GHANA
Strategy Support Program

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI
A member of the CGIAR Consortium

POLICY NOTE 09 • SEPTEMBER 2016

MEETING GHANAIAN FARMERS' DEMAND FOR A FULL RANGE OF MECHANIZATION SERVICES

Nazaire Houssou, Patrick Aboagye, and Shashidhara Kolavalli

Rising labor costs associated with increased rural-to-urban migration have compelled Ghanaian farmers to increase the use of tractors and other agricultural machines to conduct farming operations in the country (Diao et al. 2014). The adoption of these mechanical technologies is consistent with the tendency among Ghanaian farmers to save labor, rather than embrace practices that create additional labor needs (Houssou et al. 2016). Tractor use is concentrated on plowing and other tillage operations primarily (Houssou et al. 2013), but the supply of tractor services is inadequate. Earlier research estimated that plowing services represent 90 percent of the revenues of tractor service providers (Houssou et al. 2013). Both public and private supply of plowing services may have contributed to an expansion of the area under cultivation in Ghana, thereby exacerbating labor bottlenecks in post-tillage field operations for many farmers.

THE SUPPLY OF TRACTOR SERVICES TO GHANAIAN FARMERS

Facilitating agricultural mechanization is an objective of the government of Ghana. As the demand for plowing services is not met adequately by the market, government's strategy has been to import tractors and other agricultural machines and to sell them at a discount to individuals and public organizations. Since 2007, the policy has encouraged the development of private mechanization centers, Agricultural Mechanization Service Enterprise Centers (AMSEC), to provide tractor services to small farmers. Between 2007 and 2015, Government imported nearly 2,000 tractors, selling them to individual farmers, organizations, and mechanization centers at a price that included a 33 percent subsidy.

Ghana's agricultural mechanization strategy relies on concessional loans, primarily from emerging countries, as well as grants from Japan to some degree, to import new tractors to meet farmers' demand for tractors and other agricultural machinery. The effectiveness and sustainability of this strategy remains in question. Under these financing agreements, the government usually negotiates imports of small batches of machines from different countries. However, this has limited the development of maintenance and repair services for the imported tractors on the private market. When interviewed in 2012, spare parts dealers indicated that it is not economically viable to import small volumes of parts for the different brands of tractors imported under these financing agreements. They recommended instead that the government of Ghana should import only a few brands of tractors to encourage expansion of the market for tractor spare parts.

At the same time as the government has been importing tractors, private companies have been doing the same, particularly importing used tractors that are more affordable for Ghanaian farmers. Between 2006 and 2012, about 2,000 used tractors were imported into the country (Diao et al. 2014). Eighty percent of imported tractors sold through private channels are second-hand (Houssou et al. 2015).

Analysis of data from the IFPRI and Savanna Agricultural Research Institute (SARI) survey of medium and large-scale farmers and tractor owners in Ghana, which was conducted in eight districts between October and December 2013, indicates that nearly 90 percent of tractors (433 of 487) operating in the survey districts came from private sources. These tractor owners, in addition to using these machines on their own farms, offer tractor services to other farmers. These tractor owners reported that they seasonally operate their tractors over land areas of 450 acres on average. Many also use their tractors with mechanical attachments to offer shelling services. These private tractors account for the bulk of tractor service provision in the survey districts, providing more than 80 percent of all mechanized services for farming (Houssou et al. 2015).

Private tractor service provision operations generally have been found to be profitable, at the same time as the AMSEC mechanization centers struggle to be economically viable. Private tractor service providers are able to cover their costs with their revenue and realize profits without any state subsidy. Conversely, state-sponsored service centers are less efficient in offering tractor services, plowing on average only 168 acres in northern Ghana and 206 acres in southern Ghana per tractor per year. The AMSEC mechanization centers generally are unable to make profits, even with making use of tractors purchased at subsidized prices (Houssou et al. 2013). Moreover, one result of the government's strategy of importing small lots of tractors from multiple sources is that repairing the tractors following breakdowns is challenging due to an absence of spare parts. This delays the field operations of the AMSEC mechanization centers, reducing their revenue (Houssou et al. 2013). As of 2010, the overall repayment rate of tractor purchase credits obtained by AMSEC mechanization centers was 36 percent (JICA and Task Company Ltd. 2014).

