

Agricultural Mechanization in West Africa

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1. Introduction

Agriculture provides employment for the majority of Africa's people and generates a good share of GDP. Despite its important role, agriculture is largely underdeveloped in most African countries. There is high potential for expansion of the agricultural sector at all levels. The low levels of input use and mechanization have been cited as main constraints for agricultural development.

Africa is the only region in the world where agricultural productivity has been largely stagnant since 1960s. Average cereal production in Africa stood at 1.5 ton/ha in 2014; the world average was 3.6 ton/ha. Experiences in some developing countries of Asia and Latin America show that agriculture could be transformed into progressive commercial industry. Investment in agricultural machinery has enabled farmers to intensify production and improve their income and quality of life. In countries such as India, China, Brazil and Turkey, the rapid expansion in farm machinery demand has stimulated the growth of local machinery manufacturing. These countries are now major producers and world leaders in farm machinery exports (FAO/UNIDO, 2008). The same development could happen in Africa, if farmers could intensify their activities through greater mechanization. This would lead to increased input use, higher food production, enhanced food security and reduced dependence on imports.

This background paper looks at agricultural development and mechanization with a particular focus on West Africa. It describes the evolution of agricultural mechanization and discusses the major drivers and issues, followed by a look ahead.

2. Overview of Agricultural Mechanization in West Africa

Farm power in West Africa relies to an overwhelming extent on human muscle, based on operations that depend on the hoe and other hand tools. Such tools have implicit limitations in terms of energy and operational output, particularly in a tropical environment. These methods place severe limitations on the amount of land that can be cultivated per family. They reduce the timeliness of farm operations and limit the efficacy of essential activities such as cultivation and weeding, thereby reducing crop yields.

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2.1 Types of Agricultural Machinery in Use

The most commonly used agricultural machinery includes tractors, combine harvester, thresher, manure spreader and fertilizer distributor, plow and cultivating machines, seeder and planters. Figure 1 shows the evolution of agricultural tractors in use in West Africa. Nigeria leads in the total volume, followed by Côte d'Ivoire and Guinea. If we look at tractor usage per hectare, a different pattern emerges (Figure 2). In 2000, Côte d'Ivoire led the field, with about three tractors per 1000 hectares², followed by Guinea. All the other countries had less than one tractor per 1000 ha. It is worth noting that while most countries had increased the level of mechanization over time, Ghana was the reverse. The data for most recent years are unavailable from FAO, however.

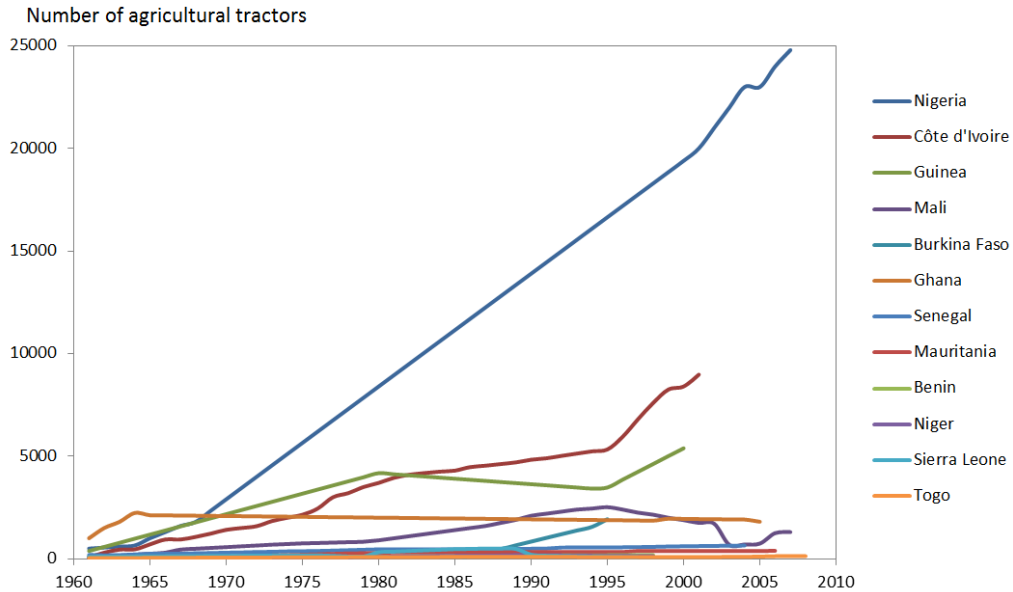


Figure 1 Number of agricultural tractors in use in West Africa, 1961-2008 (Data source: FAOSTAT)

