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Agricultural Mechanization and the Smallholder Farmers in Nigeria

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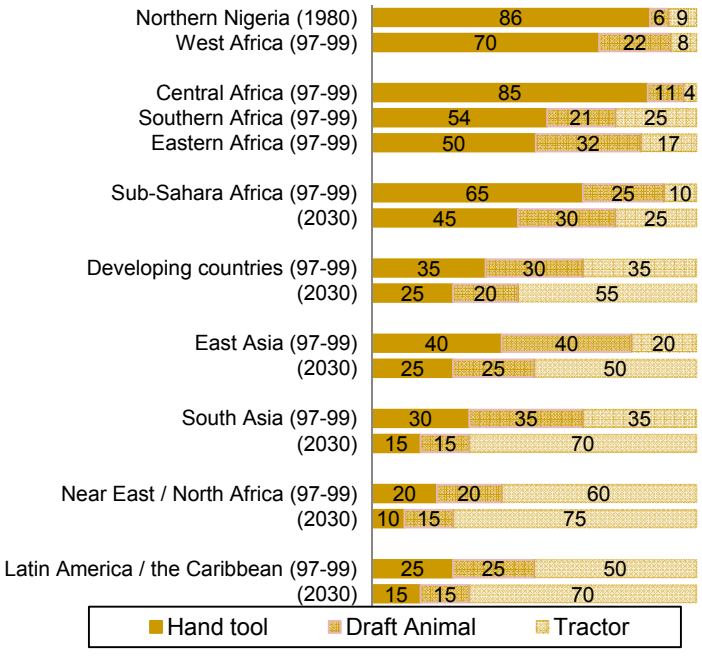
The majority of Nigeria's smallholder farmers are often too poor to employ modern tools, such as tractors and plows, even with substantial government support. In this respect, an agricultural mechanization policy would need effective targeting with regard to particular farming activities and types of farmers for which different forms of mechanization efforts could be directed. Key knowledge gaps for such targeting in Nigeria include the important roles of farm power[1] in comparison with other improved agricultural inputs, such as improved seeds and fertilizer, and the prospects for adopting different forms of mechanization, including the use of improved hand tools.

Background

Agricultural mechanization embraces the use of tools, implements, and machines for a wide range of farm operations from land preparation to planting, harvesting, on-farm processing, storage, and marketing of products. Sources of farm power include hand tools, draft animals, and mechanically-powered technologies (Rijk, 1999). Agricultural mechanization often follows various stages, starting from the use of mechanical power for power-intensive operations that require little control (such as milling, threshing, water pumping, or land preparation, followed by control-intensive operations (such as harvesting, weeding, and adapting farming systems and cropping patterns) to increased use of mechanically powered technologies, and finally to automation of production.

Nigeria is still at the early stage of agricultural mechanization; even the mechanization of power intensive operations has been slow. A significantly higher proportion of farming area is still cultivated by hand tools in Nigeria and West Africa compared to other developing countries (Figure 1). The 2004 National Living Standard Survey (NLSS) indicates that the use of farm animals is also low: only about 5 percent of farming households in Nigeria are likely to be using draft animals.

Figure 1: Percentage of area cultivated by different power sources in 1997-99 and 2030 (estimated) by regions



Source: Bishop-Sambrook (2001) based on FAO (2001), three-year average 1997–1999 (West Africa); Durham (1980) (Nigeria); FAO (2003) (All others)
Note: The current figure for the entire Nigerian region is believed to be close to the figure of northern Nigeria around 1980. The use of draft animals and tractors is less common in southern Nigeria, but the shares of these are assumed to have increased slightly since 1980. Due to rounding, not all percentages add up to 100 percent.

[1]Power available for farming from all sources including manual labor, tractor, draft animals and hand tools.

