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Synopsis: Agricultural Mechanization in Ethiopia: Evidence from the 2015 *Feed the Future* survey

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In this research note, we provide a preview of results from a study of agricultural mechanization in Ethiopia. Our research shows that 9 percent of farmers in the *Feed the Future* regions of Ethiopia used mechanization at some point during the agricultural year 2014/15. We find that mechanized ploughing was most widespread (5 percent), while mechanized threshing and harvesting was reported by 3 and 2 percent of households, respectively. We further examine the uptake of different forms of mechanization through a number of associations. The results show that farm size and rural wages are positively associated with the adoption of mechanization, while remoteness is negatively linked. These findings suggest that as Ethiopia's economy transforms and leads to higher rural wages, as well as with further development of its infrastructure, more demand for mechanized agricultural services will likely arise. Having policies that actively assure widespread availability of appropriate mechanized services at low cost, seem likely to benefit Ethiopia's agricultural transformation.

Introduction

Ethiopia's economy is transforming rapidly, mostly driven by growth in the agricultural sector. This growth has led to significant poverty reduction, given the large share of Ethiopia's population that lives in rural areas with livelihoods that depend on agriculture. Among the mechanisms through which agricultural growth has been achieved is through intensifying land use and increasing labor productivity, including through mechanization. In this research note we explore the scope and determinants of agricultural mechanization through examining data from a large household survey of nearly 7,000 smallholder households in five regions of the country. While not representative of the regions, analysis of the data set offers a first chance to look at mechanization in Ethiopian agriculture. These preliminary insights should benefit future research on agricultural mechanization in the country.

Data

In mid-2015, with support from IFPRI-ESSP, the Central Statistical Agency (CSA) conducted a survey of nearly 7,000 households in 84 of the 670 rural districts (woredas) of Ethiopia. The survey covered Amhara; Oromia; Tigray; and Southern Nations, Nationalities, and Peoples (SNNP), the four main regions of the country, plus Somali region. The survey's main purpose was to obtain post-intervention data from representative areas that are under the Feed the Future (FtF) program, and from areas selected to serve as controls for the evaluation of the program. FtF, funded by the United States Agency for International Development (USAID), seeks to improve agricultural production and nutrition.

To our knowledge, this is the first large-scale survey that contains plot-level questions on agricultural mechanization in Ethiopia. Here we focus on results from the four main regions only, due to the small sample size in Somali region (368 households).

Descriptive analysis

Table 1 shows that out of the 5,969 households engaged in agricultural production, 9 percent use machine power to either plough their land, harvest their output, or thresh their crops. 5.5 percent of households reported having used a machine to plough their land either in the 2015 Belg or 2014 Meher season. Mechanized threshing and harvesting was reported by 3 and 2 percent of households, respectively. Further disaggregation by region shows that mechanization is most common in Oromia with 11 percent of farmers in our sample reporting to have used machines. In other regions, the percentages hover around 7 and 9 percent. Using machines to plough land is more common in Tigray, while machine harvesting and threshing are more common in Oromia.

Table 1: Households using agricultural machinery, percent

Region	Farmers, no.	For any operation	For ploughing	For harvesting	For threshing
Tigray	603	9.1	8.3	0.5	0.7
Amhara	1,656	7.4	5.7	1.6	0.1
Oromia	2,111	11.5	4.1	7.1	5.6
SNNP	1,599	7.7	6.2	1.6	0.0
Full sample	**5,969**	**9.1**	**5.5**	**3.4**	**2.1**

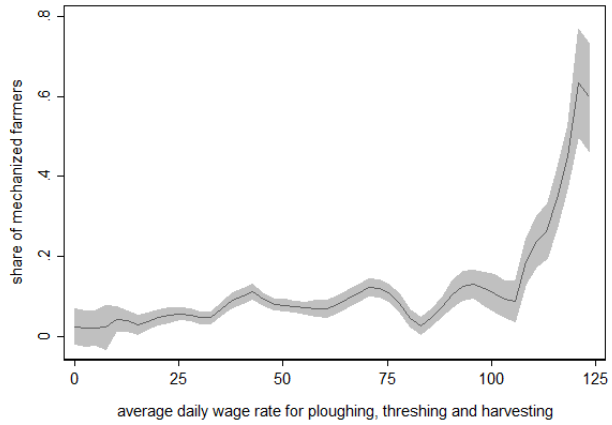
Source: Authors' calculations from the 2015 Feed the Future survey.

Farmers rarely exclusively own these machines. About 64 percent of the machines used to prepare land were rented. Only 22 percent of farmers reported owning their ploughing machine and 13 percent used government owned machines. Shared ownership was rare with only one farmer reporting this. Regarding the use of harvesters, 63 percent of farmers rented these, 20 percent used their own, 13 percent used government owned machines, and 4 percent relied on shared ownership. Virtually all farmers (96 percent) using threshing machines reported having rented them.

Previous research conducted in China found that increasing wage rates was one of the key drivers of agricultural machinery adoption. Figure 1 shows the relationship between the share of farmers using machines and the wage rate in the community. We see that the likelihood of a farmer adopting mechanized agriculture increases as the daily wage rate increases, especially towards the end of the wage distribution.

