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Mechanization and skills development for productivity growth, employment and value addition: Insights from Mali

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FARA serves as the technical arm of the African Union Commission (AUC) on matters concerning agricultural science, technology and innovation. FARA has provided a continental forum for stakeholders in AR4D to shape the vision and agenda for the sub-sector and to mobilise themselves to respond to key continent-wide development frameworks, notably the Comprehensive Africa Agriculture Development Programme (CAADP).
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Introduction

African farm systems are the least mechanized of all continents (Sheahan & Barrett, 2018). This is a concern, since low levels of mechanization are associated with low levels of labor productivity, a key determinant of farmers' incomes (Fuglie & Rada, 2013). However, with the re-emergence of agriculture on Africa's development agenda, there is now renewed interest in agricultural mechanization (FAO, 2016; Kirui and von Braun, 2018; Malabo Montpellier Panel, 2018). Governments aim to overcome "hoe and cutlass" type of farming to making agriculture attractive to the youth (Birner and Mockshell, 2015), donors are increasingly fundind mechanization-related projects and machinery companies have discovered Africa as an emerging market (Daum & Birner, 2017; FAO 2016; Oluwole and Odogola, 2018).

The renewed interest in agricultural mechanization has been fueled by increasing evidence that access to labor limits development for many smallholder farmers (Baudron et al., 2019; Diao et al., 2014; Nin-Pratt & McBride, 2014). Indeed, studies suggest that once farms are mechanized, farmers would benefit greatly from agriculture, for example, by being able to increase their farm incomes (Adu-Baffour et al., 2019; Kirui, 2019). But there are still unanswered questions by scholars regarding African agricultural mechanization. This leaves policymakers and practitioners ill-equipped to design good policies and programs. These questions include: What are the best options for the mechanization of smallholder production and processing systems from economic and institutional perspectives? What are the roles of the private sector and the state? What knowledge and skills are needed to promote mechanization? What are the effects of mechanization on rural employment?

To answer these questions, and thereby scientifically assist in the recent mechanization efforts, the Program of Accompanying Research for Agricultural Innovation (PARI) identified "mechanization and skill development for productivity growth, employment and value addition" as one of its top priorities. PARI is led by the Center of Development Research (ZEF) and funded by the German Federal Ministry for Economic Cooperation and Development as part of its *One world, No Hunger Initiative* (SEWOH). PARI's research cluster on mechanization is led by the University of Hohenheim, the Forum for Agricultural Research in Africa (FARA) and ZEF and jointly implemented with the Institut National des Recherches Agricoles du Bénin (INRAB), Kenya Agricultural and Livestock Research Organization (KALRO), Agricultural Research Council of Nigeria (ARCN), and Institut d'Economie Rurale (IER).

The overall objective of the research cluster is to identify opportunities of mechanization policy and investments to increase productivity, incomes and employment and add value to African produce. In particular, the research cluster addresses four research objectives:

1. **To compare different instit utional options for mechanization, including state-led procurement and distribution of machinery and private sector activities**. The objective was formulated in responsive to the renewed efforts of many African governments to

import and distribute machinery to farmers, despite that tractors are private goods and despite the unpleasant track record of such state-led approaches (Daum and Birner, 2017; Pingali, 2007).

2. **To assess opinions and beliefs with regard to policy instruments and effects related to mechanization, youth and digitalization.** The objective was formulated as agricultural development trajectories, including those related to mechanization, youth and digitalization are contested. For example, domestic policymakers and donors often have different opinions and beliefs with regard to the best policies; understanding these differences is key to enabling more fruitful policy dialogues (Mockshell and Birner, 2015).
3. **To assess the state of skills development for mechanization.** The objective was formulated because research and experience have shown that successful agricultural development and mechanization requires knowledge and skills development (Daum *et al*., 2018; Daum and Birner, 2017; Kirui and Kozicka, 2018). The research component analyzes the extent in which existing formal and informal training programs provide the knowledge and skills needed for successful mechanization; this helps guide future knowledge and skills development efforts.
4. **To assess the effects of agricultural mechanization on rural communities.** This objective was as a result of the fact that effects of agricultural mechanization have been subject to a controversial discussion. As Juma (2016) shows in his book on "Innovation and Its Enemies", farm mechanization has been one of the most controversial of all agricultural innovations – not only in contemporary times, but also historically. While proponents see mechanization as largely beneficial, opponents emphasize the effects on employment as downsides of mechanization. However, little actual research has been conducted on the effects of mechanization. The research component uses Participatory Impact Diagrams to assess the positive and negative impacts of mechanization at the household and/or community level.

Country Background on Agricultural Mechanization

The agricultural sector analysis has proven that, despite the large agro-sylvo-pastoral and fisheries potential, Mali has difficulty in satisfying its food needs and reaching sustainable and satisfactory level of food security. More so, demographic perspectives show that population in

Mali will double by 2025 and that 80% of this will concentrate in urban areas (in the triangle axis of Ségou-Bamako-Sikasso) (MA, 2005). According to UN sources, approximately 51.4% of the population live under the poverty line and 28% of it is undernourished. However, in the near future, Mali is expected to modernize its agricultural sector and improve livelihoods of rural population by making agriculture more attractive.

From 2012 to 2014, the number of tractors in Mali increased from 1,890 to 3,400 units, which was a relative increase of about 80% (DNGR, 2015). This increase was mainly due to the provision of subsidy for 1000 tractors by the government in 2014. The government also subsidized 500 tractors in 2018, thus increasing the number of tractors in the country. Even with the rate of subsidy of 50%, the tractors are still expensive for smallholders at $23,000 to $26,000. During the same period, but without any government intervention, the number of two-wheel tractors (motocultors) also increased from 1119 to 3330 units, with an increase of 197%. Generally, the rate of mechanization in the country has greatly increasing, from 9% in 1964 to 40% in 2011 (DNGR, 2011). Mali is currently experiencing a mechanization boom. But about 80% of the farmers are smallholders, with less than 6ha of cultivated land; hence, to significantly increase farm mechanization, the government must develop an environment which favors increased access to equipment.

Percentage of farms / land areas mechanized

According to the last agricultural census, only 0.4% of household farms owned a tractor (RGA, 2006). Hand tools (hoes, harrow, *daba*, cutlass, etc.) are still heavily used in farming activities and are estimated at 76% of farms equipped with draught animals and 90% of motorized farms. Only plowing (land preparation) is executed with tractors; the remaining activities are done by hand. In 1964, only 9% of cultivated land area used animal draught equipment; this rate reached 40% in 2011 (DNGR, 2011). The rates of mechanized lands in 2016 vary by region in Mali (Figure 1).

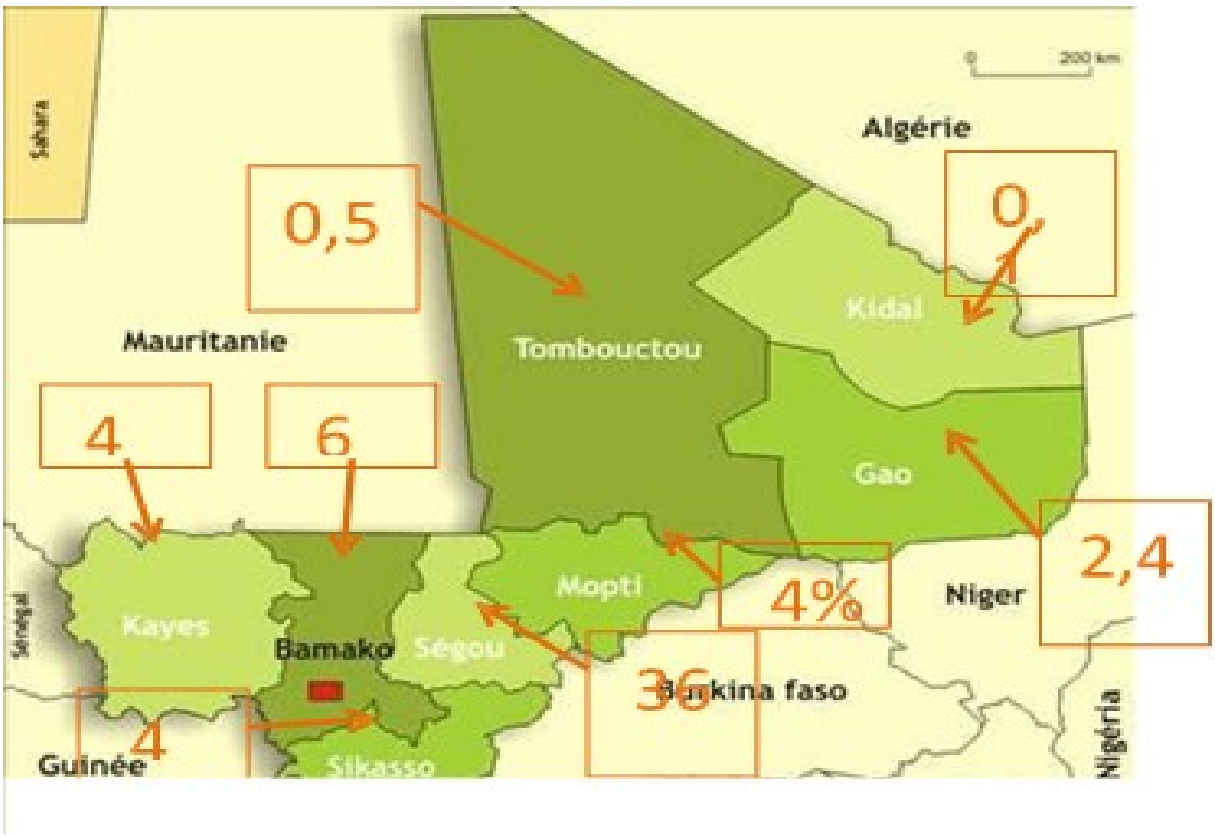


Figure1: Rate of mechanization by region

Source: Michel Harvard, 2016

The mechanization rates by administrative region according to Figure 1 are as follow:

- Kayes = 4%
- Koulikoro = 6%
- Sikasso = 47%
- Segou = 36%
- Mopti = 4%
- Timbuctu = 0.5%
- Gao = 2.4%
- Kidal = 0.1%

The Sikasso region is dominantly the cotton zone, while the Segou region is mainly the rice zone. Koulikoro region is mainly rainfed cereal and legume zone. These three regions constitute more than 80% of the total number of farm equipment in the country. Farmers in Segou and Sikasso regions are relatively less vulnerable than the others due to higher rainfall in Sikasso and irrigation development in Segou.