Owning and renting a plow is not common among farming households, and access to a tractor is even rarer. Furthermore, the common practice of mixed cropping in Nigeria, where each crop is planted in narrow spaces, does not allow economies of scale from large-sized modern tools. Therefore, Nigeria and the rest of Sub-Saharan Africa (SSA) are expected to continue to rely more on hand tools for the foreseeable future for cultivation. The use of hand tools for land cultivation is still predominant in Nigeria because draft animals and tractors require resources that many Nigerian farmers do not have easy access to (Table 1). The minimum land area needed to make the use of draft animals (5 ha) and tractors (50 ha) economically viable is too large for an average Nigerian farm household with smaller and fragmented landholdings (which account for 80 percent of total landholdings in Nigeria). For these land constrained farmers, improved hand tools are often used to increase per unit yield to reduce production costs. In contrast, tractors, draft animals and plows (referred to as "modern tools" as these are non-traditional tools for a majority of Nigerian farmers) tend to be used by only a small number of land abundant farmers to expand cultivable areas with the same labor force. The need for agricultural mechanization in Nigeria must therefore be assessed with a deeper understanding of the smallholder farmers' farming activities and what values farm power generates for them.

Table 1: Different levels of agricultural mechanization and associated resource requirements and constraints (modified from FAO (2006))

		Hand tools	Draft animals (intermediate tools)	Tractors
Major characteristics	Costs for acquisition / maintenance of tools	Low	Medium	High
	Cultivated area per farm household[a]	Low (1 ha)	Medium (5 ha)	High (50 ha)
Potential constraints		• Rising rural wage • Aging of farmers	•Animal diseases •Limited tradition of using draft animal power •High likelihood of theft	• Lack of plots of suitable sizes • Lack of reasonable access to fields • Unsuitable shape of fields • Insufficient distances between fields
Required resources		• Labor, manufacturers and suitable goods • Sociocultural traditions of using the technology	• **Materials**:suitable animals, feed/pasture, implements and spare parts, timber for yokes • **Services**: veterinary services, artisans/blacksmiths, extension services for training, harness makers , Sociocultural traditions of using the technology • **Skills**: animal husbandry skills	• **Materials**: appropriate tractors, machines and implements, fuel/lubricants, implements for weeding and harvesting • **Services**: repair and maintenance services, supply of spare parts, financial services • **Skills**: trained operators

[a] Inferred from the calculations in Durham (1980)

The Role of Farm Power in Nigeria

Farming activities generate value by using farm power, such as labor, draft animals or mechanical power. Pre-harvesting farm activities generally include (1) obtaining space for cultivation, (2) improving soil quality of the cultivated area, and (3) planting seed (Table 2). Harvesting and marketing activities can be categorized into (1) harvesting, (2) value-addition with the physical transformation of products, and (3) value-addition without the physical transformation of products (Table 2).

Nigeria's farming land commonly consists of bush and grass fallow. Farmers obtain space by chopping, slashing, and burning bush or grasses. After obtaining the space, farmers improve the soil quality of the area by either changing the form of soil (tillage and harrowing for grains, ridging for cassava, and mounding for yam) primarily with hoes, or changing the material composition of soils such as adding fertilizer, manure, and/or water, and removing pests and weeds.

Table 2: Modern tools that may replace traditional tools in pre- and post-harvesting activities