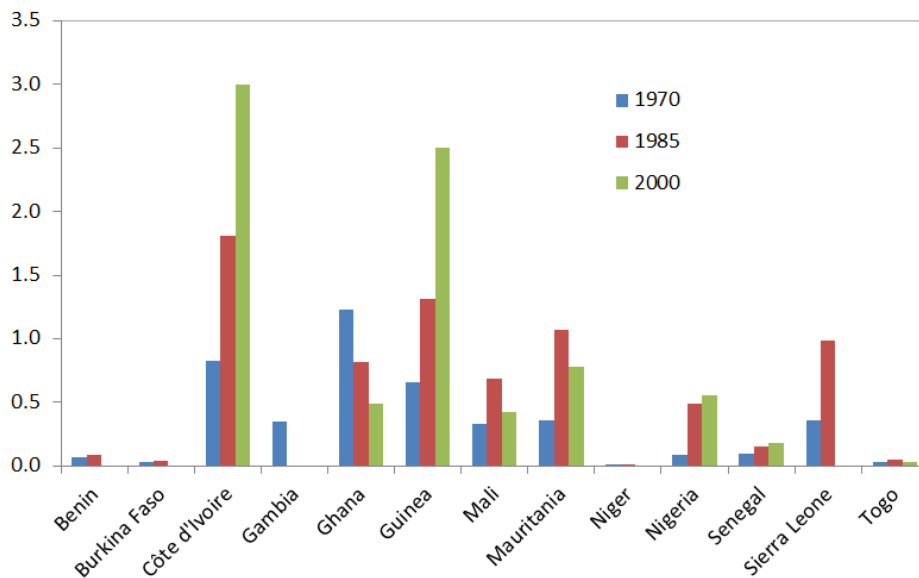


Figure 2 Agricultural tractors per 1000 ha (Data source: FAOSTAT)

² China and India have nine and 13 tractors per 1000 ha respectively in the same year.

More recent country reports show that in Mali in 2010 there were 1,114 threshing machines, 703 mills, 1,286 huskers, 3,878 motor-pumps, 520 multifunctional platforms and 9 mini rice mills (Direction Nationale du Génie Rural in Side, 2013). In Burkina Faso, about 40% of farmers were mechanized in 2006, largely with draught animals (Side, 2013). There were about 8621 tractors in the country, used on 0.4% of the farms (Table 1).

Table 1 Number of equipment units and percentage of farms equipped in Burkina Faso, 2006 (Source: Side, 2013)

Type	Equipment	Number	In % of farms
Agricultural equipment	Plows (Draught animal)	895,411	39.0%
	Tractors	8,621	0.4%
	Motor-pumps	17,392	0.9%
	Carts (Draught animal)	383,240	23.4%
	Total	1,304,864	40.0%
Draught animals	Bovine	1,060,913	25.9%
	Donkeys	616,085	28.8%
	Horses	1,045	0.6%
	Camels	6,942	0.4%
	Total	1,693,985	40.9%

To better and more systematically understand the trends in more recent times, we turned to the UN Comtrade dataset. Based on data for imports and exports of agricultural machinery and tractors, we calculated the value retained in a specific country, assuming there is no local machinery production in that year³. Three variables are used: (1) agricultural machinery for soil preparation or cultivation, (2) harvesting and produce cleaning and grading machinery, and (3) tractors (excluding work trucks and self-propelled)⁴. Figure 3 illustrates the evolution of annual investment in agricultural machinery for selected countries in West Africa. Data from most recent years show that four out of six countries spent about 1 US dollar per ha in machinery for soil preparation and cultivation annually. Mali spent 0.5 USD while Guinea invested around 0.1 USD.