Activities mechanized

Mechanization is essential not only for crop production, but also for the entire value chain. Mechanizing the whole agricultural value chain, from planting to marketing, would lead to higher value outputs, increased rural employment and reduced postharvest losses. It is necessary, therefore, to take a holistic view of the value chain in order to reduce all forms of productivity and quality constraints. Figure 2 depicts the activities mechanized along the crop value chain in Mali.

Figure 2: Mechanized activities along the rice and cotton value chains in Mali

Mechanization is carried out for animal husbandry, fisheries and forestry activities in Mali, but at a very low level, compared to that for crop production. Activities such as cutting woods, hay and hay conservation are mechanized. In terms of fisheries, only transportation and conservation activities are mechanized.

Crops mechanized

In Mali, the most mechanized crops are millet, sorghum, maize, rice, cotton, sesame, and legumes (such as peanuts and cowpea). In terms of intensity, cotton, maize and rice have the highest mechanized efforts. Millet and sorghum occupy large areas but are poorly mechanized because of their low yields and the type of soil they grow in.

State of animal traction

Mali remains a reference in the subregion regarding crop mechanization; the state of animal traction is given in Table 1.

Table 1 : Composition and evolution of animal draught equipment, 2010–2014

Animal traction equipment	2002	2007	2010	2011	2012	2013	2014
Plows	246024	348048	466024	481024	496 024	511000	524959
Hoes	13046	13845	14590	14783	14 976	15169	15363
Multicultors	234608	236608	144608	146508	156600	160900	162235
Seeders	96361	97561	111641	113551	115461	117371	119285
Carts	227276	348048	507276	609279	709500	809500	973503
Draught animals	-	-	1079000	1081000	1082000	1082000	1500331

Source: Division Mécanisation Agricole de la Direction Nationale Du Génie Rural du Mali (DNGR)

Just after independence in 1960, the government developed a mechanization strategy aimed at equipping farmers in material and draught animals through medium-term credit (Derlon, 2001; Kassambara et Kleene 2003). In 1990, with the Structural Adjustment Programs, the strategy regressed and farmers' cooperatives had to seek credit with the bank or microcredit institutions. However, the allocation per member to purchase complete equipment for animal traction was far beyond microcredit institutions' capacities. Commercial banks were reluctant to give loans on agricultural activities, as they were seen as risky. According to DNGR, in 2005, only 35% of household farms had complete equipment (315,000) while 585,000 are underequipped or non-equipped. While farmers need more and more equipment, a strategy that meets their requirement should be found in order to close the gap.

With draught animals, the main constraint that farmers face is the physical weakness of animals during the critical period of land preparation and planting. One of the solutions is to equip farmers with motorized equipment, but their purchase and maintenance costs are beyond most of them. Table 2 provides the component of motorized equipment in Mali.

Table 2: Composition and evolution of motorized agricultural equipment: 2010–2014

Motorized equipment types	Years				
	2010	2011	2012	2013	2014
Tractors and accessories	1 682	1 734	1 890	2 000	2 100
Motocultors and accessories	957	800	1 119	1 200	3328
Threshers	1 033	1 054	1 078	1 100	2 470
Mills	740	900	950	1 000	1 150
Dehullers	960	1 348	1 370	1 400	2 355
Motor pumps	2 946	3 900	3 930	4 000	4 150
Multifunctional platforms	150	1 150	1 160	1 200	1 300
Mini-rizeries	0	09	10	12	28

Source: Division Mécanisation Agricole de la Direction Nationale Du Génie Rural du Mali (DNGR)

Table 2 shows that, although the number of motorized or draught equipment keeps increasing, farmers' needs in agricultural equipment are not fully satisfied. The number of draught animal equipment is far higher than those of motorized equipment. This is explained by the following reasons: (i) the cost of equipment, (ii) introduction and adoption age of draught equipment, (iii) animal draught equipment concern both large and small farms. Large tractors thus became the only alternative in some agricultural regions, particularly in the CMDT zone.

Institutional options for mechanization, including state-led procurement and distribution of machinery and private sector activities

In Mali, agricultural mechanization policy was developed alongside agricultural extension and research services. Agricultural extension organization, management and mechanization evolved together from the colonial period. This period is discussed below.

The 1964-1980 period affected considerably agricultural mechanization evolution. The agricultural policy entrusted the implementation of priority agricultural development actions to autonomous bodies, called "programmes" operating in ecologically homogeneous areas. Thus, the advent of cotton, groundnuts, rice, etc. program led to the concept of Rural Development Operation (ODR) in 1967. This concept was essentially based on an integrated approach to rural development, aimed at improving the living conditions of farmers and their environments, and on the establishment of autonomous development structures for the implementation of development projects and the provision of extension services. The limitation of this policy of regionalization of investments through the ODR system were, however, immediately noticed. In 1964, in order to satisfy the strong demand of ODR producers for inputs and equipment for harness farming, a specialized service, called Service de Crédit Agricole et d'Equipement Rural (SCAER) was created, which operated until 1980. SCAER acquired agricultural inputs and equipment and transferred them to Rural Development Operations (ODRs).

ODRs managed the stocks of agricultural inputs and equipment by delivering them to farmers in their respective areas and recovering repayments. Thus, the subsidies granted by the state to this company made it possible for them to sell agricultural inputs and equipment within the reach of producers. With the drought of the 1970s, there were difficulties in the operations of SCAER, as ODRs defaulted in y repayment due to the meagre monies they received from farmers who had become less and less solvent. SCAER was dissolved in 1980 and its agricultural credit function was entrusted to a new institution, the National Bank for Agricultural Development (BNDA) in 1981. The supply and distribution function was given to RDAs and producers in areas not covered by these structures were left unattended to.

The period 1980-2001, known as the period of Structural Adjustments in Mali, was characterized by the gradual or total disengagement of the state in the supply of agricultural

inputs and equipment to the rural areas, and the liberalization of the market. Market liberalization deprived ODRs the means to pre-finance equipment for farmers' needs. Only producers in the cotton sector and the Office du Niger Zone were, for some time, protected from this policy. In unframed areas, producers were only served through informal or parallel channels, which usually had generally poor quality products of unknown origin.

From 2001 till date, the new state policies and strategies for rural development and women advancement focus on state disengagement from the functions of production, marketing, transport and processing and their transfer to the private sector, individual producers and professional organizations. This makes industrial or commercial operators the main drivers of the rural economy. The consequent restructuring of government services which, until these reforms, provided policy direction, equipment procurement, marketing and credit facilities, left in place a somewhat disjointed system characterized by poor policy on agricultural machinery and advisory support services.

An important aspect of the challenges of agricultural mechanization is the current debt crisis that producers have been involved in. This challenge is complex and has its origin in the credit policy of the 1960s. It is also a product of the poor transition between government credit facilities (SCAER-ODR, projects, etc.) to the credit of financial institutions (BNDA, traditional banks, decentralized financial systems). Indeed, no reliable system has replaced the ODRs in the supply and distribution function after their withdrawal from agricultural credit financing. The lack of loan guarantees deprives farmers the capacity to borrow from BNDA. Decentralized financial systems are still too localized in some areas, despite their adaptation to needs, as a strong financing system nationwide. Moreover, the equipment credit system does not cover the whole country and only affects specific areas of development. An agricultural mechanization policy should be well-situated in an appropriate legal and institutional framework.

At the legal framework level, various legal texts contain provisions that directly or indirectly affect or influence agricultural mechanization. Among them are the legislation governing cooperative societies and the Land and State Code. Law nNo.01-076 AN-RM of 18 July 2001 defines cooperative societies as "partnerships of a particular type based on the principles of union, solidarity and mutual assistance to achieve a common economic and social development goal by setting up a company that the members democratically manage and in the functioning of which they undertake to participate actively". This legislation is of interest in that it provides the legal basis for bringing together the efforts and resources of agricultural producers and blacksmith networks to organize their means of production, such as agricultural equipment and inputs. The Land and State Code is the text that defines the legal basis for the ownership of land used by agricultural producers and, above all, for securing their holdings on this land. As most agricultural lands are occupied on the basis of customary rights, the sustainability of a farm is not guaranteed, since the ownership of the land used can, theoretically, be called into question at any time. This situation is a barrier to the mechanization of agriculture in that it limits the

possibilities of permanent agricultural holdings that require huge investment in infrastructure and equipment. Consequently, the government, in consultation with civil society organizations, has drafted an Agricultural Guidance Law (LOA) which redefines an agricultural policy for the future Mali and serves as a basis for the emergence of modern agricultural sector that is economically and socially profitable. This law removes many constraints to the development of agricultural mechanization in the country.

The current institutional and regulatory environment of agricultural mechanization has been rendered unconducive by multiple restructuring within the rural sector. The current structures are not adequately organized and skilled to orientate, analyze, support, monitor and evaluate different actions related to agricultural mechanization. Given the multiple institutions involved in agricultural mechanization, effective coordination of actions at the central and regional levels is difficult to achieve in the absence of an appropriate space and linkages with stakeholders in the sector. Moreover, the policies are not often followed with capacity building for producers and other actors.

Actual programs for promoting agricultural mechanization

To date, agricultural mechanization is taken into account to a limited extent in rural development projects and programs. A few projects include medium-term credit lines. Agricultural equipment are mainly available to cotton producers and, to a certain extent, the Office du Niger (rice production zone).

In the cotton subsector, and with regad to the development of a strong production system, CMDT is responsible for supplying producers with inputs and equipment. The National Bank for Agricultural Development (BNDA) ensures the credit by paying cash to CMDT for the equipment to beneficiaries and by collecting the credit from the Village Associations when paying for the cotton produce through CMDT. In the CMDT zone, certain stages of the cotton supply chain are increasingly being transferred to farmers' organizations and producers' unions, in order to eventually enable CMDT to withdraw completely. Since 1994, cotton producers' unions have been fully involved in the supply chain (tenders, setting selling prices for agricultural inputs and equipment); this marks a decisive turning point in the mechanisms for transferring the supply function. In the OHVN area, the transfer of credit and input supply functions has been successful at the private sector level (suppliers, banks, farmers' organizations).

