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## AGRICULTURAL MECHANIZATION AND SOUTH-SOUTH KNOWLEDGE EXCHANGE:

*What can Ethiopian and Kenyan policymakers learn from Bangladesh's experience?*

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**B**angladesh recently has experienced fast growth in agricultural mechanization, with the share of area cultivated by tractors and power tillers increasing from 30 percent in the mid-1990s to 95 percent in 2015, with power tillers being used on three-quarters of the mechanically cultivated area. Moreover, agricultural machinery is not only used on large farms in Bangladesh, but has spread among smallholder farmers that own an average of 0.5 hectares (ha) of cropland. This rapid growth in agricultural mechanization has primarily relied on imported machines rather than domestic manufacture.

Bangladesh's experience can provide useful insights to many African countries that are seeking ways to promote agricultural mechanization. In collaboration with IFPRI and CIMMYT, nine African officials from four countries, Ethiopia, Ghana, Kenya, and Nigeria, participated in a study tour in Bangladesh in November 2015 to examine how expansion in agricultural mechanization has occurred there. During the tour, African officials visited two major tractor importers, ACI Motors Ltd. and Metal Pvt. Ltd., as well as the largest agricultural machinery manufacturer, Alim Industries Ltd.<sup>1</sup> The study tour participants also met with tractor and spare parts dealers, farmers, and staff members of public institutions including the Department of Agricultural Extension (DAE) of the Ministry of Agriculture, the Bangladesh Agricultural Research Council (BARC), the Bangladesh Agricultural Research Institute (BARI), and the Bangladesh Rice Research Institute (BRRI). While the observations made during the study tour are specific to the particular context of Bangladesh, the lessons learned and insights gained on how agricultural mechanization processes in low-income countries can proceed rapidly should be applicable to other countries, including Ethiopia and Kenya.

This note synthesizes one of the two study tour reports written by the participating African officials. This report provides observations made by participants from Ethiopia and Kenya, the two East African countries with participants on the tour.

### KEY OBSERVATIONS ON AGRICULTURAL MACHINERY USED IN BANGLADESH

Two-wheel tractors (2WT), such as power tillers, have revolutionized the Bangladesh agricultural mechanization sector; they are used in a number of farming operations, including tillage, harvesting, transportation, and irrigation. In Bangladesh, tillage, using both

2WT power tillers and small four-wheel tractors (4WT), is the most mechanized activity – more than 95 percent of 2WT are used for tillage. Irrigation in the country was rapidly mechanized when power tillers, imported from Japan, were introduced. Although initially too costly for common farmers, since then the use of power tillers has evolved from being used primarily for shallow tube-well irrigation purposes to increasingly being used for tillage. This is in contrast to Ethiopia where mechanization started from planting, harvesting, and threshing using larger, more expensive, and more complex 4WTs and combine harvesters. Nonetheless, today Ethiopia is in a lower level stage of mechanization (less than 1 kw/ha) compared to Bangladesh (1.83 kw/ha). A similar pattern is seen in Kenya.

The predominant soils and topography of Bangladesh may have contributed to more readily mechanizing the practices of smallholder farmers using 2WTs. In the case of Ethiopia and Kenya, the use of 2WTs is more challenging in areas with heavy soils and the crops are rainfed. However, where soils are suitable and irrigated farming is profitable, 2WT use for cultivation may be possible in East Africa. The use of 2WT for harvesting and transportation may be even more widely applicable, as both activities are less constrained by soil conditions.

The horsepower of 4WTs in use is relatively lower in Bangladesh than in Ethiopia and Kenya. Lower horsepower 4WTs (less than 35 hp) are often used for haulage, but not for cultivation. For cultivation, 4WTs with an average of 50 horsepower generally are used. According to Metal Pvt. Ltd., the most popular 4WT in Bangladesh is a 47 horsepower model that can be used for both haulage and cultivation.