In contrast, spare parts for the used tractors operated by individual farmers providing other farmers with tractor services are readily available on the private market in the country. Such expansion in the availability of spare parts and repair services for tractors has been shown elsewhere to be a key determinant of successful uptake of agricultural mechanization (Mrema et al. 2008). Other critical issues, such as poor skills of tractor operators or mechanics, have also compounded the problems facing these AMSEC mechanization centers (Houssou et al. 2013), although these issues are not unique to the state-sponsored centers alone. Some donors, such as JICA, are helping government address some of the issues that constrain the increased use of agricultural machinery in Ghana. Moreover, research suggests

that the mechanization centers could viably operate under a privatized business model if they extended the range of mechanized services that they offer to farmers (Houssou et al. 2015).

The government of Ghana continues to negotiate bilateral loans to import tractors and other agricultural machines. The latest loan is through a Brazilian facility initiated in 2011, with the first machines under this loan being imported in June 2016. This concessional loan to Ghana falls under Brazil's More Food International (MFI) program, an export credit facility for developing countries in which concessional loans are tied to the purchase of agricultural equipment manufactured in Brazil. The program draws from Brazil's domestic agricultural policy which offers subsidies to family farmers in order to support modernization through the acquisition of agricultural machinery and implements (Cabral et al. 2016).

Under the terms of the Brazilian loan, the total credit of just under US$ 95.5 million attracts an annual interest rate of 2 percent with a maturity period of 22 years. The loan is divided into three tranches, with a first tranche of US$ 35.5 million followed by two tranches of US$ 30.0 million. Under the first tranche, it is planned that 549 tractors, implements, and other machines will be imported into Ghana. These machines include tractors, such as Massey Ferguson (65 horsepower), Valtra (75 horsepower), and New Holland (65 horsepower); plows; harrows; trailers; planters; seed drills; boom sprayers; harvesters; shellers; and threshers; as well as mobile workshops for servicing. Unlike previous arrangements for importing agricultural machinery, under the Brazil agreement, the government of Ghana is importing tractors with a range of attachments to increase the uses to which the tractors can be put. Compared with the tractors imported by government from Asia a few years ago under similar loan agreements, the tractors acquired under the Brazil loan agreement are more expensive and may be more durable than the previous ones. For example, the Massey Ferguson tractors imported from Brazil each cost US$ 34,600 (Cost, Insurance, and Freight (CIF) price), while a John Deere tractor with the same horsepower imported from India eight years ago cost US$ 15,759 (CIF price).

With the new tractors from Brazil now coming into Ghana, the Ministry of Food and Agriculture is pondering how much subsidy to provide farmers in order to sustain the use of the new machines. This note assesses whether the operations of the new tractors can be economically viable and explores options regarding the kind of support that policymakers might offer prospective tractor owners. By examining farmers' willingness to pay for mechanization services, this policy note identifies some of the ways government can foster an increase in the use of tractors in Ghana.

BREAK-EVEN ANALYSIS OF OPERATIONS OF NEWLY IMPORTED TRACTORS

We use 2016 prices and tractor operating costs to assess whether Ghanaian owners can break-even and make a profit with the new tractors imported from Brazil. We applied the methodology used by Houssou et al. (2013) to estimate the profitability of tractor operations in the three northern regions of Ghana – Northern, Upper East, and Upper West – where most of the new tractors will be allocated.

Different service charges and costs are practiced across the three regions, reflecting differences in the supply of and demand for mechanization. We estimate break-even points in terms of the number of acres on which a 75 horsepower Valtra tractor would need to operate annually for revenue to meet costs for each region separately. Tables 1 to 3 present the data used for the estimations. Given that the tractors are new, the cost data on maintenance were based on quite conservative estimates. For example, maintenance and repair costs were estimated at only 1 percent of investment costs.