In the Office du Niger area, the supply of agricultural equipment and inputs is also fully liberalized. Farmers' organizations and rice farmers' unions deal directly with credit financing agencies, the manufacturing and distribution network for agricultural equipment. However, the NB's assistance to operators focuses on advising, informing, training and organizing operators so that they are genuine partners in the input and equipment subsector, and on training blacksmiths to equip them with less expensive and efficient equipment.

In other unframed areas, producers were, for a long time, left uncared for, despite their numerous supply challenges. In response, the government has initiated two projects: project

towards reforestation, and project on overcoming poverty. These are to help equip certain categories of very poor farmers, by encouraging them to engage in reforestation activities for more income in the short and medium–term; the projects would also contribute to the objective of achieving a green Mali. During the last six years (1999 to 2004), the project on reforestation has invested about FCFA 1,570,190,623 to 3,971 farmers, who have reforested 7,585.67ha, the products of which guaranteed the loans contracted. The equipment covered included: ploughs, carts, pairs of oxen, multi-cultivators, seeders, donkey cheeks, and motor pumps.

The project on overcoming poverty of te Ministry of Social Development only covers the circles of Yorosso (Sikasso), Baraoulé (Segou) and Dioila (Koulikoro); the equipment provided were similar to those on the reforestation project. The financing of both projects was through the Special State Investment Budget. With regard to the reforestation project, the bank balances resulting from the recoveries of all the regions and the district of Bamako were estimated at FCFA303,785,848 at the end of the 2004 campaign.

In addition, in May 2005, the Group of Cotton and Food Producers' Unions of Mali signed a contract with the Chinese company DTE-SA to acquire 156 tractors for the benefit of their members.

Recently, the government initiated the "National Program for the Provision of Agricultural and Irrigation Equipment for the Benefit of Rural Producers". Funding for this program is through a negotiated on the Line of Credit made available to Mali by the Government of India under the "TEAM 9 Initiative". The current discussion (a Convention has just been ratified by the National Assembly) between the two countries, two Indian companies have been selected to provide the following equipment and materials: 395 tractors (50-60 HP power) with standard kits and spare parts, 300 disc ploughs, and a workshop for the assembly and commissioning of equipment and training of beneficiaries.

The equipment thus acquired are to be on medium-term credit, either with interested individual producers or with EIGs providing agricultural services, made up of unemployed tractor drivers and young graduates. The loan will be granted by the BNDA; the beneficiaries would imperatively direct the operating revenue. A trust account will be opened at BNDA to receive payments and establish a revolving fund for the equipment

The current programs are attempts to respond in the short term to the producers' pressing need for equipment. They are yet to ensure the full take-off of a mechanization policy of Malian agriculture.

The implementation of the national agricultural mechanization strategy (which is in line with the Agricultural Orientation Law) is the government's short and medium-term response to the problem of under-equipment in rural areas.

So far in Mali, the forms of agricultural mechanization adapt well to the socio-economic environment of the farmer. But it is difficult to accurately specify the need and projections for agricultural equipment. One reason for this is that available data are imprecise and only concern well-managed regions. In any case, the trend for the different forms of mechanization is discussed below.

Manual mechanization is developed through a diversification of equipment to meet the needs of farmers in agricultural work. The local manufacture of this material is booming, especially around large urban centers, which are major consumers of gardening products. The equipment relating to the processing of agricultural products and the packaging of by-products should be further developed to lighten the daily tasks of women and young people.

Animal traction offers an opportunity to develop agriculture in most of the country's production systems. Therefore, there is the need to consider the generalization of animal traction for agricultural work on family farms as a preliminary step towards achieving advanced form of mechanization for the country.

Large motorization is making its way into cotton farms. With the intensification and diversification of crops and more appropriate agricultural calendars for transportation, motorized agricultural mechanization will increase.

Intermediate motorization, including the use of power tillers, is increasingly becoming a response to the intensification of irrigated rice production. In this motorization option, all technologies relating to processing (threshing and shelling machines) and water drainage (hand and motor pumps) are expected to be developed in large numbers in the coming years.

Agricultural Orientation Law (LOA) was adopted in December 2005 to ensure the country’s food security and help promote economic and social development of the rural population through modernized agriculture.

This Law emphasizes the modernization of household farming; hence, the government of Mali has set mechanization actions to facilitate increased farmers’ access to mechanization and motorization inputs (Act 137 of LOA).

There are two mechanization distribution channels in Mali:

1. Government distribution channel, which involves government managing the equipment bought by public service organizations, development projects, and NGOs.
2. The distribution channel involving commercial enterprises, which specializes in selling agricultural machineries originating from Europe, Asia, and America.

The low knowledge level of distributors, the imperfection of supply services and the long-term lag in equipment delivery are major constraints in the distribution networks (Ministère de l'agriculture, Promotion de la mécanisation agricole, 2005).

State and private-led efforts to promote mechanization

Mali has carried out several programs on agricultural equipment as part of the larger objective to promote modern agriculture, particularly through mechanization / motorization. These programs are discussed below.

Rice Initiative (2008-2011)

This operational plan was developed by the Malian government to meet the rice needs of the country and cushion the impact of the rise in grain prices in 2007. Rice production accounts for 5% of GDP, a figure which increases with the national market (different from cotton which depends on export). The main strategy of this operational plan is to increase the productivity of the agricultural system for Mali to achieve rice self-sufficiency through increased supply of inputs (chemical, seeds and mechanized equipment).

The state made available agricultural equipment and pre-financed chemical inputs for farmer organizations (FOs). The equipment sold on credit for 5 years to the FOs included 70 tillers, 5 mini rice mills, 36 motor pumps, 120 threshers and 130 hullers (Ministry of Agriculture Mali, 2009).

Programme TEAM 9

The techno-economic approach to cooperation between Africa and India (TEAM 9) started in 2004 and linked East India with African countries (Chad, Côte d'Ivoire, Equatorial Guinea, Ghana, Guinea Bissau, Mali, Burkina Faso, Senegal, Niger and Benin). These countries had agreements with India for the purchase of agricultural equipment to mechanize their agriculture. Mali benefited from 300 equipped tractors and 450 other equipment, such as sprayers, rice threshers and trailers. The country then sold the acquired equipment with a subsidy of up to 50% for tractors and credits, ranging from 3 to 5 years. This program also led to the establishment of tractor assembly plants in Mali (Mali-Tracteur SA) and Chad (Saizonou, 2009).

Projet de tracteurs destinés aux jeunes ruraux (Tractor project aimed at rural youth development). The Malian government's project under the LOA for rural youth was implemented the Ministry of Agriculture and regional technical commissions, which sold about 400 tractors to farmers at subsidized rates. In Bamako district, for example, 36 tractors and accessories (9 tractors of 75Hp, 15 tractors of 50Hp, and 12 tractors of 39Hp) as well as 9 sprayers with 18 disks and 15 sprayers with 14 disks were sold to farmers. The tractors were sold

at interest-free loans repayable up to 10 years. The State subsidized the sale up to 25% of the prices. The subsidized prices were (CCA-ONG, 2007):

- FCFA5,860,500 for 75HP (real price of FCFA7,814,000).
- FCFA4,250,625 for 50HP (real price of FCFA5,667,500).
- FCFA2,808,500 for 39HP (real price of FCFA3,744,667).

Overview of private tractor market (Brands and Prices tractors)

There are a few players in the country in the manufacture and sale of tractors of different brands. These are:

Tuleu Consulting Company

The Company was established in 2001 as John Deere's only distributor in West Africa. This company has 8 branches in West Africa that supply new equipment, spare parts and after-sales services. Chola Trading Company is one of the agencies of this company based in Bamako. Their customers are mainly agro-industrial players (Tuleu Consulting Company, 2012). With regard to offers, their tractors are guaranteed 24 months (=2,000 hours), which corresponds to the John Deere guarantee. The range offered varies from the 50Hp to 560Hp tractor, from 2 to 4 wheel drives.

- KEITA-Services International

KEITA is a German-Malian company selling cars and commercial vehicles of different brands (German, French and Indian), both secondhand and new. The company guarantees the transport of supplier's equipment to Bamako. This company sometimes sells used tractors.

Mali Tracteurs SA

Mali Tracteurs SA is a tractor assembly plant located in Samanko, 25km from Bamako. This plant is the result of the collaboration between Malian government and the Indian company, Angelique International Limited, which hold 49% and 51% respectively of the capital of 1 billion CFA francs. It was commissioned on 24 April 2009.

Photo 1: Mali tractor plant (Mali Tracteurs SA)

Mahindra is an Indian company, founded in the early 1960s. The manufacture and marketing of tractors is one of its major activities. It sells nearly 214,000 tractors annually in more than 40 countries around the world. It is the leader in tractor sales in India and holds a 42% market share in the country. Its tractors are distributed in Mali by Angélique International Limited.

Angelique International Limited is an Indian company founded in 1996 with a capital of 250 million US dollars. It supplies tractors in unassembled or semi-assembled kits for Mali Tracteurs SA (Angelique International Limited, 2012).

The tractors in kits are received in the factory and assembled on site. They are then distributed to authorized dealers, who then sell them in Mali and in other West African countries (Guinea Conakry bought 14 tractors of 70Hp, and Burkina Faso, 2 of 39Hp). The company has a nominal production capacity of 8 to 12 tractors per day. The tractors assembled in this factory are those of the Mahindra brand. The factory assembles tractors of 4 different power ratings: 39hp, 50hp, 60hp and 70hp. It also produces accessories for the tractors. The table below shows the models sold by the company, as well as the production and sales quantities since its creation (2011 data, Annex 3 - Mali Tractors SA estimate).

