

Small-scale farmers and large machines

The why and how of agricultural mechanisation in Ghana



In brief

- Despite the small farm sizes and large investment required for agricultural machinery, cereal-producing farmers in Ghana have widely adopted tractor plowing.
- This brief uses a case study of Yendi district to understand how the sharing of tractor service works, and the impact that tractor use has on the use of labour and other inputs.
- The research finds that the private market for tractor service relies upon strong family and social networks to overcome the coordination problem at the core of the market – namely, how to order service provision given transport costs and localised rainfall patterns.
- Improving the timeliness of land preparation is a greater motivation for machinery use than labour replacement.
- The authors outline five policy implications to guide the targeting of future government support to mechanisation, and to consider the bottlenecks and environmental consequences created by mechanised land preparation.

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Motivation

The mechanisation of agriculture has occurred relatively slowly across sub-Saharan Africa, even though agro-ecological conditions seem generally favourable. Although cropland remains relatively abundant in many parts of the continent, which would normally be conducive to the use of tractors and other machines, the vast majority of farm land continues to be prepared and farmed with human power – or with animal traction in some locations (Mrema et al., 2008). Since colonial times, governments have sought to introduce tractors, using a variety of programmes and interventions, but to little effect; farmers have been slow to take up tractors and other machines. In many ways, tractors exemplify the kinds of problems that limit technology adoption across African agriculture: they are lumpy capital investments, requiring knowledge and learning, and susceptible to many kinds of risk. Perhaps it is unsurprising to find that tractors are used on less than 10% of cultivated area in most of West and Central Africa.

Against this backdrop, it is interesting to look at a surprising success story. In the cereal-producing areas of northern Ghana, mechanisation has become commonplace within the local farming system, with more than 90% of farmers relying on tractors for plowing. This is not driven by large farms or consolidation of land holdings; the region is characterised by smallholder agriculture. Instead of farmers buying or owning tractors, they contract with hired operators to provide land preparation services at the start of the growing season. This market for tractor services has taken off since the early 2000s. This trend contrasts with perceptions of agricultural stagnation and also runs counter to frequently voiced arguments that mechanisation does not make economic sense in settings where capital is expensive and labour is cheap.

The adoption of tractor use emerges from a context of long government support: the government of Ghana has long promoted mechanisation as one of its strategic objectives. The Food and Agriculture Sector Development Policy (2007) includes as a crosscutting objective to increase the area of land, which is cultivated with machinery, and also increase the ratio of machinery to farmers. Similarly, the METASIP (2010) details the spending by government to establish agricultural mechanisation centers in each of Ghana's districts. However, this episode of mechanisation has largely been driven by private markets, albeit building on a long legacy of government support. The findings of this research project provide the government and other local stakeholders with improved information about the current mechanisation use, its interaction with existing farming systems and institutions, and a better understanding of the constraints and policies that might allow for mechanisation to expand.

Research methods

The project used several methods to investigate the use of agricultural machinery. First, the 2009-10 Ghana Socioeconomic Panel Study Survey was used to understand the extent of machinery use across the country, as well as to investigate how mechanisation interacts with other aspects of the farming system¹. The survey found that 31% of farm households across Ghana were using agricultural machinery for cultivation on at least one of their plots in 2009. Once this is broken down by region, however, a strong pattern emerges. Depending on the measure, 88-95% of farm households in the three northern regions used tractors for cultivation. The same survey found only eight households which owned agricultural machinery, demonstrating that most farmers access mechanised technology through the hiring market. The second component of the research was an in-depth case study of Yendi district (Northern region). This case study was carried out through focus groups discussions and individual interviews in 21 villages, and a 250 household quantitative survey. Yendi is amongst the more highly mechanised districts in the Northern region, and it is typical for the region in terms of population density and agricultural growing conditions. The case study enabled investigation of the hiring market for tractor services.

Key findings

The agro-ecological specificities of the northern region, combined with the high demand for maize, make it profitable to carry out land preparation within a narrow time window. The need for timely land preparation is the driver of tractor use.

In the northern regions of Ghana, where there is a single growing season, maize is highly profitable relative to other crops, but it is a somewhat marginal crop in terms of its suitability for the climate. In particular, there is a narrow planting window for farmers at the time of the arrival of seasonal rains. Farmers face powerful incentives to prepare their land for maize farming within a few days. Traditional methods of land preparation, such as reliance on shared labor, cannot deliver this rapid land preparation, because within communities all households need to carry out land preparation at approximately the same time. Tractors can plow large swathes of land quite quickly. This means that tractor use has been taken up widely, driven by farmers' desire to grow maize.