A similar trend can be observed from the investment in harvesting and produce cleaning and grading machines (Figure 4). All six countries invested less than one USD per ha on such machinery per annum. Figure 5 shows the net imports of tractors. Clearly, all the countries invested much more heavily in tractors than other agricultural machinery. Ghana leads, with 22 USD/ha in 2013, a sharp increase from 2010. Côte d'Ivoire invested about 15 USD/ha in 2015, followed by Senegal. Nigeria experienced a severe decline in tractor investment from 2006, but since 2010 this has steadily increased again.

³ This is appropriate for economically smaller countries where local production is non-existent.

⁴ For a precise definition, please refer to <http://comtrade.un.org/db/mr/rfCommoditiesList.aspx?px=H2&cc=87>

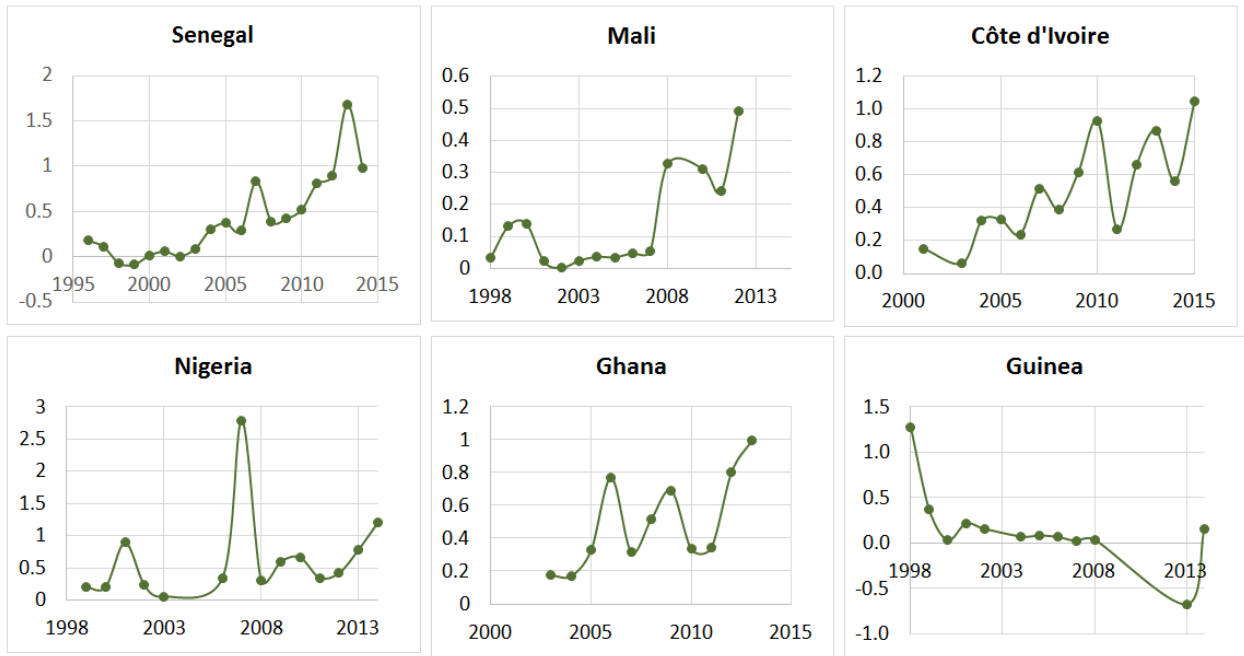


Figure 3 Net imports of agricultural machinery for soil preparation or cultivation (USD/ha)