Table 3: Products and prices of Mali-Tracteurs SA

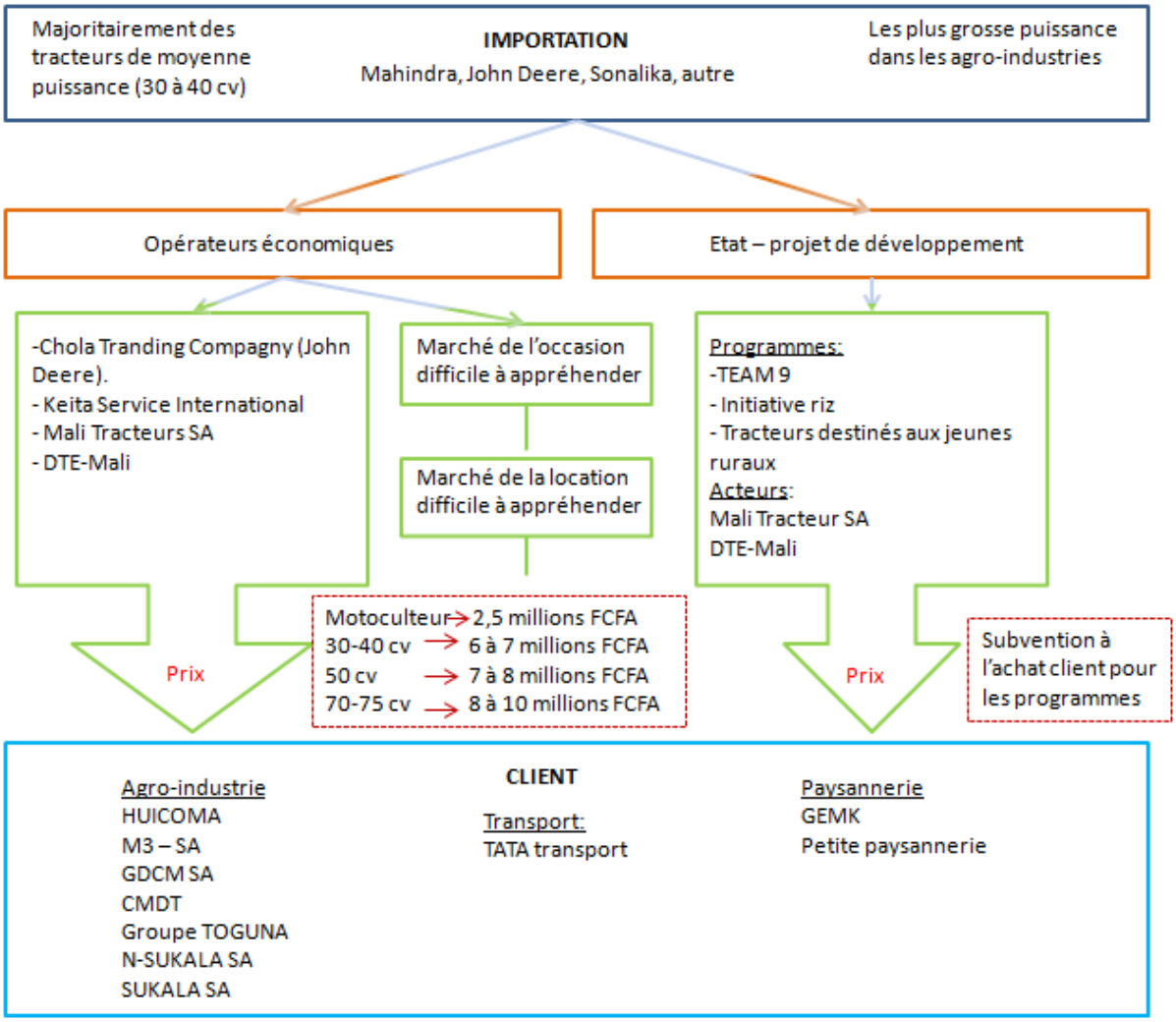
Modèle de tracteur (Mahindra)	Types	Quantité assemblée	Quantité vendue	Prix pratiqués (FCFA)
 Mahindra B275 DI	39 cv 2 RM	156	132	7 000 000
 Mahindra 605 DI	50 cv 2 RM	126	126	8 000 000
 Mahindra 605 DI	60 cv 2 RM	24	24	9 000 000
 Mahindra 705 DI	70 cv 2 RM	70	70	10 000 000

Source: Invoice of Mali Tracteurs SA

The sale of Mali-Tracteur SA tractors is carried out in 2 different ways: by direct purchase with cash payment and by purchase on credit, with the help of a banking network (National Bank for Agricultural Development). The company has implemented a service system for its tractors and equipment; the tractors are guaranteed for 12 months.

- DTE-Mali (Datong Enterprise Group) and the Sikasso Plant

DTE-Mali SA is a Chinese tractor assembly company in Sikasso, with a minimum production capacity of 10 tractors per day. On May 1, 2005, it obtained a contract for the supply of 156 tractors and equipment. The tractor market in Mali is as shown in the Figure below. This sectoral scheme is, however, not exhaustive in the face of the difficulty of collecting information and viable information. But it gives an overall idea of the structure of the tractor sector. The Figure depicts how tractors are distribution in Mali.



Source: Rapport marchee machinisme agricole au Mali, 2013

Sampling, data collection and study sites

A document that gives an overview of tractors distributed as part of a 2014/2015 government subsidy programme was obtained. The document showed the number of tractors allocated by horse power in the different Regions of Mali. Also, an exhaustive list of tractor beneficiaries during this subsidy programme was obtained; this contained the following information for each tractor distributed: Order Number, Carriage number, First name, Surname, Bank Name, HP of tractor, Age of beneficiary, Gender, Telephone, Village, Commune, Cercle, Region.

The document showed that most tractors were distributed in the rice and cotton producing zones. The production zones covered were in the administrative regions of Koulikoro, Mopti, Segou and Sikasso. The Region of Mopti was excluded from this study for security reasons.

The remaining three regions accounted for 81% of total tractor allocations (810 of 1000 tractors subsidized in 2014/2015) (cf. Table 4). In order to further define the sample, the most important Cercles in terms of the number of tractors distributed were selected in a way that the retained cercles accounted for approximately 75% of the tractors in the three regions. In each Region, three largest Cercles were retained. An exception was the Region of Sikasso. In Sikasso, although Yorosso had more distributed tractors than Bougouni, Bougouni was selected, for security reasons. By this methodology, approximately 62% (616 of 1000) of Mali-wide subsidized tractor beneficiaries were surveyed.

The sample used for questionnaire administration comprised 150 beneficiaries of government programs, with each cercle being proportionally represented. This size represented approximately 25% of all tractors in the selected cercles. To be consistent with the approach, the study randomly selected 25% of the beneficiaries in each Cercle. In addition, the values were roundup (i.e. 4.1 became 5), leading to a slight over-sampling of 157 subjects. This gave the advantage of having more possible study subjects, creating a room for replacement where already selected candidates could not be identified on the field. Table 5 provides an overview of the Régions and Cercles selected.

Table 4: Overview of tractor allocation per selected region and cercle (extract only)

Région	Tractors	Cercle	Dominant Culture	Tractors counted	Samples per région (%)	Figures (25%)	Rounded figures
KOULIKORO	214	KATI	Cotton/maize	112		28,00	28
		DIOILA	Cotton/Rice	35		8,75	9
		KOLOKANI	Millet/sorghum	20	78	5,00	5
Sub-total				167			42
SEGOU	70	SEGOU	Rice	30		7,50	8
		BLA	Cotton/Rice	17		4,25	5
		NIONO	Rice	15	89	3,75	4
Sub-total				62			17
SIKASSO	526	SIKASSO	Cotton	250		62,50	63
		KOUTIALA	Cotton	76		19,00	19
		BOUGOUNI	Cotton	61	73	15,25	16
Sub-total				387			98
TOTAL	810			616	76	154,00	157

Random sampling

The process of random sampling in this work was in order to make it comprehensible for all participants in this study, in particular, in case re-sampling was necessary. Random sampling was conducted using Microsoft Excel. In an extensive list obtained, each beneficiary of government programme was associated with an "order number" ("N d'Ordre") on regional basis. The researchers created a spreadsheet for each cercle, in which all order numbers of beneficiaries were inputted in a column. A random number (between 1 and 0) was then associated to each order number in a separate column (thus, each line contained a random number and an order number). In the following step, the randomly assigned order numbers were sorted in ascending order (from lowest to highest figure); the selection was extended in such a way that the order of *order numbers* was also changed. The first *n* order beneficiaries (corresponding to the order number) were retained for the sample list, whereas *n* was the sample required for each cercle (Figure 1). When there was need to sample an additional beneficiary (security reasons, or when the initially sampled beneficiaries could not be found, for example), the *n+1* entry in the list was selected as alternative (and so on). For example, the village of Kogoni was initially selected randomly; but was later excluded from the list due to security reasons. The two closest villages on the list (Kala Nampala, Sirbabougou) could not also be sampled for the same reason. Hence, village *n+3* (Siguivounsé) was sampled.

The methodology for sampling private tractor owners (without government subsidy) was based on the geographical zones used for sampling beneficiaries of government programs. There was no list of private tractor purchases. The territorial level on which the identification of private owners was based on was the "Communes". All communes, in which 150 government beneficiaries were selected, were used to sample private owners. Information on private owners was demanded at the level of the commune (local administration and extension service unit).

The data on tractor owners was done through paper-based questionnaire by two teams of enumerators, with one supervisor for each team, making a total of 8 enumerators and 2 supervisors. The regions of Segou and Koulikoro and the Cercle of Koutiala (in the region of Sikasso) were assigned to one team; the other team surveyed Sikasso and Bougouni cercles in the region of Sikasso.

The guide was conducted with three different groups in each commune; farmers who used tractor services, tractor owners and tractor drivers and mechanics. Fort the policy brief, key informant interview was used.

The survey was been conducted in Segou, Sikasso and Koulikoro regions where the country has the largest proportions of agricultural land allocation to crop production. Located in the Sudan Savanna zone and in the "Dela du Niger", the survey area relative to the climatic and agro-ecological zones of Mali is shown in Figure 2. The survey was implemented entirely within the

isohyets, corresponding to the broad Sudanian and Sahelian zones, from 500mm to about 800mm isohyets.

Access to arable land is more constrained in the Delta du Niger, where irrigation infrastructure and water are prevalent, than in the largely rain-fed Sudan Savanna. On average, farm households in the Delta cultivate 8.5 hectares, compared to 12.3 in the Sudan Savanna zone. As a result, farm households in the Delta tend to be smaller than in the Sudan Savanna.