Pre-harvesting			Operations		Tools	
					Traditional	Modern
Obtain physical space for cultivation			Land clearing	Chopping and de-stumping	Cutlass and machete	
			Land development		Hoe, spade, basket, and wheelbarrow	Tractor & blades (cutting blade, piling blade, etc)
Improve soil quality	By forms of soil		Land preparation	Tillage	Hoe	Plow
				Harrowing	Hoe	Harrow
				Hilling, ridging, mound making	Hoe	Tractor/animal attachment ridger
	By adding/ removing various components	Nutrient	Soil amendment		Hand broadcasting and cutlass	Motor knapsack sprayers
		Water	Irrigation		Water can	Irrigation pump
		Pest	Remove pest by chemicals		Hand sprayer	Motor knapsack sprayers
		Weed	Weeding		Hoe and cutlass	Weeder
Plant seed, seed stick		Seed and seed stick	Sowing		Hand broadcasting and cutlass	Seed planter and Cultivators
Harvesting and Post-harvesting						
Harvesting			Harvesting		Sickles, scythe, cutlass, and lifter (cassava)	Reaper and tractor
Value-addition ***with*** physical transformation of materials	Separate edible parts from others		Threshing and, winnowing		Thumping by draft animals	Tractor and threshing machine
			Dehulling		Mortar, pestle	Huller
			Peeling		Kitchen knives, water	Peeling machine
			Extraction (oil)			Oil pressing machine
	Preservation and storage		Drying and storage		Mats and racks	Artificial drier
	Attract demand from consumers		Milling, grating, grinding, and pounding		Traditional grater, mortar, and pestle	Grater and milling machine
			Various (soaking, boiling, roasting, pressing, steaming, frying fermentation)		Sacks, fuel woods, iron pan, earthen pots, water, fryer, stones or tied wooden frames (pressing)	Hydraulic jack press (pressing)
Value-addition ***without*** physical transformation of materials	Attract demand from consumers		Sorting, grading, packing, assembling		Hand sorting, grading	Sorter and grader
	Change of locations		Transportation		Head loading, pushcart and wheelbarrow	Draft animals and truck

Nigerian farmers often harvest crops with manual labor using simple tools. After harvesting, the labor activities involve the separation of edible parts from other parts (such as threshing and winnowing for rice, dehulling for cowpea, and peeling of cassava and yam), preserving products (such as drying cassava), and further physical transformation of the products (milling, grinding, grating, and pounding) to increase shelf life. Human labor is further used to add more value to the products without physical transformation, such as standardizing, sorting, grading, assembling, and transporting to buyers.

From the foregoing, it is clear that most smallholder farm operations in Nigeria are accomplished through the use of hand tools. For smallholder farmers, modern tools—even if rented or shared among users—are too costly. Many farmers prepare their farms at the same time of the year, thereby raising rental fees for tools such as tractors. Sharing tools with other farmers often brings in risks of mismanagement and breakdown. Smallholder farmers are particularly averse to these types of risks.

Consequently, very few Nigerian farmers own, share, or rent modern agricultural machinery. Even Nigeria's rapid urbanization and the aging of farmers have not been accompanied with higher agricultural output prices in rural areas or increased farm household income through remittances, and therefore have not increased the effective demand for modern tools.

Agricultural mechanization policies that promote modern tools are therefore not sufficient in Nigeria. While the general trends in Figure 1 indicate that the

ultimate focus of mechanization in Nigeria in the long term should be on promoting the use of tractors[2], the attention to improved hand tools and draft animals is also important in the short to medium term. Nigerian agricultural mechanization policy particularly needs to focus more on identifying the potential of improved hand tools in improving labor productivity for various farming activities, from pre-harvesting and harvesting to marketing.

Key Knowledge Gaps on Agricultural Mechanization in Nigeria

The constraints to mechanization as they apply to large scale farms are well identified in the literature in Nigeria. They are (1) access to credit, (2) setting up of manufacturing and repair services by entrepreneurs, (3) improved infrastructure, (4) affordable and secure access to complementary inputs (fuel, electricity, and larger consolidated plots of land), (5) better legal and regulatory capacity to protect the rights of owners of machinery, and (6) higher efficiency and capacity of public sector for implementing policy. Resolving these constraints should be the policy objectives of the government.

On the other hand, relatively fewer studies have been conducted on why and under what conditions Nigerian farmers would demand more farm power rather than modern inputs like improved seeds, fertilizer or agro-chemicals. These viewpoints are important because agricultural mechanization may be viable only under specific conditions particularly for resource-constrained smallholder farmers.