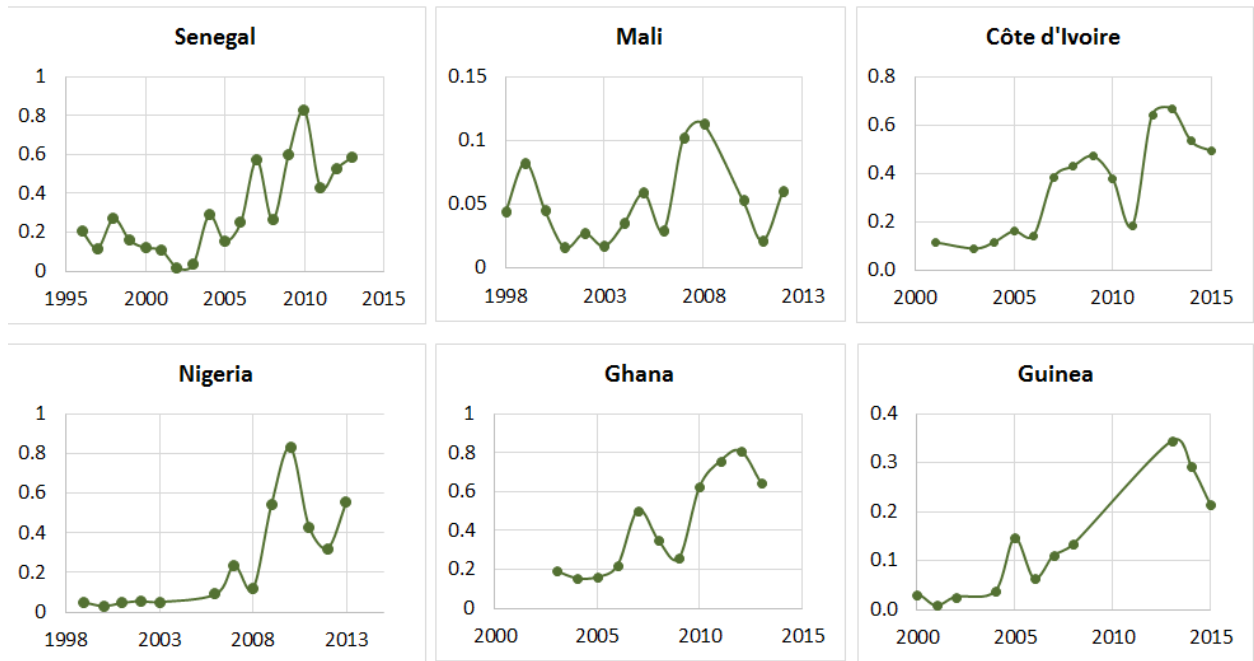


Figure 4 Net imports of harvesting and produce cleaning & grading machinery (USD/ha)

