a Research Fellow at the International Food Policy Research Institute

**Ben Belton** is an Assistant Professor at Michigan State University

**Joanna Van Asselt** is Senior Research Assistant at the International Food Policy Research Institute (IFPRI)

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