The results of the break-even analysis are summarized in Table 4. A service provider in the Northern region using a Valtra tractor will have to plow 973 acres annually to break even. However, this likely is not possible, as the 2013 IFPRI/SARI survey shows that providers from the Northern region only plow 312 acres per tractor on average. Moreover, the limit on the area that can be plowed based on the length of the plowing period in

Table 1—Tractor and plow, prices and operating costs

Cost component	Details
Tractor and implement	One Valtra tractor (75 horsepower); one three-disc plow GH₵ 158,000 (2016 CIF price)
Tractor field capacity	9.88 acres per day (4 ha/day)
Tractor lifetime	10 years
Plow lifetime	10 years
Annual tractor & plow depreciation	10 percent of initial investment
Fuel consumption per acre	1.5 gallons per acre
Fuel price per gallon	GH₵ 13.5
Lubricant costs as percentage of fuel costs	15 percent
Maintenance and repair costs	1 percent of new tractor & implement price
Tractor shed building costs	GH₵ 1,400
Shed useful life	10 years
Annual shed depreciation	10 percent of shed building costs
Comprehensive insurance per year	GH₵ 571.02
Business registration (one-time)	GH₵ 100
Business renewal fees per year	GH₵ 20
Tractor registration at Driving License Authority	GH₵ 62.70 (one-time payment)
Discount rate or saving interest rate	7 percent

Source: Field data, 2016. Cost of imported tractor is as under Brazilian loan terms, provided by the Agricultural Engineering Services Directorate.
Notes: GH₵ denotes Ghanaian Cedi. GH₵ 4 = US$1.00 in July 2016. CIF – Cost, Insurance, and Freight

Table 2—Tractor-mounted planter and sheller, prices and operating costs

Cost component	Details
Planter	
Planter	GH¢ 15,000 (2016 market price)
Daily planting capacity	20 acres per day
Planter lifetime	10 years
Annual planter depreciation	10 percent of initial investment
Lubricant costs as a percentage of fuel costs	15 percent
Fuel consumption per acre planted	3/4 gallons per acre
Fuel price per gallon	GH₵ 13.5
Maintenance and repair costs	1 percent of planter price
Discount rate or saving interest rate	7 percent
Sheller	
Sheller (imported)[b]	GH¢ 9,287
Daily shelling capacity	100 maxi-bags per day
Sheller lifetime	5 years
Annual sheller depreciation	20 percent of initial investment
Lubricant costs as a percentage of fuel costs	15 percent
Fuel consumption per maxi-bag shelled	0.1 gallon per maxi-bag
Fuel price per gallon	GH₵ 13.5
Maintenance and repair costs	1 percent of sheller price
Discount rate or saving interest rate	7 percent

Source: Field data, 2016. Cost of planter provided by a service provider. Cost of imported sheller is as under Brazilian loan terms, provided by the Agricultural Engineering Services Directorate.
Notes: one maxi-bag of maize = 100 kilogram of maize. GH₵ denotes Ghanaian Cedi. GH₵ 4 = US$1.00 in July 2016.

Table 3—Region-specific data for mechanized plowing, planting, and shelling operations in northern Ghana, 2016

Cost component	Northern region	Upper East region	Upper West region
Plowing			
Effective plowing days	45	45	45
Number of days required to plow 10 acres with a tractor	1	1	1
2016 plowing service charge per acre (GH¢)	60	80	80
Casual labor wages (one operator and one assistant) for plowing, as percentage of plowing revenue	10%	10%	10%
Planting			
Effective planting days	20	20	20
Number of days required to plant 20 acres with a tractor	1	1	1
2016 planting service charge per acre (GH¢)	30	40	50
Casual labor wages (one operator and one assistant) for planting, as percentage of planting revenue	10%	10%	10%
Shelling			
2016 maize shelling service charge per maxi-bag (GH¢)	6	7	8
Casual labor wage rate per maxi-bag of maize shelled (GH¢)	10%	10%	10%

Source: Field data. Shelling is assumed to be time unbound in the year.
Notes: One maxi-bag of maize = 100 kilogram of maize GH¢ denotes Ghanaian Cedi. GH¢ 4 = US$1.00 in July 2016.

the region is 450 acres. The area a tractor services supply operator would have to plow to break-even cannot be plowed during the short plowing season in the Northern region. Although the break-even plowed areas for tractor operators providing plowing services in the Upper East and Upper West regions are not as large as for Northern region, those break-even areas, nonetheless, exceed the area that a single tractor can plow in those regions in a single plowing season, i.e., 450 acres.