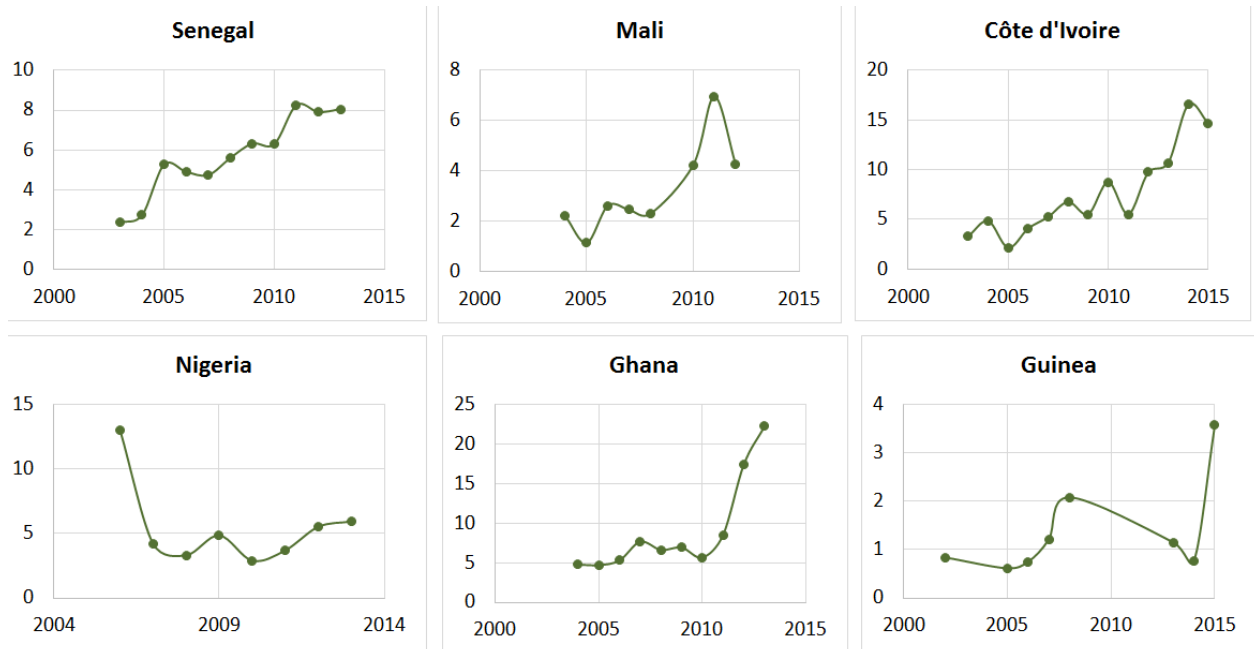


Figure 5 Net imports of tractors (USD/ha)

How does West Africa compare with other countries in Africa or Asia? Drawing on the UN Comtrade data, we compared the use of “tractors” across countries. Kenya, South Africa and Morocco are the leaders in tractor investment in 2012, far higher than countries in West Africa. Two small Asian nations, Cambodia and Vietnam are at comparable levels with Ghana and Nigeria.

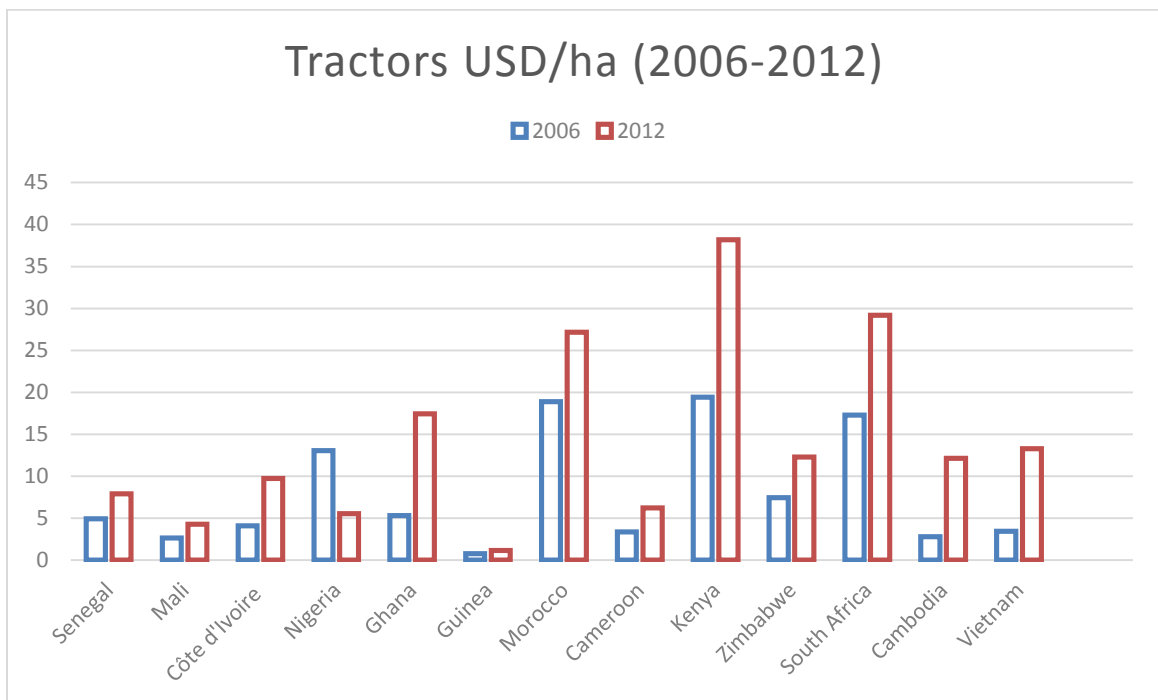


Figure 6 Comparison of tractor imports (net value)

If we look at regional averages, we find that Sub-Saharan Africa (SSA) has the lowest percentage of engine power in total power for land preparation (Table 2). East Asia fares only slightly better with 20%; but the percentage of draught animal power is much higher than in SSA. As in Africa, farms in East Asia are predominantly small, which limits the use of mechanization. Latin America has the highest level of mechanization in the developing world.