### PRIVATE SECTOR IN THE AGRICULTURAL MACHINERY SECTOR IN BANGLADESH

There is a vibrant and committed private sector working in the agricultural machinery sector in Bangladesh. Machinery importers are well organized and have networks established throughout the country. This is in contrast to importers in Ethiopia or Kenya that are located in the national capitals and some regional cities, but with limited direct access to farmers. Importers in Bangladesh provide after-sales services with warranties that help owners receive low-cost access to timely repair services and spare parts in the early stage of ownership after their purchases. Both ACI

<sup>1</sup> ACI Motors imports Sonalika tractors (35 to 60 hp); Metal Pvt. Ltd. is the sole dealer in Bangladesh of TAFE tractors (35 to 60 hp) and also imports Eicher tractors from India; and Karnaphuli Ltd. supplies Mahindra tractors. All of these brands of tractors are imported from India. Alim Industries Ltd. specializes in the manufacturing of tillers, seeders, fertilizer applicators, rice & maize power threshers, mechanical dryers, water pumps, and winnowers. The company also assembles power tillers to which multi-purpose crop planter implements can be attached

Motors Ltd. and Metal Pvt. Ltd. reported that they respond to calls for service from customers within 6 to 8 hours. In Ethiopia, importers provide limited after-sales services. A critical element in raising use of agricultural mechanization is to induce suppliers to open sales and service centers in the major farming areas of the country.

Bangladesh importers also provide credit to buyers. One importer, Metal Pvt. Ltd., has a special division exclusively dedicated to applicant screening, credit management, and repayment monitoring.

Bangladesh importers and manufacturers promote the benefits of mechanization and inform farmers on available mechanization equipment using signboards, street advertisements, and other advertising. The companies also collaborate with the agricultural extension system. Similar collaboration between private agricultural machinery supply firms and the agricultural extension system is needed in both Ethiopia and Kenya.

The private sector in Bangladesh meets the demand for machinery that is locally adapted for the farming systems in Bangladesh. Alim Industries Ltd. is focused on developing the frames and implements for power tillers, threshers, and other machinery, using imported engines from China to power the machines. This has created an opportunity for users to purchase the machines at cheaper prices than if all components were imported and provides them with easy access to parts and services.

Importantly, importers, manufacturers, and dealers often have diverse business portfolios. ACI Motors Ltd. is a conglomerate with businesses ranging from pharmaceuticals to consumer products to logistic services. Many dealers and service providers for the machines imported by ACI Motors Ltd. are young adults, some of which have side businesses that make additional income from the resale of other ACI products. Service providers diversify their services by owning different types of agricultural machinery, including power tillers, harvesters, and sprayers. Having this range of machinery and implements helps them secure income throughout the year from the provision to farmers of different services, including tillage, harvesting, and transportation of goods and grain to and from villages. Such diverse business portfolios is a way for these individuals and firms to mitigate many of the risks associated with engaging in agricultural machinery supply.

There is no public enterprise in Bangladesh to distribute or manufacture tractors. This is in contrast to Ethiopia where there is one public tractor industry, Adama Tractor Industry, that is engaged in assembling tractors and manufacturing small scale irrigation pumps. The marketing strategy for the Ethiopian tractor factory is not well studied, but it is clear that is not as well organized as those of agricultural machinery firms operating in Bangladesh. Whether in Bangladesh, Ethiopia, or Kenya, major growth in the manufacturing of agricultural machinery, if it occurs, will be led by private firms.

## AGRICULTURAL MECHANIZATION POLICIES

There are relatively few specific policies that have directly contributed to the development of smallholder focused agricultural mechanization in Bangladesh. Several government efforts indirectly encouraged this process, including research, better land tenure systems, low or zero taxes on agricultural machinery imports, and limited standardization or regulation being imposed on the firms involved. Little standardization and regulation seems to

have helped to encourage the growth in agricultural mechanization, but at the risk of future problems emerging in the sector.