In the Delta, millet and rice dominate cropped area, attracting two to four times as much planted area as in the Plateau. In contrast, in the Sudan Savana, cotton dominates farming systems, accounting for over one-third of cropped area. Two coarse cereals, maize and sorghum, account for a further one-third of cropped area. Cowpea intercropping appears most important in the Delta, while in the Sudan Savana, farmers intercrop cowpeas with millet, sorghum and maize.

Livestock ownership is more prevalent in the Delta than in the Sudan Savana. However, given the larger farms and cultivated area, farmers in the Sudan Savana own more plowing oxen than do those in the Delta. Small ruminants are more evenly dispersed with a majority of farmers owning sheep and goats in both zones.

With regard to farm equipment, distinct differences also emerged. Farmers in the Delta are ten times more likely to own motorized pumps and mechanical threshers than their counterparts in the Sudan Savana. In contrast, Sudan Savana farmers are more likely to own mechanical grain mills and tractors.

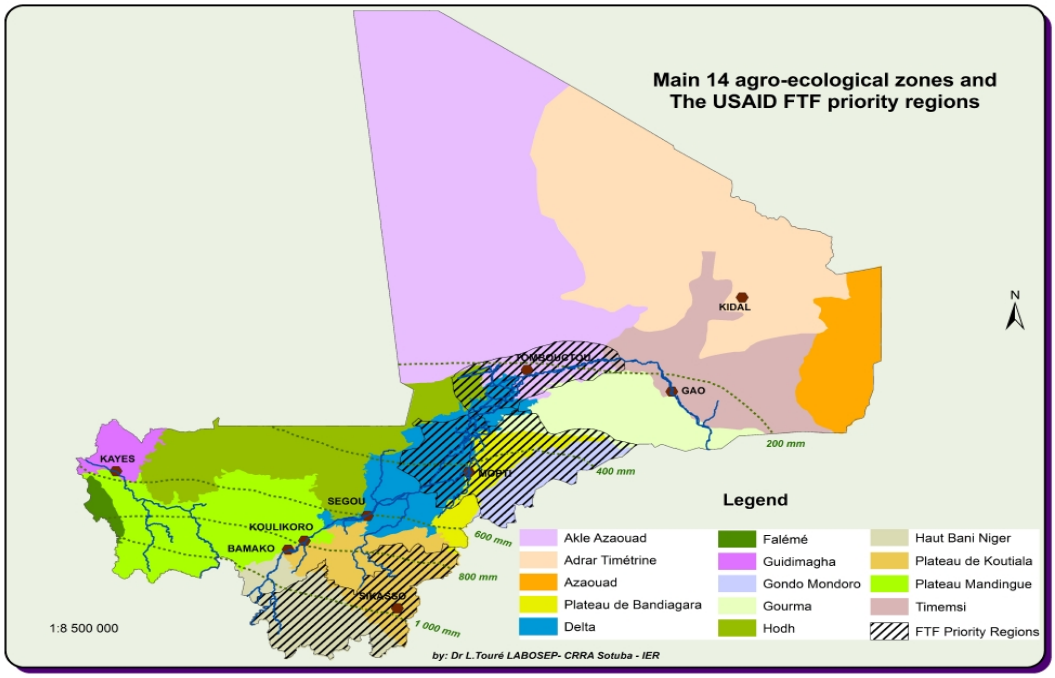


Figure 2: Survey sites and agro-ecological zones

During land preparation tasks, hand labor and ox-drawn animal traction dominate, with application on over two-thirds of plots. Motorized land preparation with tractors takes place on Sudan Savana farms; in the Delta, particularly in the Office du Niger, farmers prepare all plots with small motorized cultivators. Tractor-powered land preparation proves most prevalent on cotton fields.

Rental markets are prevalent for both animal traction and motorized land preparation. Since owners prepare their own fields first, the risks of late planting and weeding are highest among renters. Rental markets are also important for mechanized cultivators, as over one-fourth of the farms are prepared with mechanized cultivators. Although hand seeding is done on most plots, mechanical seeders are used on over half of all maize and cotton plots. This leads to higher rates of mechanical seeding in the Sudan Savana than in the Delta zone.

Farmer organizations exist throughout rural Mali; and because of the long-standing institutional and organizational support by CMDT in Mali's cotton zones, membership of producer organizations remains highest in these zones – farmers are members of an OP (organization paysanne).

Results

Demographic, employment and farm characteristics

Table 5 presents data on the two types of tractor owners in Mali. The data on education were not significantly different between private purchasers and farmers who benefited from government subsidy. However, the majority of tractor owners for both types were largely illiterate, with about 27% of state-supported owners and 28% of privately-purchased owners being literate. The age difference between the two groups was also not significant. But subsidy beneficiaries tended to be older than private purchasers. Heads of farm households tended to apply for state subsidy tractors on behalf of their family or household; they were also mostly older members of the households.

All tractor owners in the sample generated income from other sources other than farming; only 10% of income of state subsidy beneficiaries and 8% of those of privately- purchased owners were from farming. Tractor owners practiced other activities, such as: trading, transport, civil servant, non-agricultural employment, etc. They benefitted from remittances of family members living abroad or in traditional mining.

Within the communities they leaved, nearly 56% of tractor owners played one role or another in their respective villages, such as chief, religious leader, community association president, champion farmer, health agent, and mechanic. It the data in Table 5 shows that committee or association presidents constituted the highest (20% or 24%) group to own a tractor due to their

direct contact with government development agents. Some tractor owners, whether they benefited from government subsidy or they privately purchased their tractors, did not play any other role in their communities.

The data also showed that tractor owners generally belonged to more than a group in their communities. There was no significant difference between the data on group attendance for both types of tractor owners.

The percentage of income of privately purchased tractors from farming activities was greater than that from government-purchased ones. Privately-purchased owners had 3.85% of their income from tractor working in farms, while subsidy beneficiaries had 2.33% of their income from same activity.

Privately purchased tractor owners got 25.12% of their income from other services rendered by their tractors while government-subsidized tractor owners got only 17.24%; the difference between these data was highly significant Table 5). Private owners were more inclined to efficiently use their tractors for other services than farming, while government-subsidized owners used their tractors on their farms first before extending the service to others.

Government-subsidized owners were more involved in formal and informal businesses than privately purchased tractors. About 27.15% of subsidized tractor owners' incomes and 5.67% of private tractor owner's incomes were from formal/informal activities. Many of those who got their tractors from government were doing other jobs than farming; these included trading, civil service, politics, and agricultural extension. They benefitted from the subsidy programs because of their access to information, bank loans and politicians.

Table 5: Comparison data on government-supported and privately purchased tractor owners

		Unit	State-imported	Privately-purchased	Statistical difference
Education level	Illiterate	%	72.6	68.0	0.467
	Primary level	%	11.0	18.0	
	Secondary level	%	8.5	10.0	
	Tertiary level	%	7.9	4.0	
Age of head		Year	58.85	53.82	0.854
Percentage of Income from Farming		%	12.78	11.93	0.145
What role do you play in community	None	%	43.3	44.0	0.936
	Chef du village	%	1.2	2.0	
	Fils du chef	%	3.7	4.0	
	President de comité/association	%	24.4	20.0	
	Leader religieux	%	6.1	6.0	
	Paysan pilote	%	3.7	8.0	
	Agent de santé	%	.6	0.0	
	Autre,precisez	%	17.1	16.0	
Number of group memberships		number	1.40	1.35	0.360
Percentage of income from tractor services		%	17.24	25.12	0.000
Percentage of income from formal/informal business		%	27.15	5.67	0.000
Percentage of income from regular wage/salary		%	32.12	3.75	0.001
Land owned last season		ha	40.54	28.61	0.549
Land cultivated last season		ha	4.79	4.54	0.723

The difference between incomes from regular wage/salary of government- subsidized and privately purchased tractor owners was highly significant; more than 32% of the income from subsidized tractor owners came from regular wage/salary. Government-subsidized tractor owners had more land (40.54 ha) than private owners (28.61 ha), but land cultivated by individual within a tractor owner's family was 4 - 5 ha, which was more than that for non-owner's family (1.5 ha).

Ownership, motivation and financing of machinery and accessories

Tractor owners stated several reasons for buying tractors; the most important reason was to develop their farms, which was 88.5% for those who benefited from government subsidy and 72.5% for privately-purchased tractor owners. A few private tractor owners (3.9%) purchased their tractors for replacing old ones, while 7.9% of government beneficiaries and 13.7% of private owners bought their tractors for producing in time.

The most important source of information on tractors was government for those who benefited from the subsidized program (54.3%), while it was 'other producers' or 'owners' for private tractor owners (60.8%). The most important criteria for choice of tractor was horse power (HP) for both types of owners; (12.1%) for government beneficiaries and (41.2%) for privately

purchase owners. The make of tractor was an important criterion (3.6% for subsidy beneficiaries and 13.7% for private tractor owners); capacity of tractor (9.7% for government subsidy beneficiaries and 7.8% for private owners) in the choice of tractor to buy. The age of tractor did not determine the choice of tractor.

Table 6: Comparison of data on the purchase of types of tractor

		Unit	State-imported	Privately-purchased	Statistical difference
Number of tractors		%	2.74	2.68	0.492
Main reasons to buy tractors	Develop his farm	%	88.5	72.5	0.026
	produce in time	%	7.9	13.7	
	Supply services	%	3.0	7.8	
	Replace old machines	%	.6	3.9	
	others to precise	%	0.0	2.0	
Main source of information for choosing	Government	%	54.3	3.9	0.000
	Other producers/owners	%	37.2	60.8	
	distributor of used tractors	%	.6	7.8	
	distributors of new tractors	%	0.0	5.9	
	local industries	%	.6	3.9	
	Others to precise	%		7.3	17.6
Which criteria to choose	power/horses	%	12.1	41.2	0.000
	2/4 wheel drive	%	.6	0.0	
	Fabricant	%	3.6	13.7	
	Âge	%	0.0	2.0	
	Capacity	%	9.7	7.8	
	No choice	%	8.5	3.9	
	Fuel consumption	%	1.2	2.0	
	Quality	%	1.2	17.6	
	Easiness of Fixing by mechanics	%	.6	0.0	
Number of tractors functioning last season		number	2.74	2.64	0.347
Brands	Massey Ferguson	%	1	20	0.000
	Mahindra	%	17	67	
	Others to precise	%	82	10	
Horse power		HP	58.33	11.63	0.000
Age		year	3.07	5.86	0.000
Average amount paid for tractors at time of purchase, excluding insurance, registration, and transport?		CFA	7277254.10	9715718.33	0.000
% of the purchase price subsidized		%	49.30	0.00	0.271
How much of the payment came from inheritance/family/ friends		%	42.14	72.5	0.041
How much of the payment came from personal savings		%	64.94	87.68	0.000
How much of the payment came from remittances		%	47.50	100.0	0.116
How much of the payment came from bank loans		%	71.99	64.36	0.836
How much of the payment came from NGO loan		%	-	80.0	-
How much of the payment came from NGO grant		%	55.00	86.67	-
How much of the payment came from microfinance loan		%	-	100.0	-
How much of the payment came from circles loan		%	35.00	-	-
Years saved before purchase		year	2.11	3.62	0.000
How long did it take to get the loan in months?		month	16.63	3.69	0.093
What is/was the loan term? (years)		year	4.48	4.00	0.010
What is/was interest rate?		%	16.56	24.13	0.015
Percentage of equipment locally manufactured	Yes	%	0	0	-
	No	%	100	100	

On the market, there were many tractor brands. Private tractor buyers chose mostly Mahindra (67.0%) and Massey Fergusson (20%), while government-subsidized tractor beneficiaries preferred Mahindra (17%) or other brands (82%) in most cases. Tractors were acquired from savings, inheritance, remittance, bank loans, NGO grants or government subsidy (Table 6).