Table 2 Sources of power for land preparation (% of total)

	Human muscle power	Draught animal power	Engine power
Sub-Saharan Africa	65	25	10
East Asia	40	40	20
South Asia	30	30	40
Latin America and the Caribbean	25	25	50

Source: FAO, 2006.

2.2 Different Models of Machinery Usage

There are several different models of equipment usage, including individual ownership and usage, collective ownership, fee-based service delivery and renting/leasing. For large landowners who can afford it, individual ownership is the obvious choice. The other models are discussed below.

Collective ownership

Joint use of machinery, especially for soil preparation or cultivation, is possible through farmer organizations or structured cooperatives. A case in point is the Farm Machinery Cooperative in Benin. Most farmers there cannot afford to purchase machinery individually, so shared ownership is one of their few options. Modelled after the French system of the *Coopérative d'utilisation de matériel agricole* (CUMA), the first cooperative system for the purchase and use of agricultural machinery was built in Benin in 1997. Since then, about 120 CUMA organizations have been established across the country, with around 1,200 members (FARM, 2015). CUMA is based on voluntary membership of small farmer groups that wish to invest in machinery. Group members coordinate their farming tasks and exchange skills and best practices. The focus of investment depends on major crops grown in a particular farmers' group or region. Some CUMA concentrate on tractors, plows and trailers, others on processing equipment such as cassava graters or palm nut oil machines (FARM, 2015). Each member is obliged to contribute financially to the CUMA; shares are proportionate to the area of land on which a farmer wishes to use the machinery. Thus, membership and machinery access become feasible for small-scale farmers, while at the same time also offering viable opportunities for medium-scale farmers.

However, in Benin, the purchase of mechanization equipment is difficult. Lacking access to credit, farmers save up money within the group, which can take several years. In addition, it is hard to find adequate and affordable machinery. As a result, most CUMA depended on intermediaries such as government funds or NGOs to acquire or import the necessary machinery. Once the machinery is purchased, farmers have to establish a financial buffer for cases of damage, or when additional equipment is needed. Within the CUMA network, training is offered in machinery use and maintenance and in proper use of the plow in order to minimize soil degradation through misuse and to extend the machinery's working life. The training also raises awareness among farmers that the higher costs of

machinery ownership within the CUMA are justified, compared to private service providers who are often not properly trained in plowing techniques.

CUMA tractor users predominantly farm cotton and corn. The tractors enable them to time planting better and cultivate about 3.5 times more land than before. The farmers involved specialize their production and focus on the market. With a tractor and plow, only certain tasks in the growing cycle are mechanized, so more manual labor is needed for in planting, weeding and harvesting. CUMA farmers mainly hire labor to cope with the surface increase in cultivation, turning their family farm into a family business and providing rural employment. Most farmers report an increase in income, allowing for further investments in the farm, but also in livelihood improvements through access to education, health services and food.

Service delivery models

An alternative to collective ownership is payment for use of a machine and driver for a specific period of time or land area. Such services are usually provided by private companies able to make large upfront investment. Some well-resourced farm cooperatives can offer machinery hire. Pre-harvest services typically include land preparation, sowing, cultivation and harvesting. Post-harvest services include threshing, and crop processing.