Finally, we study the characteristics of the farmers using machines through a regression model. Table 2 reports estimates from a probability model that regresses the (latent) probability of households operating machines in agricultural production on a number of household characteristics. The estimates suggest that household size, gender, and the age of the head are not important determinants of mechanization. In contrast, households with educated heads are more likely to use agricultural machines. As

Figure 1: Mechanization and daily wage rates, Birr/day



Note: Local polynomial regression. Shaded area represents 95-percent confidence interval. Source: Authors' calculations from the 2015 *Feed the Future* survey.

expected, land size is positively associated with the probability of using machines during land preparation, harvesting, and threshing. Interestingly, households with predominantly flat land are more likely to use machines during harvesting and threshing, but less likely during ploughing. Similarly, farmers with more fertile land are less likely to use machines during ploughing. However, (self-reported) soil quality does not predict the likelihood of adoption of machinery during harvesting and threshing. Teff farmers are more likely to use machines during land preparation, but less likely during harvesting and threshing. In contrast, maize farmers are more likely to use machines during harvesting, but not for other operations. Sorghum farmers are more likely to use machines for ploughing and threshing, but not for harvesting.

We also explored whether remoteness plays a role in technology adoption. We find that farmers that are located farther away from the towns are less likely to engage in mechanized agriculture. This could be because transporting the, mostly rented, machinery to remote areas is difficult and expensive and spare parts can be difficult to access. Finally, the regression model shows that agricultural wage rates predict machine use especially during ploughing and harvesting, although less so during threshing.

Concluding remarks

In this research note we provide a preview of agricultural mechanization in Ethiopia. We show that 9 percent of the smallholder farmers in FTF zones used mechanized services at some point. We find that mechanized ploughing was most widespread (5 percent), while mechanized threshing and harvesting was reported by 3 and 2 percent of households, respectively. While adoption of mechanization is low, it is worth emphasizing that these findings are based on a non-representative sample of the regions that were surveyed. Therefore, in the future any further work should seek to verify these findings through specialized surveys on agricultural mechanization. Moreover, the results evolving from the regression framework should be considered as associations only and not to indicate the causes of mechanization adoption. Further research is needed to establish the latter.

Table 2: Determinants of mechanization

Variable	mean (std. dev.)	For any operation	For ploughing	For harvesting	For threshing
Female household head	0.272	0.008	0.007	0.000	0.002
	(0.445)	(0.009)	(0.007)	(0.005)	(0.004)
Age of household head	44.77	0.000	0.000	0.000**	0.000**
	(14.82)	(0.000)	(0.000)	(0.000)	(0.000)
Education of household head (in years)	1.588	0.004***	0.001	0.002**	0.002***
	(2.843)	(0.001)	(0.001)	(0.001)	(0.001)
Household size	5.047	0.003	0.001	0.002	0.000
	(2.165)	(0.002)	(0.002)	(0.001)	(0.001)
(log) land size	0.694	0.016***	0.012***	0.005*	0.007***
	(0.995)	(0.005)	(0.004)	(0.003)	(0.002)
Number of parcels	3.471	-0.001	-0.003*	0.003*	0.000
	(2.324)	(0.002)	(0.002)	(0.001)	(0.001)
Share of flat land	0.690	-0.029***	-0.047***	0.017***	0.014***
	(0.400)	(0.010)	(0.009)	(0.006)	(0.004)
Share of infertile land	0.053	(ref.)	(ref.)	(ref.)	(ref.)
	(0.181)				
Share of fertile land	0.657	-0.059**	-0.057***	-0.002	0.014
	(0.418)	(0.025)	(0.021)	(0.015)	(0.012)
Share of semi-fertile land	0.287	-0.103***	-0.088***	-0.019	-0.002
	(0.392)	(0.026)	(0.022)	(0.015)	(0.011)
Tropical livestock units owned by household	3.291	0.000	0.001	-0.000	-0.000
	(3.418)	(0.001)	(0.001)	(0.001)	(0.001)
Teff	0.401	0.007	0.016**	-0.013***	-0.020***
	(0.490)	(0.009)	(0.007)	(0.005)	(0.003)
Maize	0.509	0.015*	0.011	0.011**	0.004
	(0.500)	(0.009)	(0.007)	(0.006)	(0.005)
Barley	0.228	0.002	0.010	-0.009	-0.014***
	(0.420)	(0.010)	(0.008)	(0.007)	(0.005)
Wheat	0.293	0.064***	-0.004	0.068***	0.071***
	(0.455)	(0.010)	(0.007)	(0.007)	(0.006)
Sorghum	0.183	0.053***	0.041***	0.007	0.013***
	(0.386)	(0.013)	(0.012)	(0.006)	(0.005)
Roots and tubers	0.313	0.003	0.001	0.001	-0.016***
	(0.464)	(0.013)	(0.011)	(0.008)	(0.005)
Fruits and vegetables	0.239	0.007	0.008	0.000	-0.002
	(0.427)	(0.010)	(0.009)	(0.005)	(0.003)
Other crops	0.709	-0.023***	-0.007	-0.019***	-0.028***
	(0.454)	(0.009)	(0.007)	(0.006)	(0.005)
(log) distance to the nearest town	2.358	-0.016***	0.004	-0.019***	-0.019***
	(0.770)	(0.005)	(0.004)	(0.003)	(0.002)
daily wage for the activity (in 10 birr)	5.694	0.015***	0.003*	0.005***	0.000
	(3.225)	(0.003)	(0.002)	(0.001)	(0.000)
daily wage rate squared	n/a	-0.0004***	n/a	n/a	n/a
		(0.0001)			
Zone dummies?	n/a	yes	yes	yes	yes
Adjusted R^2	n/a	0.127	0.125	0.131	0.217

Note: Sample of 5,795 farmers. The four rightmost columns are results of linear probability models. Robust standard errors in parentheses. Statistical significance denoted at *** p<0.01, ** p<0.05, * p<0.10.
Source: Authors' calculations from 2015 Feed the Future survey.

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