Background on selected machinery only

State-imported

In Mali, government subsidized tractor beneficiaries had information mainly through extension agents, public authorities or friends/family/neighbor. Table 7 ranks the sources of information from the frequency of responses.

Table 7: How did you hear about government tractor program?

Tractor information Source	Response	%
Agricultural extension	62	33.7
Public authority	49	26.6
Friend/Family/Neighbor	37	20.1
Media	29	15.8
Other sources	7	3.8
Total	184	100.0

Due to the insufficient number of tractors, farmers booked for tractor services well ahead of time. The number of waiting days for a farmer varied according to the zone, from 1 to 30 days where available. Some farmers soon give up and use animal traction instead. The data in Table 8 show an overview of the number of days it required for a farmer to demand and receive tractor services. When the services are secured, the tractor stayed in the farm for a maximum of 3 days.

Table 8: Number of days to apply for and receive the tractor service

	Mean	Minimum	Maximum
Number of days to book for tractor service	7	1	30
Number of days tractor remains on your field	1.5	1	3

Generally, farmers paid in advance to secure the services of a tractor. To apply for a service, the farmer must have an account in bank which gives loan service as well as receive payment for tractor hiring services. The advance paid varied according to the type of tractor and the credit

system used (microfinance bank or commercial bank). Most tractor owners (61.4%) themselves paid in the process of applying for a tractor. Those who did not pay had support from an NGO or other donors. The amounts paid for tractor services varied, from 87,977 CFA to 1,000,000 CFA per service (Table 10).

Table 9: Did you have to pay anything in the process of applying for the machinery?

Particulars	%
Yes	61.4
No	38.6
Total	100.0%

Table 10: How much did you pay for tractor service?

Mean	Minimum	Maximum
87 977	5 000	1 000 000

Many farmers stated that they would purchase a tractor even without the government program of subsidizing 50% of the cost of the tractor; this is confirmed by approximately 71% of beneficiaries. The others about 30% of owners who said that they wouldn't apply are generally political party members or the youth or civil servants. The table below gives the proportion of owners willing to purchase tractor without government program.

Table 11: Would you have bought a tractor without government support?

	%
Yes	71.1
No	28.9
Total	100.0

About 82% of surveyed beneficiaries of government programs preferred Mahindra to other tractor brands. Those who preferred Fergusson and Massey Fergusson were 13.5%. Other brands were not much appreciated by farmers. The Mahindra brand ranked first because of the price and availability of spare parts. Massey Fergusson seemed the most preferred, but because of the high price and unavailability of spare parts, it ranked second.

Table 12: What brand would you have chosen yourself?

Brand	%
Massey Ferguson	11.1%
Mahindra	81.7%
Ferguson	2.4%
Foton	1.6%

Other	3.2%
Total	100.0%

Tractors of different HP were available in the market, the most popular being 30 to 70HP (Table 12). The choice of tractor was also determined by the nature of soils and the area cultivated. Many tractor owners were located in the cotton zone where the soil was light and areas cultivated were larger, hence, where low HP tractors could work comfortably. In the rice zone, farmers preferred small tractors or 2 wheel tractors (motorcultors).

Table 13: Which HP tractor would you have chosen yourself?

Average power	Minimum	Maximum
60	30	75

Privately-purchased

Majority (66.7) of the privately-purchased tractor owners had not benefited from any government program before. This relatively high proportion could be explained by the criteria for benefiting from government's subsidized tractor programme, the political linkages, the credit system used, and access to information, among others (Table 14). The 33.7% tractor owners who had benefitted from government tractor programs in the past was because of their connection to government officials or as organization leaders or highly ranked personalities in their community.

Table 14: Have you received machinery as part of a government program before?

Response	%
Yes	33.3
No	66.7
Total	100.0

Those who did not receive any tractor from government program stated several reasons, the most important of which were the administrative burden, the lack of trust and the perception that tractors provided through government programs are not strong (Table 15)

Table 15: Data on the reasons for having benefitted from government tractor program

Response	%
Too fastidious	27.8

Not sure that it will work	25.0
Don’t appreciate this type of machine	13.9
Je ne suis assez influent	5.6
Don’t know	5.6
Low financing capacity	5.6
Not necessary	8.3
Credit ongoing	8.3
Total	100.0

Among the privately purchased tractor owners, only a few (5.9%) succeeded in benefitted from government tractor program. The majority (94.1%) of them, although involved in farming or other businesses, had not been selected for any programme.

Table 16: If yes, were you successful?

Response	**%**
Yes	5.9
No	94.1
Total	100.0

Many (43.8%) of the respondents did not know why they were not selected as beneficiaries of government program, while a 31.2% of them though they were not influential enough in their community and 25% stated that it was because their lands were not large enough. Indeed, a subsidized government program can be used for political purposes, hence, the beneficiaries are those that are politically relevant to the system and who are often not farmers. At the end of the day, those who benefit from government programs use them for other gains than agriculture.

Table 1: If not successful, why do you think you were not successful?

Response	**%**
Have not insufficient land	25
Not influential	31.2
Don’t know	43.8
Total	100.0

Maintenance of selected machinery

When acquiring a tractor, 55% of government-subsidized tractor owners stated that the service package was a consideration, while 38% of private tractor owners said it was not a consideration. In practice, many private owners bought their tractors as secondhand, hence, there was very low probability it had any service package.

Tractor maintenance was done mostly at the mechanic shop (52.7% for government-subsidized tractors and 46% for privately-purchased ones). However, many private owners maintained their tractors on their fields (48%); some had knowledge in mechanics, which explains why they maintained their tractors on their own.

Table 18: Comparison data on maintenance of tractors

		Unit	State-imported	Privately-purchased	Statistical difference
When you acquired machinery, was a service package included?	Yes	%	55.8	38.0	0.028
	No	%	44.2	62.0	
Who is doing maintenance/ servicing currently?	Yourself at the farm	%	27.3	48.0	0.028
	Mechanic shop	%	52.7	46.0	
	Machine distributor	%	5.5	2.0	
	Other	%	14.5	4.0	
Satisfaction with maintenance and services	Really	%	60.3	56.8	0.592
	Yes	%	28.4	37.8	
	Some how	%	6.0	5.4	
	Not really	%	2.6	0.0	
	Not at all	%	2.6	0.0	
How many times did you change engine oil last year?		year	4.79	5.18	0.045
How many times did you grease last year?		year	5.18	8.08	0.000
How many times did you change filters last year?		year	3.48	3.40	0.239
How much did you pay last year for maintenance and services?		CFA	192163.05	188862.50	0.748

A majority of the respondents were satisfied with the maintenance of their tractors (60.3% for government-support owners and 56.8% for private owners). On average, the engine oil was

changed 5 times the previous year for both types of owners. Private tractor o wners greased the engine about 8 times a year, while government program beneficiaries did it 5 times a year. Both types of owners changed their filters more than 3 times a year; and they spend approximately the similar amount as others on tractor maintenance.

Preferences for machinery

Tractor owners preferred the use of tractor on their fields to the use of other machines (69.5% of government program beneficiaries and 46.9% of private owners); this is followed by the use of thresher (7.9% and 8.2%, respectively) and small rice dehullers (3.0% and 16.3% respectively).

Table 19: Comparison data on tractor preferences

		Unit	State-imported	Privately-purchased	Statistical difference
If you were to own (additional) machineries/attachments, which would you buy given the resources you have? (Repeat for all types)	Tractor	%	69.5	46.9	0.011
	Motocultor	%	0.6	0.0	
	Harvestor	%	0.6	0.0	
	Dehuller	%	3.0	16.3	
	Thresher	%	7.9	8.2	
	Water pump	%	1.2	4.1	
	Mill	%	.6	0.0	
	Plow	%	2.4	6.1	
	Harrow	%	1.2	0.0	
	Sprayer	%	0.0	2.0	
	Layer	%	0.6	2.0	
	Wagon	%	0.6	4.1	
	other precise	%	11.6	10.2	
Which brand do you prefer?	john deere	%	0.7	8.6	0.012
	massey ferguson	%	7.9	17.1	
	Mahindra	%	74.8	62.9	

		Unit	State-imported	Privately-purchased	Statistical difference
	other, precise	%	16.5	11.4	
Why do you prefer this brand?	Price	%	2.2	0.0	0.723
	Power/hp	%	16.5	20.6	
	Fabricant	%	30.2	17.6	
	Age	%	2.2	2.9	
	Capacity	%	11.5	8.8	
	Quality	%	28.1	35.3	
	cost of service after sale	%	1.4	5.9	
	The repair by mechanics	%	2.2	2.9	
	other precise	%	4.3	2.9	
Which horse power do you prefer?	Under 40hp	%	6.1	10.3	0.019
	40-60hp	%	34.1	34.5	
	60-70hp	%	35.6	20.7	
	70ch and +	%	24.2	27.6	
	Don't know	%	0.0	6.9	

The most preferred brand was Mahindra (74.8% and 62.9%), followed by then Massey Fergusson (7.9% and 17.1%) and John Deer (0.7% and 8.2%) for government program beneficiaries and private owners respectively. Preference was based on quality (28.1% and 35.3%), brand/fabrication (30.2% and 17.6%) and HP (16.5% and 20.6%) respectively. Most respondents preferred tractors with horsepower ranging between 40 and 60 (34.1% and 34.5%, respectively).