Knowledge Gaps and Needs of Empirical Research

The preference for using mechanization for pre-harvesting activities relative to the use of other modern inputs is limited. We know farmers face various constraints with pre-harvesting activities that can be lessened with the use of inputs such as improved seed and fertilizer or mechanization. For instance, the need for more land space can be reduced by the use of higher-yielding varieties of seeds, while the need for improved soil quality can be met with fertilizer and improved seeds that resist weeds, pests, or drought. If technologies are available, farmers have options to choose between using more farm power and/or inputs. Empirical research is therefore needed on the relative accessibility of farm power (labor, improved hand tools/machinery) and other modern inputs and how it relates to farmer characteristics. The tools needed for the harvesting or post-harvesting stages are different from those of the pre-harvesting stage. Most Nigerian smallholder farmers grow many different crops in order to mitigate production risks and guarantee availability of labor across seasons. Most pre-harvesting activities target the soil, and therefore, the same tools could be used regardless of the crop. For post-harvest processing, however, farmers may demand traditional tools or improved implements that are adaptable for multiple crops, rather than more sophisticated tools usable only for certain crops.

Recent experience by the U. S. Agency for International Development-funded Maximizing Agricultural Revenue and Key Enterprises in Targeted Sites (MARKETS) project in promoting rice parboilers has shown that the use of processing machines for major crops such as rice is encouraging. However, empirical research is needed in Nigeria on how the profitability of different processing tools depends on farm and farmers' characteristics, and on the level of support farmers need for adopting modern processing tools.

Lastly, agricultural mechanization is often assumed to raise labor productivity, while other inputs such as improved seeds are assumed to improve land productivity, indicating that agricultural mechanization may benefit farmers more in areas where labor is relatively scarcer than land. Empirical research verifying such claims can help government target the regions within Nigeria where different types of agricultural mechanization should be promoted more intensely.

Other knowledge gaps particularly relevant to modern tools in Nigeria include the difference between the price of available modern machines and farmers' willingness to pay for these tools. This research would assist in determining the necessary level of public support for the increased adoption of modern machines. In addition, information on the impact of adoption of modern tools on smallholder farmers is unknown. For example, a production increase by adopters of modern tools may significantly lower crop prices at the market where smallholder farmers trade their crops, thereby reducing their incomes. The production expansion may, however, also provide higher wages for these smallholder farmers,

[2] This is likely to lead to labor displacement but such labor would need to move up the value chain (into processing).

increasing their off-farm source of incomes. More empirical information is needed on whether such outcomes have been observed in Nigeria.

Other general knowledge gaps specific to improved hand tools include how the improved traditional tools can raise labor productivity and reduce labor requirements and how this saved labor is used for other activities. Some empirical studies have shown how traditional tools can be improved, such as by developing longer, lighter hoes with different blade angles (affecting scooping efficiency), and improving tools based on studying the hands of male and female farmers. However, more empirical information is needed on the impacts of such improvements on labor productivity and how the level of impact might vary by the agroecological and socioeconomic characteristics of farmers.

Conclusion

The trend in other countries indicates that increases in farm size are key to expanded use of mechanization. Increasing farm size is, however, difficult for Nigerian smallholder farmers because of existing land tenure systems. Therefore, agricultural mechanization efforts for smallholder farmers in Nigeria would need to take into consideration the following issues. First, smallholder farming in Nigeria still predominantly relies on manual labor equipped with traditional hand tools. Second, smallholder farmers in Nigeria are still too poor to purchase modern tools, and therefore, policies and projects are needed to increase the affordability of modern tools as well as improve the hand tools currently in use. Third, smallholder farmers' demand for agricultural mechanization depends on its relative affordability compared to other modern inputs such as improved seeds or fertilizer, which are also needed to support productivity improvement.

The key knowledge gaps include the identification of (1) the types of agricultural mechanization appropriate for different production environments and farm activities for Nigerian smallholder farmers; (2) the labor productivity impacts of improved traditional tools on smallholder farmers; and (3) the capacity of farmers in adopting modern tools. As evidence is generated to fill these knowledge gaps, the mechanization policy should be reviewed and updated to accommodate this new knowledge.

This Policy Note deals with topical issues of general interest and is intended to promote discussion; it has not been formally peer reviewed, but it has been reviewed by at least one internal and/or external reviewer.

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