An example of sustainable service delivery model is the Center for Mechanized Services (CEMA) developed and tested by the Syngenta Foundation for Sustainable Agriculture since 2014 in the Senegal River Valley in the northern Senegal and in the Office du Niger area in Mali. The model has been established in order to address the issue of timely completion of field preparation and grain harvesting in rice growing systems. Essentially, CEMA aims to aggregate demand of mechanization services from many smallholders and to organize the sustainable supply of such services through large-scale machinery (and thus considerable upfront investment). These include tractors, combine harvesters and storage facilities. The machines are owned by a farmer union but are managed by a private entity which is responsible for operations, maintenance and financial management in accordance with agreed terms and conditions. A Guarantee Fund was set up to help farmer unions to access bank loans for purchasing agricultural equipment. After two years of operation, the pilots already proved that (1) paid services are well accepted by farmers, (2) CEMA constitutes a viable business model for machinery services, and (3) CEMA creates opportunities for rural employment.

Another innovation is “Hello Tractor”, a young Nigerian start-up enterprise that buys tractors and hires them out via an SMS-based hiring and mobile payment scheme (Ströh de Martínez et al., 2016). Hello Tractor equipped some farmers with tractors and established a so-called Smart Tractor network, via which other farmers can hire these. The tractors come with a range of equipment parts which can be used for different crops and production systems. This enables tractor owners to offer service year-round. A unique feature is the GPS antennae, which allows Hello Tractor to track the usage, location and uptake of the tractors and assures tractor owners about where their tractors are at all times. It also has a comprehensive booking system, allowing farmers to request a service, schedule the exact date and time, as well as pay - all through one system. Since its operation in 2014, participating farmers have increased their yields by 200 percent.

Successful service delivery requires realistic business plans. These need to take account of the strong seasonality of demand. The plans should further consider aspects such as various agro-ecological environments in which equipment is operating, smallholders' typically fragmented farmland, variation in interest rates, availability of spare parts, and the cost of maintenance. Good scheduling is also essential, as farmers in the same region tend to demand land preparation and harvesting services simultaneously.

Leasing

Before the 1980s, mechanization efforts in many African countries focused on governments importing large tractors and hiring them out in state-run schemes. Despite huge efforts and large sums of aid, this approach proved unsustainable. Spare parts, technicians and fuel were all lacking, causing long downtimes (Ströh de Martínez et al., 2016). In addition, large tractors were inappropriate for smallholders' plots. Long distances between small farms made state hire schemes unprofitable, with corruption and elite capture aggravating the situation (FAO, 2008). Some of these constraints still apply today, but machinery supply in Africa has become much more diverse. Smaller and cheaper equipment adapted to smallholder agriculture has been imported from Asia and Latin America. This has created new opportunities for the rental services.

Where public sector leasing services are not sustainable, private sector models or some forms of public-private sector partnership are possible alternatives. IFPRI (2015) suggests that a promising approach is the development of a mechanized service hiring market, in which medium- and large-scale tractor-owning farmers provide hire services to smallholders. This has happened to some extent in West Africa, where tractor owners have spare capacity and hire out machines to help cover their costs. Customers are usually their neighbors. More entrepreneurial farmers have also started to invest in two or three machines and run small contractor (hire) businesses, typically in communities where the contractor knows his clientele (FAO, 2016).

2.3 Key Issues and Challenges in Mechanization

One of the biggest challenges for successful mechanization in West Africa is access to finance. The cost of tractors and agricultural machinery is far beyond the reach of most farmers (see Table 3). Farmers typically lack collateral for bank loans. This severely holds them back from investing in machinery. Collective ownership can be a solution. However, this requires time for members to accumulate adequate funding, as well as strong cooperative management and training in machinery use.

Table 3 Types and prices of the main equipment units in West Africa

Equipment	Type	Accessories	Price in euros
Donkey*		Plow	100 to +300
Pair of oxen*		Plow	400 to +800
Tractor	35 to +100 hp	Plow, cover-crop, cart	10,000 to 20,000 (second hand on local market) 25,000 to 35,000 (from Asia) +50,000 (from OECD)
Power tiller	10 to +20 hp	plow, drill, cart	4,000 to +10,000
Husker*			3,000 to +10,000
Threshing machine	10 to +20 hp		3,000 to +10,000

Combine harvester	20 to +100 hp		10,000 to +100,000
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Source: Side, 2013 and *combined data from Roesch, 2004 and Faso-Jigi, 2016

Another challenge is the availability of well-adapted machines for local production systems. Locally produced machinery is usually low in quality and high in price. Provision of spare parts, advice and other services is often underdeveloped, particularly in remote areas. Adaptation of machinery to current production systems and farmers' needs is badly needed. The private sector also needs to step up its efforts to provide adequate maintenance and repair services.