Machine utilization and service provision

Tractors were mostly used for plowing (89.1% and 93.9%); and a majority of them were used farm hiring services (79.3% and 85.7%), respectively by government-support owners and private owners. The frequency of tractor uses for the owner's farm and for hire was higher among private tractor owners than their government counterparts.

Government tractor program beneficiaries used their tractors, on the average, for 26 days in a year, while private owners used theirs for 29 days. For own operation, government-support owners used their tractors on 48.1ha, while private owners used theirs on 37.4ha. For other farmers, government-support owners worked on 81.7ha, and private owners on 89.7ha.

Table 20: Data on tractor utilization and service provision

Indicator		Unit	State-imported	Privately-purchased	Statistical difference
Farming operation mechanize	Weeding	%	7.9	2.0	0.114
	Plowing	%	89.1	93.9	
	Subsoiling	%	0.0	2.0	
	Puddling	%	2.4	0.0	
	Transport	%	0.6	2.0	
% who provided services last main season	own farm	%	20.1	12.2	0.317
	Renting	%	0.6	2.0	
	Both	%	79.3	85.7	
For how many days did you use your machine last main season?		Number	26.5	29.1	0.967
What is the area (bags) that you needed for own operations on own farm last main season?		Number	48.1	37.4	0.694
What is the total area (bags) that you serviced for other farmers for this operation last main season?		Number	81.7	89.7	0.515
Did you meet all your customer requests last season?	Yes	%	77.9	54.8	0.317
	No	%	22.1	45.2	
Did you provide more services last compared to previous season?	Yes	%	52.7	61.9	0.357
	No	%	44.3	38.1	
	Same	%	3.1	0.0	
How many customers did you provide services to last main season?		Number	150	140	0.039
How many customers did you provide services to last main season? (below 2ha) (Quantitative)		Number	9.8	12.3	0.304

What is the average distance of the customers		Number	9.2	6.3	0.215
How many of the customers were female?		Number	6.2	11.3	0.001
What was the service charge/fee per unit?	Lowest fee	CFA	21498.1	22329.5	0.168
	Highest fee	CFA	26171.9	25170.5	0.798
How long do you need per unit?	Lowest duration	Hour	2.1	2.1	0.484
	Highest duration	Hour	3.6	2.8	0.332
How many liters to fuel do you need per unit?		Liter	12.0	10.1	0.285

However, none of the two categories of tractor owners was able to fully satisfy their customers' demand: government-support owners satisfied 77.9% of their demand, while private owners covered only 54.8% of their demand. But both groups provided more services than what was obtained the previous year (52.7% for government-support and 61.9% private owners).

The government-support tractor owners served 150 customers, while private owners served 140 customers, with about 10 and 12 respectively having below 2ha on the average. The average distance between customers and tractor owners was 9km (for those with government support) and 6km (for those that were private). The number of women served was 6 (for government program tractors) and 11 (for private owners). Service charges were the same (between 20000CFA and 30000CFA/ha). The average time it took to service a hectare was 3 hours, while the volume of fuel used to service a hectare was 12 liters for government-support and 10 liters for private tractors.

Additional service provision

The rationale for providing hiring services varied according to types of tractor owners. For government tractor owners, the most important reason was to get financial resources (37.8%), while it was to finance other activities (63.6%) for privately-purchased owners. For both types of owners, the planning of customer services was based on first come, first served (64.2% and 63.6%) and on the location of the farm (32.1% and 25.0%, respectively).

Both types of owners refused services to clients in almost equal proportion (48.2% for government tractor owners, and 47.7% for private owners). Tractor servicing was mainly done

by tractor owners on credit; they made the full payment after harvest (50.4% and 43.2% for government-support tractor owners (GTOs) and private tractor owners (PTOs) respectively).

Both types of tractor owners had competitors in mechanization services (91.2% and 86.4%) and were either within their operational zone (7.67 and 9.34) or outside the zone (4 on the average). Also, some public services related to agriculture used tractors informally on farmers' fields with low charges.

Table 21: Additional service provision of tractor owners

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
Why do you provide hiring services to others? (Repeat for all reasons)	To get financial resources for own farm	%	37.8	29.5	0.000
	To finance other activities	%	30.4	63.6	
	Help neighbors	%	10.4	0.0	
	Other	%	21.5	6.8	
How do you plan in which order customers are served? (Repeat for all options)	First arrived first served	%	64.2	63.6	0.329
	Depending on locality	%	32.1	25.0	
	Priority to parents/friends	%	0.0	2.3	
	Priority to regular clients	%	1.5	4.5	
	heavy demand in an area	%	1.5	2.3	
	other precise	%	0.7	2.3	
Have you refused farmers asking for your service last season?	Yes	%	48.2	47.7	0.959
	No	%	51.8	52.3	
What kind of credit scheme do you mostly provide to customers? (Repeat for all option)	Total payment after harvest	%	50.4	43.2	0.074
	Partial payment in advance	%	25.9	43.2	
	No credit	%	23.7	13.6	
Do you have other competing mechanization service providers in your service	Yes	%	91.2	86.4	0.355

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
area?	No	%	8.8	13.6	
If yes, how many of your competitors are based your service area?		number	7.67	9.34	0.111
If yes, how many of your competitors are coming from other areas outside your service area?		number	4.25	3.74	0.616
Are there any government led/supported mechanization service providers your service area?	Yes	%	3.0	0.0	0.252
	No	%	97.0	100.0	
Are they a competition to you?	Yes	%	23.5	0.0	0.127
	No	%	76.5	100.0	
Did you migrate to provide services in other rainfall zones / countries / other areas last season?	Yes	%	50.0	55.8	0.507
	No	%	50.0	44.2	
If yes, for how many days did you migrate?		number	14.81	15.27	0.693
If yes, what are the average daily extra costs by staying in other rainfall zones / countries / other areas? (e.g. for hotels)		CFA	14181.67	12647.73	0.857

Tractor owners moved from one place to another to provide services (50% for GTOs and 55.8% for PTOs) half of the time, a migration situation that lasted for about two weeks. The extra costs of staying in other rainfall zones are estimated between 12000 CFA and 15000CFA.

Moreover, being the son of a tractor owner was the most frequent relationship between tractor operators and tractor owners (33.3% for GTOs and 38% for PTOs), followed by being other members of the family. For GTOs, it was rare to see tractor owners operating their tractors themselves (9.7%), which was different for PTOs (26%). Also, GTOs hired more labour (24.2%) than PTOs (24.2% and 14%).

The tractor operators did not have much driving experience (59.1% for GTOs and 45.% for PTOs). For those licenced to drive tractors (32.1% for GTOs and 28.6% for PTOs), they were more frequent in rice and cotton zones, which had shops for the training of tractor operators.

Operating/mentainance experience from formal training institutions was not common; rather, there were many with experience from informal training organizations. The number of days for training varied, from 40 days for PTOs to 83 days for GTOs. For both types of tractor owners, the time it took to find a suitable operator was about 44 days. Moreover, 72.4% of GTOs and 70.0% of PTOs were satisfied with the knowledge and skills of operators.

Table 22: Additional service provision of tractor owners

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
Relationship with owner (Repeat for all options)	Owner	%	9.7	26.0	0.011
	Son/daugther	%	33.3	38.0	
	Other member	%	32.7	22.0	
	Hired labor	%	24.2	14.0	
What kind of prior driving experience/certificate does he/she has? (Repeat for all options)	None	%	59.1	45.2	0.009
	experience/car driving license	%	8.8	26.2	
	experience/tractor driving license	%	32.1	28.6	
Has he/she received training on machine use/ maintenance? (Repeat for all options)	Formal	%	35.4	24.0	0.034
	Informal	%	31.7	24.0	
	training by the owner or another	%	24.4	46.0	
	No	%	8.5	6.0	
How many days?		number	83.5	40.1	0.531
How long did you need to find a suitable operator?		number	44.1	42.9	0.009
How satisfied are you with the knowledge and skills?	Really	%	72.4	70.0	0.100
	Yes	%	22.1	27.5	
	somehow	%	5.5	0.0	
	Not at all	%	0.0	2.5	

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
Is this person paid a wage (cash/kind)? If yes, how much on average per month?		CFA	29412.3	27708.3	0.797
Were there any other payments last season (daily expenses, bonus or incentive)? If yes, how much?		CFA	22885.7	25909.1	0.923
If paid per unit, how much was the payment per unit?		CFA/ha	2715.9	2681.8	0.687
How do you control operator? (Repeat for all options)	No control	%	31.5	20.0	0.015
	register in km	%	2.1	0.0	
	Timing work	%	0.0	2.5	
	owner/parent fallow the tractor	%	39.9	37.5	
	control by assistant	%	2.8	10.0	
	field verification	%	11.9	7.5	
	operator working at a limited area	%	2.1	5.0	
	control the fuel	%	.7	0.0	
	Client calls	%	8.4	7.5	
	Others, specify	%	0.0	5.0	

Considering the wage rate, tractor operators were paid between 25000 and 30000 CFA per month by all types of owners. In Mali, most operators were not paid on the basis of unit. Operators were controlled by owners or parents of owners at 39.9% for GSOs and 37.5% for PTOs. The non-control system was also frequent in both cases (31.5% and 20%, respectively).

Tractor owners

More than of half of the tractor owners or members of their households had received training on mechanization (53.9% GSOs and 52% PTOs). Those who not benefited from training were not eligible (46.1% GSOs and 48% PTOs). The training received by owners or members of their households was on tractor driving (81.8% GSO and 95.8% PTOs). Some tractor owners also received training in maintenance etc.

