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Agricultural Mechanization and South-South Knowledge Exchange:

What can Ghanaian and Nigerian policymakers learn from Bangladesh's experience?

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Synthesized by Hiroyuki Takeshima

Introduction

Bangladesh recently has experienced fast growth in agricultural mechanization. Nationally, the share of area cultivated by tractors and power tillers increased 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. Supply of machinery for this rapid growth of mechanization has been based primarily on imports, as the capacity for local manufacturing of agricultural machinery is still limited.

Bangladesh's experience can provide useful insights for many African countries that are seeking sustainable ways to promote agricultural mechanization. In collaboration with IFPRI and CIMMYT, nine African public officials from four countries, Ethiopia, Ghana, Kenya, and Nigeria, participated in an agricultural mechanization study tour in Bangladesh from 3-7 November 2015. During the tour, African officials visited two major tractor importers, ACI Motors Ltd. and Metal Pvt. Ltd.; the largest agricultural machinery manufacturer in Bangladesh, Alim Industries Ltd.; tractor and spare parts dealers; farmers; and 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 conditions in Bangladesh and the experience of agricultural mechanization there are unique to the country, nonetheless, the tour provided useful insights into how small-scale agricultural mechanization can expand in low-income countries.

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

Key Observations on Agricultural Machines Used in Bangladesh

In Bangladesh, tillage using two-wheel tractors (2WTs) and small four-wheel tractors (4WTs) accounts for greater than 95 percent of tillage activity. 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 different from Ghana or Nigeria where mechanization has been promoted with higher horsepower (hp) tractors. However, mechanization levels are much lower in Nigeria and Ghana than in Bangladesh.

The predominant soils and topography of Bangladesh was likely a factor in the increase in mechanization of land preparation with 2WTs. In Ghana and Nigeria, the use of 2WTs is challenging in areas where the soils are heavy and agricultural practices are mostly rainfed rather than irrigated. However, where soils are suitable and irrigated farming is feasible in Nigeria and Ghana, 2WTs may be applicable for cultivation. In addition, the use of 2WTs for harvesting and transportation may be more widely applicable as these activities are less constrained by soil conditions.



The use of heavy duty, higher horsepower 4WTs as a share of all agricultural machinery is relatively lower in Bangladesh than in Nigeria and Ghana. This is partly because lower horsepower 4WTs (less than 35hp) are often used for haulage in Bangladesh, particularly for construction materials such as bricks, rods, cement, and sand. In the areas visited, 4WTs typically carry sand for an average of 50 km. Tractors used for haulage are 30hp, which is a lower horsepower than tractors used for tillage (over 45-50hp). Hauling sand for construction to access roads is often difficult with tipper or pickup trucks, so is done with 4WT. In addition, there seems to be some cost advantage. Hauling sand with 4WT is 30 percent cheaper than hauling sand with pick-up trucks, even though it is more time-consuming. Where hauling sand is not time-pressured, 4WTs seem to be used.

Private Sector in Bangladesh's Mechanization Sector

The role of the private sector in agricultural mechanization in Bangladesh has been important and should not be downplayed. The Government of Bangladesh provides a good environment for private businesses to thrive without any undue favors. Local entrepreneurs have latched onto this and are doing quite well importing or manufacturing and selling agricultural machinery and tools. The government subsidy scheme for agricultural equipment is helping sales by the private sector firms, as it enhances the purchasing power of farmers.

The machinery importers and manufacturers in Bangladesh have extensive sales and service networks established all over the country. Alim Industries has 170 dealers and service points nationwide. They believe that the good quality of their products, among other things, is the prime reason for their success.

Suppliers and importers offer after-sales service, often free of charge for multiple servicing periods. Suppliers and importers offer credit to farmers or service providers for the sale of agricultural machinery. Customers are required to make a down payment on the cost of the machinery of 30 to 35 percent, paying the balance with interest over 24 months. Agricultural machinery firms use a number of steps to screen customers to minimize the risk of default. Application forms of beneficiaries are rated and evaluated, and credit applications are linked to the national ID system in order to ensure security. Supplier and importers require post-dated checks for 3 months of payments from customers as a source of security. They require no collateral from the customer, but retain ownership of the machine until the final payment is made.

In the event of payment default by a customer, the machine is repossessed and resold to another interested farmer.

Importantly, importers, manufacturers, and dealers often have diverse business portfolios. ACI Motors Ltd. is a conglomerate that handles a variety of products ranging from pharmaceuticals to consumer products to logistics. Having such a diverse portfolio of businesses mitigate the risks for the firm that would be associated with engaging solely in the agricultural machinery supply business.