If the government of Ghana wishes to subsidize the new farm machinery being obtained from Brazil, given that mechanization is under-developed in the country, the Northern region would require the highest level of subsidy, up to 60 percent. The other two regions would require lower, but still significant, levels of subsidies, because in 2016 the plowing service charge in these two regions was 80 cedis per acre compared to 60 cedis in the Northern region (Table 3). However, it may be impracticable to fine-tune the subsidy rate to a specific region.

The results also show that if the service provider puts the tractor to additional uses, such as planting and shelling, profit levels will increase and the operator is more likely to break-even. The 2013 IFPRI/SARI survey data shows that 20 percent of providers also offer shelling services, each shelling an average of 1,500 maxi-bags of maize. If a tractor service provider from the Northern region purchases a Valtra tractor from government and is able to plow 440 acres during the plowing season and shell 4,900 maxi-bags of maize after harvest, equivalent to about 90 days of operations in total for the tractor, the operator could break-even without a subsidy. This requires only an additional capital investment of 9,300 cedis to purchase the sheller imported by the Ministry under the Brazilian loan agreement. Cheaper locally manufactured shellers are available at a cost of 7,000 cedis.

In short, if tractor service providers offer multiple services, there would be no need for the government of Ghana to subsidize the machines. Private operators, by providing a combination of mechanized farm services, can break-even in supplying tractor services on a commercial basis to other farmers.

Table 4—Profitability of supplying tractor services on a commercial basis to other farmers using a Valtra 75 horsepower tractor imported from Brazil

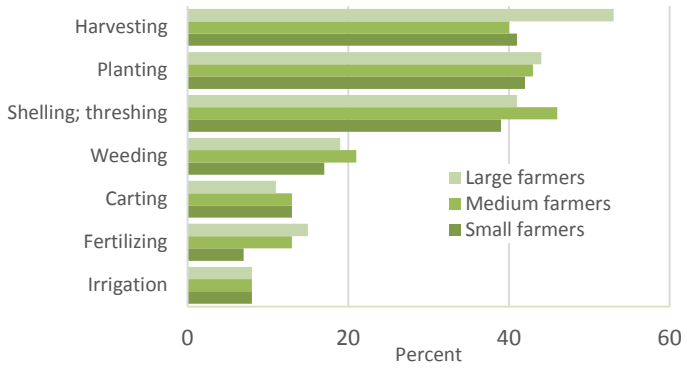
Financial performance	Northern region	Upper East region	Upper West region
Plowing only			
Initial investment (tractor and plow)	158,000	158,000	158,000
Maintenance costs	2,327	2,327	2,327
Break-even point (acres)	**973**	**611**	**611**
Subsidy rate required	58%	28%	28%
Plowing and planting			
Additional investment (planter)	15,000	15,000	15,000
Additional maintenance cost	150	150	150
Break-even point (acres)	**687**	**437**	**389**
Subsidy rate required	41%	0%	0%
Plowing and shelling			
Additional investment (sheller)	9,287	9,287	9,287
Additional maintenance cost	93	93	93
Break-even point (acres)	**440**	**315**	**284**
Subsidy rate required	0%	0%	0%
Plowing, planting, and shelling			
Additional investment (planter & sheller)	24,287	24,287	24,287
Additional maintenance cost	243	243	243
Break-even point (acres)	**384**	**271**	**235**
Subsidy rate required	0%	0%	0%

Source: Authors' estimations based on 2016 field data.
Notes: Investments and costs are estimated in GH¢ (Ghanaian cedi). GH¢ 4 = US$1.00 in July 2016.