## Research System Linking with Stakeholders

BARI and BRRI have invested extensively in research and development (R&D) activities on crop variety development. These efforts indirectly may have helped in raising the profitability of mechanized farming. R&D activities for machinery design in Bangladesh are also commendable, being focused primarily on problem solving. Coordinating organizations for R&D, like BARC, enhance the role that agricultural mechanization can play in the country. Such organizations are absent in Ethiopia and Kenya, although such organizations are now on their way to being operational in Ethiopia. Moreover, the level of mechanization research in Bangladesh has a longer history than what is seen in East Africa. For example, Ethiopian scientists have engaged in agricultural mechanization research for less than 20 years. It is important to develop a system, like that in Bangladesh, that aligns and coordinates agricultural mechanization research in a strategic manner with other agricultural research. Agricultural engineers in Bangladesh also have designed and produced tools, like simple maize shellers, that can particularly benefit female farmers who are often involved with post-harvest processing.

In terms of human capital, all research staff involved in agricultural mechanization efforts at BARI and BRRI seem to be well trained. Higher officials in the mechanization units of these institutions display a good understanding of the needs of smallholder farmers for mechanizing their farming operations, so these higher officials are contributing to bringing useful mechanized farming technologies into the lives of smallholder farmers. In addition, researchers have done a great job in documenting the agricultural mechanization products that have been developed and the quantities of such machinery in use in Bangladesh. East African countries should attempt to improve their agricultural mechanization documentation procedures in a similar way.

An insight from Bangladesh that can be applied to Ethiopia and Kenya is that the balance of how much to invest in the development of local machinery designs and how much to focus on direct transfer of foreign designed machines is still not resolved by BARI and BRRI. For example, Bangladesh faces challenges in developing an adjustable row-width transplanter and a harvester specifically suited to small fragmented farm holdings. Some of the designs for such machines developed by BARI and BRRI have resulted in heavy machinery. While these heavy machines may be useful in Bangladesh where plots are closer to the households, in Africa they would be more difficult to use, as plots are sometimes far from households. Lighter machines from foreign sources may better serve the needs of Bangladeshi farmers than the locally-designed adjustable row-width transplanter and harvester now available. Altogether, these insights from Bangladesh can help Ethiopia and Kenya strengthen their agricultural mechanization related R&D activities.

## Access to Credit Based on Land Titling

It appears that there is easy access to loans for farmers in Bangladesh to obtain for purchasing agricultural machinery. These loans are made possible by farmers using their land as collateral. In Ethiopia the land certifications produced by the government can also be used for the purpose of obtaining loans. This provides an important opportunity for extending adoption of agricultural machinery in the country.

## Relatively Unclear Role of Subsidies

Bangladesh provides subsidies for some of the less popular machines, like transplanters and harvesters. The government previously subsidized power tillers and tractors, but their widespread adoption has meant that the government has discontinued the subsidy program for them. There is a high subsidy for fertilizer for all farmers and for other improved technologies for selected farmers.

The effect of subsidies on agricultural mechanization growth in Bangladesh is unclear at this point. The adoption of both power tillers and 4WT's grew strongly without the use of major subsidies. Moreover, the effectiveness of subsidies depends on appropriate targeting. The subsidies also need to be complemented by appropriate technologies and infrastructure. Further engagement with experts in Bangladesh can inform policy makers in Ethiopia and Kenya as to how Bangladesh in developing its agricultural machinery sub-sector has or has not been able to avoid the inefficiencies that are often associated with subsidy programs.

## Standardization and Regulations are Relatively Weak

The regulatory framework of Bangladesh for agricultural machines is weak. It is not in balance with the achievements of agricultural mechanization in the country. Testing and quality assurance related to imported tractors are not systematically conducted by the government. Since the 1988 flood, the committee in charge of testing new machinery has been suspended to facilitate the import of large quantities of machines. Tractor use in Bangladesh has grown rapidly since the relaxation of testing. It is unclear if tractor growth was due to the liberalization of imports or due to dropping of testing requirements. Imports may well have grown even if testing processes had been resumed, with farmers benefiting from a large supply of agricultural machines of better quality. It is too early to say whether similar growth in the adoption of agricultural machinery by farmers can be experienced in African countries through trade liberalization alone.