Not all agricultural machines find a market in Bangladesh. Farmers have generally rejected combine harvester equipment due to its high costs. Straw is important to farmers, so, therefore, they prefer to use reapers for harvesting operations.

In some places such as the area of Sylhet, rice yields are about 11 or 12 mt/ha, as a result of efficient land preparation practices involving multiple tillage and crossing by power tillers. Since poor land preparation leads to low yields, farmers are willing to pay for multiple intensive tillage operations on their plots. No-tillage practices are not employed by farmers, although research on minimum tillage, strip tillage, and conservation tillage are ongoing in Bangladesh. Given the strong emphasis on good tillage under current production practices, this enables power tiller owners to realize substantial returns from land preparation on small plots.

A result of the long history of power tiller use by farmers in Bangladesh is that farmers have acquired substantial knowledge on the repair and maintenance of the power tiller. In consequence, power tillers are largely repaired by their owners without recourse to the dealers or other mechanics.

Agricultural Mechanization Policies

Several government agencies collaborate in Bangladesh to achieve the national agricultural mechanization goals – the Bangladesh Agricultural Development Corporation (BADC), the Bangladesh Rural Development Board (BRDB), DAE, BRRI, BARI, and BARC. They share information and are on the same page on most issues. Similar institutions exist in Nigeria, but there they have some overlapping functions, sometimes leading to an unhealthy rivalry among agencies. It is clear from what was observed in Bangladesh that the roles and functions of the Nigerian agencies should be clearly delineated and harmonious working relationships should be promoted among these institutions for effective and efficient

among these institutions for effective and efficient collaborative work. Similar institutions exist in Ghana that focus on crop and agricultural research, but there is no research unit that solely researches agricultural mechanization development. Moreover, while Ghana has mapped some broad strategies on mechanization, it has yet to develop its policy on agricultural mechanization.

Research System and Extension Network

BARI and BRRI have invested extensively in research and development (R&D) activities on improved crop varieties, which might indirectly have helped raise the profitability of mechanized farming. In recent years, average yields reported in Bangladesh were 5 mt/ha for rice and 6 mt/ha for maize. These yields are much higher than yields for the same crops in Ghana and Nigeria, which are around 2 mt/ha.

There are functional agricultural machinery and post-harvest research units situated at BARI and BRRI. Funding for these research units is from the Government of Bangladesh, FAO, and other development partners. The activities of these institutes are solely to design, develop, and promote the adaption of agricultural machinery and other equipment for various farm operations. The government played a role in developing machine prototypes that were then offered to the private sector to assess usability and to receive feedback from farmers. Prototypes developed at BARI and BRRI are tested and commercialized through local manufacturers, who are given the designs to use in manufacturing the machines for farmers. The research units in BARI and BRRI are involved in the commercialization of machinery products through monitoring and supervision to ensure that quality standards are adhered to. One of the promotion mechanisms for the adoption of new technology is through the research units consulting with agricultural extension officers to release finished products on a temporary basis to key farmers for demonstration purposes. Through such efforts, the research units have developed a power tiller implement that undertakes four operations – rotary tilling, seeding, fertilizer application, and levelling – in a single pass. This implement is presently being utilized by wheat and maize farmers on fields visited during this study tour. An efficient fertilizer applicator, the urea super granular (USG) applicator, has been developed and commercialized for farmers by the research units. Researchers have also designed and developed tools like simple maize shellers, which can be a benefit for female farmers who are often responsible for post-harvest processing tasks.

BARI and BRRI focus their machinery design and development efforts on implements that can be operated with power tillers, which are widely used on the small and fragmented farm plots of the country, but are still not widely used in neighboring countries like India. They also have modified implements to be operable with power tillers developed in China. These are adapted for a range of crops with different seed sizes, since multi-crop farming is still dominant in the farming systems of Bangladesh.

These institutions have effectively documented the products they developed and the quantities of machinery products in use in Bangladesh. Ghana and Nigeria similarly should improve their documentation of machinery innovation.

One dimension of agricultural machinery development that has not been resolved by BARI and BRRI is the balance between how much to invest in the development of indigenous machinery designs and how much to focus on direct transfer of foreign designed machines. Many agricultural machines, such as reapers and harvesters, are imported from India, China, Vietnam, South Korea, and Thailand. As Ghana and Nigeria face the same question, the countries could learn lessons from Bangladesh in this regard. However, given the limited development of indigenous machinery in Ghana and Nigeria, at present the countries can best strengthen their R&D systems by gathering information of available machines in other countries.