IS THERE DEMAND FOR MECHANIZED POST-TILLAGE SERVICES?

The 2013 IFPRI/SARI survey results show that Ghanaian farmers who hire plowing services are also willing to mechanize post-plowing operations, such as harvesting, planting, shelling, and weeding, among others, if the services were available. Figure 1 provides information on what proportion of farmers would be willing to pay for the mechanization of a range of field operations.

Figure 1: Willingness to mechanize post-tillage field operations among different types of farmers in Ghana



Source: Authors' estimations based on 2013 IFPRI/SARI survey data.

One-third to one-half of farmers would like to mechanize harvesting, planting, and shelling or threshing. For example, a little over fifty percent of large-scale farmers and as much as forty percent of small- and medium-scale farmers indicated that they would like to mechanize their harvesting operations. Mechanical harvesting of rice is already widely practiced using combine harvesters (Takeshima et al. 2013). As expected, compared to small-scale farmers, a larger share of medium- and large-scale farmers wish to mechanize their post-plowing operations.

Table 5 shows the service charges that farmers in the north of Ghana would be willing to pay for mechanizing some of the post-tillage operations on their fields. As expected, the charges

Table 5—Prices that Ghanaian farmers in the northern regions wish to pay for mechanization services in 2013, cedis/acre

Service charge (cedis per acre)	Small farmers	Medium farmers	Large farmers	Hired labor cost
Planting	26	29	30	29
Weeding	28	28	32	39
Harvesting	39	37	48	39
Shelling*	3	3	3	5

Source: Authors' estimations based on 2013 IFPRI/SARI survey data.
Notes: For shelling, the price is estimated in cedi per 100kg bag of maize.

they are willing to pay are slightly lower than what it would cost farmers to undertake the same operations using manual labor. Large farmers are willing to pay significantly higher prices. The key message here is that private tractor service providers are likely to realize a profit if they are able to charge these fees for their tractor services. Expanding the tractor services that owners provide to other farmers beyond plowing alone would not require an extraordinary level of investment. Purchasing a planter and a sheller requires an additional capital investment of only 15 percent of the initial investment in a tractor and a plow (Table 4).

The results also show that the larger the size of a farmer's farm, the higher the price that farmers would be willing to pay, reflecting that mechanization is more critical for farmers who are farming larger areas. Hence, larger farmers are likely to drive the development of post-plowing mechanization, as they have done with the development of commercial plowing services. Tractor service providers then can be expected to extend their hiring services to smaller farmers as competition in tractor services provision increases and farmers better understand what level of commercial returns they can expect from the use of such services.

KEY MESSAGES

Demand for agricultural mechanization services for plowing is not adequately met in Ghana. But, using tractors for plowing alone is not economical. Recent tractor imports with attachments to perform many of the post-plowing operations on farmers' fields has the potential to avoid some of the pitfalls of previous tractor import schemes. Tractors can be utilized for many more operations than tillage alone. Our analysis suggests that farmers are willing to pay for additional mechanized farming services.

Efforts to promote mechanization in Ghana have a long history, and there is much to be learnt from what has already been done. These lessons should serve to assist in identifying how to address the challenges of ensuring proper training for tractor operators, the continuous availability of affordable spare parts, and better repair skills in the country.

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INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
2033 K Street, NW • Washington, DC 20006-1002 USA
T: +1.202.862.5600 • F: +1.202.467.4439
Skype: ifprihomeoffice • Email: ifpri@cgiar.org

GSSP – IFPRI
c/o IWMI, PMB CT 112 • Cantonments, Accra, Ghana
CSIR Campus (Opposite Chinese Embassy) • Airport Residential Area
T: +233 (0) 302 780 716 • F: +233 (0) 302 784 752
gssp.ifpri.info
Contact: Shashi Kolavalli, Senior Research Fellow & Program Leader

This publication of the Ghana Strategy Support Program is made possible by the generous support of the American people through the United States Agency for International Development (USAID). It has not been independently peer reviewed. The contents are the responsibility of the author(s) and do not necessarily reflect the views of USAID, the United States Government, or the International Food Policy Research Institute.