Land security poses an additional challenge to mechanization. Many farmers lack land tenure or long-term land use rights. They therefore tend not to invest heavily in their farms, or in preventative measures against degradation (e.g. grubbing, anti-erosion methods). In addition, with little extension support, farmers in West Africa lack the knowledge and skills to operate mechanized equipment. This can lead to misuse and mismanagement of machinery, especially of more sophisticated items.

3. Major Drivers and Trends in Mechanization

Funding of agricultural mechanization in West Africa remains a major challenge. Existing financial models include leasing, grants, government subsidies, joint ownership, and lease-to-own financing. In "lease-to-own", farmers make regular payments (through a loan or cash) over a set period, and take ownership once the payments are complete. Some models have demonstrated success like CUMA in Benin (albeit still at limited scale), which was replicated in Mali in 2001 and Burkina Faso in 2004. However, where conditions for profitability are missing, failures abound. Successful mechanization depends, for example, on its suitability for the soils, physical geography (e.g. slope) and crops, as well as on the intensity of work, purchasing costs, and functioning of equipment and usage rates.

An interesting feature of recent developments is that organizations along the food value chain are now engaged in mechanization. For example, producer organizations tend to help their own farmers with services related to machinery for soil preparation or cultivation. Food processors and traders increasingly help farmers have access to harvesting, produce cleaning and grading machinery. In addition, there are agri-businesses that work with both upstream and downstream supply chain partners; they provide mechanized support ranging from land preparation to harvesting and processing.

Another recent trend has been for policy-makers to integrate mechanization as a pillar of broader agricultural policy protecting local production against market risks and providing research and development, training and necessary inputs. In 2010, the Beninese government clearly specifies the development of agricultural mechanization as one of the main components in the Agricultural Investment Plan 2010 – 2015 (MOA, 2010). The objective is to increase the rate of mechanized operations through adaptation of technologies and public-private partnerships. Moreover, an increasing number of development projects focus on mechanization adaptation to local production systems. For example, CIMMYT, together with the Syngenta Foundation is working in Zimbabwe to develop locally adapted machinery prototypes.

4. The Way Forward

The experience from South Asia (especially India and Bangladesh), where small farms dominate, shows that it is possible to improve mechanization through access to smaller and well-adapted machinery. Strong public policies in India have also helped create favorable conditions (e.g. credit, insurance, R&D, infrastructure) for mechanization development and uptake. This could happen in West Africa as well if governments and the private sector work together. The government needs to develop conducive policies and strategies for mechanization. One example would be increased funding for research and training programs to best adapt the techniques of farm machinery to the needs of family farms. Another would be tax and legal incentives that “crowd in” private investment to establish a stable national farm machinery sector. The private sector has a role to play in establishing a market for farm equipment and spare parts, and in bridging the gap between demand and supply in various adjacent services. Furthermore, new and innovative models of public-private partnerships (PPP) could play a key role in the development of sustainable mechanization.

The issues of access to finance and lack of land tenure security remain in the foreseeable future. Innovation in finance and service delivery is needed including the uberization of mechanization and leveraging of other opportunities provided by the shared economy (via ICT, social media). Land governance remains a fundamental driver for mechanization. For farmers, it is essential to have the legislation that guarantees access to land and the right to protect their investment in land. Farm size also determines the purchase and usage decision of machinery. How farm sizes will evolve in Africa (consolidation vs. fragmentation) would affect the level of mechanization.

The Dakar Conference aims to discuss current local initiatives and policies for mechanization, and to explore different possibilities and levers (policies, finance, adapted equipment, management models, service delivery, and PPP) to scale up machinery use for greater productivity, employment and wealth in the agricultural sector. The conference offers an excellent opportunity for public and private sector representatives to exchange, share and debate a wide range of issues and ideas.

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