The extension system in Bangladesh is quite strong. The Department of Agricultural Extension has 26,000 staff across the country, realizing a relatively high extension staff-to-farmer ratio. Nigeria only within the last three years created a department dedicated to agricultural extension in the Federal Ministry of Agriculture and Rural Development. The seemingly better extension network in Bangladesh might have helped in strengthening awareness about agricultural mechanization options, but also more broad technology dissemination, which indirectly made more intensive mechanization profitable for farmers.

Infrastructure

Based on visual observations from the field, the access of farmers to roads is better in Bangladesh than in Nigeria or Ghana. Better road quality, transportation networks, and access to those networks certainly has helped overall demand for agricultural intensification and the expansion among farmers in the use of agricultural machinery.

Bank Loans

In Bangladesh, interest rates on government bank loans for farmers are between 7 and 8 percent per annum, which is lower than interest rates in Nigeria and Ghana. However, the bureaucratic processes involved in accessing this type of loan in Bangladesh makes it unattractive for farmers to take loans from government banks. Interest rates on commercial bank loans for machinery importers or suppliers is between 17 and 18 percent while, importers and suppliers extend credit facilities to farmer customers at an interest rate of 22 percent per annum. Nonetheless, this interest rate is slightly lower than rates in both Nigeria and Ghana.

Tariff and Tax Policies

In Bangladesh, the government's tariff policies have had mixed results. Import tariffs for power tillers and tractors from China were removed after the 1988 flood, and this removal of tariffs coincided with a rapid growth in imports. Conversely, the government has placed higher tariffs on raw materials for local manufacturing, with these tariffs ranging between 20 and 60 percent. The Government of Bangladesh grants tax exemptions for importing finished agricultural machinery products. However, it charges between 5 and 40 percent import duties on spare parts for agricultural machinery.

Relatively Unclear Role of Subsidies

Bangladesh provides subsidies to encourage farmers to purchase some of the less widely adopted machines, like transplanters or harvesters. The subsidy is paid directly to the supplier or importer after delivery and fulfillment of all documentation by the relevant agencies. Subsidies are not provided for power tillers and tractors, which are already widely adopted throughout the country. There is a very high subsidy for fertilizer for all farmers and for other technologies for selected farmers.

The effect of subsidies on mechanization growth in Bangladesh is unclear at this point. The adoption of power tillers and 4WTs expanded significantly in Bangladesh without major subsidies. It is important to note that the effectiveness of subsidies depends on appropriate targeting, and subsidies for agricultural machinery need to be complemented by appropriate technologies and infrastructure. Ghana and Nigeria, through a process of collaboration with experts in Bangladesh, can learn how Bangladesh has or has not been able to avoid inefficiencies

the design of their efforts to increase farmer use of agricultural machinery in their own countries.

In Bangladesh, government is not involved in the direct importation and supply of agricultural machinery. If the government decides to procure machinery for its farmers, it procures them from local suppliers and importers through competitive tendering. This is typically not the case in Ghana or Nigeria.

Reflections

The private sector in Bangladesh is playing a leading role in agricultural mechanization efforts there. Local manufacturing of spare parts grew in response to increasing demand coupled with increased importation of machinery parts and engines from abroad, particularly China. Generally, service providers are able to recover half the cost of a thresher in one season. In areas where there are three crop rotations in a year, the thresher operator is able to recover the full cost of a thresher in a year. The cost of a power tiller is usually recovered in two years.

Bangladesh farming enjoys intensive use of irrigation and high crop intensity. Increased investments into public irrigation can significantly raise the demand for Bangladesh-type small-scale mechanization in Nigeria and Ghana. Bangladesh has a total land area of about 144,000 km² (14.4 million ha), a cultivable area of 8.5 million ha, of which 70 percent is irrigated. This allows for multiple crop rotations, leading to an average cropping intensity of about 200 percent nationwide. Nigeria has a total land area of 92.3 million ha, 70 percent of which is arable, and only about 50 percent of the arable land is cultivated. Irrigation development in Nigeria is also far below potential with many large scale irrigation schemes only partially developed or utilized. Additionally, the heavy reliance on rainfed farming is a major constraint to production in Nigeria, while in Ghana only 11 percent of cropland is irrigated. Cropping intensity and output could be greatly improved in both Nigeria and Ghana if the schemes are made to function at optimal capacities.