Profits are thus sensitive to tractor access. Farmers in Yendi district indicated that in 40% of plots where planting was done late, the reason was difficulty in accessing tractor services. The data show a significant

1. The survey is a joint effort undertaken by the Institute of Statistical, Social and Economic Research (ISSER) at the University of Ghana, and the Economic Growth Centre (EGC) at Yale University. Disclaimer: ISSER and the EGC are not responsible for the estimations reported by the analyst(s).

correlation between timely planting, tractor use, and yield per hectare, even controlling for fertiliser and hired labour use.

The tractor hiring market is structured around communities, family relationships, and informal networks, rather than depending entirely on formal market arrangements.

Although tractor hiring in northern Ghana clearly takes place through market transactions, the market is strongly mediated by social networks, community cooperation, family relationships, and other social institutions. The market in many ways reflects pre-existing social institutions that supported mutual assistance and cooperation in planting. In earlier times, farmers shared labour to prepare fields with hand tools. Now communities coordinate to access tractor services. Typically, they jointly arrange to hire a single operator to come to the village and plow all the fields at the same time. This allows for efficient sharing of the fixed cost of bringing a tractor from a nearby town, and it reduces the total costs of plowing the community's fields, relative to an alternative in which each farmer contracted separately with a tractor operator.

These collective action solutions are built on top of existing social structures and relationships, so that the market is mediated through a web of relationships. Farmers in Yendi are more likely to plant on time if they access tractor services from an owner or operator who is known to them; they are also more likely to get timely services if they belong to a household that includes a village chief or elder. Communities are more likely to get timely services when the tractor is owned by a village member, and individual farmers are more likely to get prompt service when the operator is from the same village or social network. When a farmer relies on a tractor operator/owner whom she or he does not know personally, the probability of the work being completed on time is only 25%. By contrast, when a farmer knows the tractor owner/operator personally, the probability of getting timely service rises to 61%. Qualitative discussions with farmers confirm that they prefer to get services from tractor owners or operators with whom they have some existing connection, either through family networks, or other farming transactions such as hired or communal labour exchange. Therefore, transactions in the tractor hiring market must be considered in the context of the existing social capital that connects participants in the market.

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Mechanisation is not reducing the labour requirement for agricultural production

In the short term, we find evidence that the use of machinery for land preparation is associated with increased labour use per hectare, rather than with decreased labour input. (These are correlations, rather than causal claims, but the patterns are strong.) Although we might expect human labour to be replaced by tractors, the farming system remains highly labour-intensive for all other agricultural operations. By improving

the supply of machinery services, farmers are able to access and use machinery services more reliably and therefore make within-season investment decisions to improve their output per unit of land. Tractor use is also associated with higher levels of fertiliser use. However, we find no conclusive evidence that machinery use is associated with increased area of cultivation or with improved land or labour productivity, at least in the short term; possibly this reflects constraints on farm size that are due to population density and land institutions. However, we note that relatively small farm size does not appear to be a barrier to the use of machinery for land preparation, since farmers of all scales are using machinery.

Policy implications

- The government should consider carefully the targeting of any subsidies for machinery. A thriving rental market suggests that private incentives are strong.
- To the extent that the government seeks to continue subsidies for tractor purchase, these subsidies will be most effective if they are directed to tractor owners and operators who are well connected to the areas that they serve. This reflects the reliance of smallholder farmers on relationship-based contracts for tractor services.
- As an alternative to government supply of machinery, credit facilities for groups of farmers to purchase machinery on the private market could also work to improve the timeliness of service delivery.
- The benefits of agricultural machinery in terms of increasing agricultural production will continue to be limited by challenges in accessing land and working capital for investments in other productivity-enhancing inputs. Therefore, mechanisation should be considered in tandem with effort to improve bottlenecks in other areas of the farming system.

As a caveat to the above recommendations, farmers frequently raised a long-term and serious issue. The soil fertility in Yendi, and likely elsewhere in northern Ghana, is said to be declining. Farmers and agricultural experts attribute this problem to intensive cultivation with inappropriate plowing technology (i.e. using disk plows rather than moldboard plows). Government should consider the effect of increased mechanisation on the current and long-term sustainability of farming system. Declining soil fertility will reduce labour and land productivity over time.