In Bangladesh, due in part to the absence of testing and formal training institutions, injuries associated with machinery use sometimes occur. There is no formal insurance for such incidences, so oftentimes these injuries are compensated informally. Machinery owners often will compensate those affected for injuries incurred by machinery operators. While such risks have not slowed the growth of mechanization in Bangladesh, these incidences suggest that governments may be able to play some role in reducing such risks through appropriate machinery testing and training. Ethiopia has an agricultural mechanization strategy under its second Growth and Transformation Plan in which are outlined the main intervention areas and bottlenecks to be addressed and priorities to be made in the coming years with regard to machinery testing and training. The Bangladesh experience suggests that, while standardization and proper testing systems alone cannot boost mechanization growth, there are costs associated with not having strong testing standardization mechanisms for agricultural machines, and, in the long-run, building such regulatory and standardization mechanisms is important.

## Cooperatives are Relatively Rare

Some East African countries, like Ethiopia, are pushing to have cooperatives play a major role in providing agricultural mechanization services to their members. However, in Bangladesh, such cooperative systems are not widely regarded as having provided a major breakthrough in mechanization. Rather, agricultural mechanization has come about through the integration of the efforts of

private sector agricultural machinery companies and research institutes. The experience in Bangladesh suggests that forming cooperatives is generally not a prerequisite for promoting growth in agricultural mechanization. The appropriate roles of cooperatives in mechanization in Ethiopia and Kenya will need to continue to be investigated.

## OVERALL REFLECTIONS

### Promotion of Private Sector Involvement

The agricultural machinery sub-sector needs to be developed through the promotion of private businesses. This has worked well for Bangladesh's farmers. Farmer ownership is not required for significant expansion of the sub-sector. Farm machinery service providers profit from hiring out their machines to local farmer for tillage and other crop operations that can be mechanized. One such service provider interviewed on the study tour confirmed that he repaid his mechanization loan within one year through such a business. This model should work in Ethiopia, as smallholder farmers are now paying about 14 USD per day for plowing services from a pair of oxen. A pair of oxen can plow only 0.25 to 0.35 ha of a land per day. Moreover, the cost of a pair of oxen can sometimes be more than 1,000 USD, which is not much less than the cost of a power tiller in Bangladesh, currently less than 1,500 USD.

In general, the agricultural mechanization program in Ethiopia is viewed with skepticism by many in Ethiopia, including farmers and policy makers. The study visit to Bangladesh demonstrated that Bangladeshi farmers are receiving additional income and are able to carry out farming operations on their lands in a timely manner as a result of the introduction of agricultural machines to their farming systems. Agricultural mechanization is a private sector activity where all actors – from well-to-do farmers to landless youth to entrepreneurs – are able to be agricultural machinery service providers.

The private sector is far more active than the public sector in Bangladesh in addressing the needs of farmers for mechanizing their agricultural activities. Mechanization in Bangladesh has largely grown through increasing demand for machinery. The experience of Bangladesh suggests that farmers have to be aware and convinced of the benefits of mechanization technologies. Local demand has to be in place before agricultural machinery firms establish service providers and open supply points in specific areas. For instance, in one area visited, tillage and threshing are more than 95 percent and 75 percent mechanized, meaning that the basic conditions for mechanization are in place. However, harvesting is not yet mechanized in the same area because farmers have yet to receive appropriate mechanized technology that can work properly in wet paddy farms or were not convinced of the correct use of existing technology. It was observed in Bangladesh that government may not have any comparative advantage in agricultural machinery distribution over the private sector. In this regard, Ethiopia and Kenya must both strongly consider shifting the practice of distribution of agricultural machinery to farmers through government programs to the private sector for sustainability and efficient use of resources.