In Bangladesh, mechanization service providers double as farmers – they own and operate farm machinery, such as power tillers, transplanters, and threshers, for hiring purposes. Some service providers also rent water pumps for irrigation. One service provider visited rendered threshing services to about 100 farmers for 15 days. Experience in Bangladesh shows that such a system is effective in meeting the mechanization needs of smallholder farmers.

In Ghana and Nigeria, the role of the private sector in mechanization service provision has become increasingly recognized. Ghana and Nigeria have shifted from traditional systems of government-managed hiring units to private-sector managed hiring enterprises, such as Agricultural Equipment Hiring Enterprises (AEHE) in Nigeria and Agricultural Mechanization Service Enterprise Centers (AMSEC) in Ghana. In these schemes, the government is responsible for various management decisions, such as locations, types of machines to be stocked, and how beneficiary farmers will be selected. The experience in Bangladesh shows that, in the long-run, these functions can be and should be transferred to the private sector, as the private sector is more likely to have a comparative advantage in these decisions.

In Nigeria, the majority of farmers are smallholder farmers, but past mechanization efforts focused on the provision of tractors of between 60 and 75 hp, a size of tractor which is beyond the reach of most smallholder farmers. In consequence, in Nigeria the tractor density is low at 0.027hp/ha. There is no doubt that the popularization of power tiller use in Bangladesh has contributed significantly to the success story of agricultural mechanization. Farmers can conveniently own, utilize, repair, and maintain power tillers, allowing them to plan their operations and deploy the power tillers with great flexibility. The increased quantity of power tillers around localities has grown, generating local industry and creating employment opportunities. Current efforts in Nigeria aimed at promoting the use of power tillers through the provision of tiller hire services at AEHE is a step in the right direction to sensitize the farmers to the capabilities of power tillers. In many countries in Africa, soils may not be conducive for the use of low horsepower machines like power tillers for tillage operations. However, for other operations like transportation, harvesting, and irrigation, such restrictions may not apply, allowing implements attached to power tillers to be usable in African settings.

Increased promotion of power tillers has to be undertaken to ensure their widespread ownership by Nigerian farmers for use on their farms. This should be supported with the development of appropriate tools and implements to use with the tillers. In this way, the development efforts of the agricultural machinery R&D centers in Nigeria can be sustained. Deliberate policy should be enacted in both Ghana and Nigeria to encourage machinery suppliers to collaborate with government agricultural research and development institutions to obtain designs for the manufacture by the machinery supplier firms of production, processing, and other relevant equipment for farmers.

Diffusing Information for Various Options

Both Nigeria and Ghana attempt to engage with private mechanization service providers through public-private partnership, namely AEHE in Nigeria and AMSEC in Ghana. Under these mechanisms, typically governments are responsible for providing the machinery, but the governments are only acting as a catalyst for the schemes to take-off. One of the areas that requires continued investigation is how to gradually hand over the responsibility of machinery selection from government to the private sector. Under AEHE, the service provider takes possession of the machinery and equipment and the farmer only becomes the full owner after the final loan payment is made. In Bangladesh, private sector service providers and importers largely determine what types of tractors (design, horsepower) are used in the country. This shows that in the long-run, the private sector will be more efficient than the government in identifying the appropriate types of tractors for Nigerian and Ghanaian conditions. It is important to continuously provide the private sector with information regarding the types of tractors available abroad and link the private sector with international suppliers. Establishing the link with tractor importers in Bangladesh may be a good starting point.

Some states in Nigeria have created agencies to procure and deploy mechanization machinery, equipment, and tools in the state for land preparation and farm operations at affordable costs to farmers. Ghana may also plan to provide subsidy programs for less adopted machineries like power tillers, planters, seeders, levelers, harvesters, and threshers to popularize the utilization of small powered machinery by smallholder farmers. While subsidizing tractors can alleviate constraints in accessing machinery, governments may not have comparative advantages in selecting the best beneficiaries. If subsidies are needed, the option of providing universal subsidies through an electronic voucher system may be considered, while government remains focused on providing information of available types of machineries and suppliers in or outside Nigeria and Ghana.

Final Remark

Past agricultural mechanization efforts in Ghana and Nigeria have focused more on the styles of machinery used in western countries or Latin America, where average farm sizes are much larger. While West African countries, particularly Ghana, are still relatively land abundant compared to Bangladesh, seeking the right balance across various models is important for achieving mechanization growth across diverse types of farms.

Learning from the experience of agricultural mechanization in Bangladesh offer useful inspirations toward how widespread mechanization growth can happen for smallholders in Ghana and Nigeria.

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