### Promotion of Private Sector

Once local demand is in place, East African governments can promote private sector participation to supply agricultural machines and services. Incentives and other supporting policy areas have to be assessed to encourage the private sector to contribute to the development of agricultural mechanization. This will be an area

where the Ethiopian and Kenyan governments and other stakeholders will be working in the coming five years. Of course, there will be some trial and error for the private sector in identifying demand and developing supply capacity. The history of the local agricultural machinery manufacturing industry in Bangladesh demonstrates that there are many obstacles to overcome to get the acceptance of farmers. Alim's products are distributed not only in Bangladesh, but also in neighboring areas of India and to some African countries.

For direct involvement in agricultural mechanization sub-sector development, the lessons learned from this study tour will serve as an input to initiate private–public dialogue on how best to encourage local agricultural machinery manufacturers and importers to be more active in their businesses. In Ethiopia, the Adama tractor factory and other private producers can initiate this dialogue. A consultation forum should be established to envision an agricultural mechanization sub-sector development approach similar to that used in Bangladesh.

Private sector manufacturers and importers of tractors must promote their products and services – this is the heart of the private sector system, and stands in contrast to the approach of the government agricultural extension system. In Ethiopia, importers and manufacturers should open dealer centers and arrange technology fairs for local farmers for awareness and demand generation. In Ethiopia, Adama Tractor Industry, other manufacturers, and importers should discuss ways to move forward in creating local mechanized farming service providers across the country. The Ethiopia Agricultural Transformation Agency and the Ministry of Agriculture can discuss the issue of mechanization and move forward with selected stakeholders and partners, including potential service providers in selected districts.

It is also important to engage other agencies in agricultural mechanization service provision, particularly those who offer financing. Such business models will include consideration of 1) loan access guidelines and arrangements, as have been applied in Bangladesh; and 2) identifying loan providers and designing loan repayment arrangements and linkages with banks and local microfinance institutions in consultation with local and regional government agencies.

## Diffusing Information

The scale of mechanization in Bangladesh is appropriate to the production scale of farmers there. The government and private

sector institutions have succeeded in mechanizing some of their major farm activities, especially for smallholder farmers. The power tiller has revolutionized agricultural activity in Bangladesh. In contrast, in Ethiopia and Kenya the 2WT is not given too much attention, although there are opportunities to assemble this machine domestically. It is important that many different brands of tractors should be tried in East African countries. For example, the TAFE tractors that are manufactured in India under Massey Ferguson UK, are the most popular in Bangladesh and were introduced in Kenya in the 1990s. However, the number of TAFE tractors did not grow, indicating that there may be some differences in production environments between Bangladesh and Kenya which prevented agricultural machinery uptake by farmers.

## Balancing Mechanization and Employment Growth

Mechanization brings opportunities to the rural sector. One such opportunity is employment creation in transporting, operating, repair, maintenance, and other related services for agricultural machines. Educated youth can be retained in rural areas to work in the agricultural mechanization industry instead of migrating to urban centers. Youth and farmer entrepreneurs can employ themselves in the provision of tillage and other services to farmers. This can be replicated in Ethiopia and Kenya with the proper selection of service providers, arrangements for loan services, and proper awareness creation programs on the technologies that farmers can hire for their crop operations.

## Final Remarks

While Bangladesh is more advanced in terms of agricultural mechanization, Ethiopia and Kenya can repeat the same success. Indeed, Ethiopia is one step ahead of Bangladesh in that it has developed an agricultural mechanization strategy – something Bangladesh has not done. This strategy is now being used to address the bottlenecks limiting the development of the agricultural machinery sub-sector at all points of the value chain. If their agricultural mechanization strategies are developed wisely, drawing on lessons learned from the experiences of Bangladesh and other countries, it is possible for Ethiopia and Kenya to even surpass Bangladesh in terms of farmer uptake of agricultural machines to aid them with their farming.

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