Table 23: Comparison data on tractor owners

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
Have you or any household member received any training on mechanization?	Yes	%	46.1	48.0	0.810
	No	%	53.9	52.0	
Which training? (Repeat for all options)	Driving course	%	81.8	95.8	0.402
	Machine mainteance	%	14.3	4.2	
	Machine fixing	%	1.3	0.0	
	Machine safety	%	2.6	0.0	
Overall lengths for all options					
How many days?					
How long did you need to find a suitable operator?					
How satisfied are you with the knowledge and skills?					
Is this person paid a wage (cash/kind)? If yes, how much on average per month?					
Were there any other payments last season (daily expenses, bonus or incentive)? If yes, how much?					
If paid per unit, how much was the payment per unit?					
How do you control operator? (Repeat for all options)					

Knowledge of Machinery

The data show that tractor owners had little knowledge on machinery as 62.6% GSOs and 41.7% PTOs stated that they had limited knowledge on tractor hydraulic system. Only 7.4% and 6.3%, respectively had good knowledge of hydraulic system.

Regarding cooling system, 50% GSOs and 38% PTOs had limited knowledge; 9.8% and 6% had good knowledge of the system. Moreover, 46.6% and 32% had knowledge of the lubrication system, while 14.7% and 12% respectively had appreciable knowledge. Most of the owners (46.6% and 34%) had knowledge of the fuel system.. Generally, the owners had no knowledge of tractor electricity system; only 4.3% and 4.1% of them had appreciable good knowledge of the system, while 69.8% and 57.1%, respectively, were ignorant of the system.

The data in Table 24 show that the majority of owners had no knowledge of tractor functions. The difference between GSOs and PTOs was significant only for hydraulic, driving and machinery economics.

Table 24: Knowledge of tractor functions among owners

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
Hydraulic system	Too Limited	%	62.6	41.7	0.025
	Lmited	%	7.4	20.8	
	Average	%	8.0	14.6	
	Good	%	14.7	16.7	
	Very good	%	7.4	6.3	
Cooling system	Too Limited	%	50.0	38.0	0.199
	Limited	%	7.3	6.0	
	Average	%	14.6	28.0	
	Good	%	18.3	22.0	
	Very good	%	9.8	6.0	
Lubrication	Too Limited	%	46.6	32.0	0.044

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
system	Limited	%	9.2	4.0	
	Average	%	15.3	22.0	
	Good	%	14.1	30.0	
	Very good	%	14.7	12.0	
Fuel system	Too Limited	%	46.6	34.0	0.200
	Limited	%	9.2	4.0	
	Average	%	12.3	22.0	
	Good	%	16.6	22.0	
	Very good	%	15.3	18.0	
Electrical system	Too Limited	%	69.8	57.1	0.136
	Limited	%	8.6	6.1	
	Average	%	10.5	14.3	
	Good	%	6.8	18.4	
	Very good	%	4.3	4.1	
PTO	Too Limited	%	65.0	46.0	0.153
	Limited	%	7.4	8.0	
	Average	%	11.0	20.0	
	Good	%	11.7	20.0	
	Very good	%	4.9	6.0	
Engine	Too Limited	%	67.5	51.0	0.117
	Limited	%	10.4	8.2	
	Average	%	10.4	20.4	
	Good	%	6.7	14.3	
	Very good	%	4.9	6.1	
Steering mechanism and tires	Too Limited	%	51.2	40.8	0.758
	Limited	%	8.5	10.2	
	Average	%	14.6	16.3	

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
	Good	%	18.9	22.4	
	Very good	%	6.7	10.2	
Maintenance	Too Limited	%	64.0	48.0	0.254
	Limited	%	4.3	4.0	
	Average	%	9.8	14.0	
	Good	%	11.6	22.0	
	Very good	%	10.4	12.0	
Driving	Too Limited	%	62.2	46.0	0.020
	Limited	%	7.9	2.0	
	Average	%	7.3	6.0	
	Good	%	13.4	30.0	
	Very good	%	9.1	16.0	
Machinery economics	Too Limited	%	19.1	6.3	0.006
	Limited	%	4.5	4.2	
	Average	%	15.3	16.7	
	Good	%	25.5	52.1	
	Very good	%	35.7	20.8	

Constraints

Majority of GSOs and PTOs (73.2% and 70%, respectively) reported no specific constraint in their tractor operations. Also, 29.3% of GSOs and 35.4% of PTOs stated that technicians were not readily available. The lack of genuine spare parts was also a constraint for both types of owners. The data also show that demand for services was not a constraint for both tractor owner categories; although, they could not sufficiently satisfy the demand.

Access to fuel, good quality operators and technicians were also not a challenge for the owners; but price and availability of spare parts and accessories were serious challenges, as tractor owners stated that such parts were very expensive. Moreover, ignorance of the different systems in a tractor was not a challenge to both owners.

Table 25: Constraints faced by tractor owners

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
High prices/ unavailability of operators	No	%	73.2	70.0	0.305
	Little	%	6.1	2.0	
	average	%	8.5	18.0	
	big	%	8.5	8.0	
	huge	%	3.7	2.0	
High prices / unavailability of technicians	No	%	39.0	35.4	0.088
	Little	%	4.9	8.3	
	average	%	14.6	20.8	
	big	%	29.3	35.4	
	huge	%	12.2	0.0	
Lack of genuine spare	No	%	23.8	24.0	0.995
	Little	%	6.7	6.0	
	average	%	9.1	8.0	
	big	%	31.1	34.0	
	huge	%	29.3	28.0	
Low demand	No	%	67.7	72.0	0.150
	Little	%	9.1	14.0	
	average	%	9.1	6.0	
	big	%	14.0	6.0	
	huge	%	0.0	2.0	
Lack of access to fuel	No	%	70.6	65.3	0.685
	Little	%	14.7	22.4	

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
	average	%	9.8	6.1	
	big	%	3.7	4.1	
	huge	%	1.2	2.0	
Low quality of operators	No	%	75.5	63.3	0.007
	Little	%	12.3	10.2	
	average	%	4.3	20.4	
	big	%	6.1	6.1	
	huge	%	1.8	0.0	
Low quality of technicians	No	%	60.2	47.9	0.021
	Little	%	11.2	8.3	
	average	%	6.8	18.8	
	big	%	15.5	25.0	
	huge	%	6.2	0.0	
High prices / unavailability of spare parts	No	%	19.5	18.8	0.093
	Little	%	8.8	2.1	
	average	%	17.6	18.8	
	big	%	34.6	52.1	
	huge	%	19.5	8.3	
Machine / accessories too expensive	No	%	15.5	6.1	0.011
	Little	%	4.3	2.0	
	average	%	7.5	10.2	
	big	%	45.3	71.4	
	huge	%	27.3	10.2	
Lack of	No	%	58.6	47.9	0.000

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
knowledge on mechanized operations	Little	%	14.2	6.3	
	average	%	9.3	33.3	
	big	%	11.1	12.5	
	huge	%	6.8	0.0	

Aspirations

Both GSOs and PTOs ranked their incomes as being over average; and there was no significant difference between these. Both groups expected to be among the top income earners in ten years' time. Other members of the communities where they lived ranked the incomes of both groups of tractor owners as above average; the data from the communities also showed no significant difference between the incomes of both groups. However, even though private tractor owners (PTOs) had higher aspiration in their communities than government-support owners (GSOs), the difference in their aspirations was not significant.

Table 26: Aspirations of tractor owners

Question	Unit	State-imported	Privately-purchased	Statistical difference
What is the level of income that you have?	scale	7.0	6.8	0.447
What is the level of income that you would like to achieve?	scale	9.4	9.3	0.463
What is the level of income that you think you will reach within ten years?	scale	9.9	9.9	0.062
What is the level of social status you have at present?	scale	6.9	7.1	0.102
What is the level of social status that you would like to achieve?	scale	8.5	9.3	0.000
What is the level of social status that you think you will reach within ten years?	scale	9.2	9.9	0.000

Tractor assessment

The level of coolant was between b and c for nearly half of the tractor owners (58% GSOs, and 41.7% PTOs). For almost all tractors visited (89.2% and 91.7% respectively), the engine started without help. The hydraulic system and PTO functioned normally in almost all cases. The level of hydraulic oil was acceptable at 62% for both types of owners, as shown in Table 27.

The data also show that 58% of PTOs changed the hydraulic oil when it turned brown, while 51.8% of GSOs changed it when it turned black. This implies that PTOs took better care of their tractors than GSOs. Both owners used draft control for ploughing, but the proportion was higher with GSOs (69.7%) than PTOs (58.3%). The oil level was kept well by the majority of owners (71.2% and 79.2% respectively). However, 51.8% of GSOs and 70.8% of PTOs had the presence of sediments in the tractor oil bowls.

The greasing points were muggy for 48.2% of GSOs and 70.8% of PTOs; while the points were dry for 34.8% and 16.7%, respectively, for the two groups. The majority of tractor owners/operators were able to show their greasing guns (76.6% and 75%); most of these guns (72.6% and 73.9%) functioned properly. Moreover, the majority of radiators were clean and functional at 47.3% for GSOs and 66.7% for PTOs. The fan belts functioned at 81.3% optimum for GSOs and 95.7% for PTOs, while the air filters were at 53.2% and 50% optimum respectively.

Table 27: Tractor assessment of the two types of owners

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
How is the coolant level?	Too high (above b)	%	32.1	33.3	0.100
	Too (low under c)	%	9.8	25.0	
	ok (between b and c)	%	58.0	41.7	
	not applicable/not visible	%	0.0	0.0	
Does the engine start?	Yes without help	%	89.2	91.7	0.634
	Yes with help	%	7.2	8.3	
	no	%	3.6	0.0	
Does the hydraulic system work?	yes	%	95.5	100.0	0.292
	no	%	4.5	0.0	
Is the PTO functioning?	yes	%	91.9	100.0	0.353
	no	%	2.7	0.0	
	not applicable/not visible	%	5.4	0.0	
What is the level of the hydraulic	Too high	%	10.7	20.8	0.432
	Too low	%	10.7	4.2	

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
oil?	ok	%	61.6	62.5	
	not applicable/not visible	%	17.0	12.5	
What was the color of the hydraulic oil when last changed?	Yellow brown	%	42.0	58.3	0.260
	black	%	51.8	33.3	
	not applicable/not visible	%	6.3	8.3	
Do you use draft control for ploughing?	yes	%	69.7	58.3	0.093
	no	%	22.9	41.7	
	not applicable/not visible	%	7.3	0.0	
How is oil level?	Too high	%	14.4	16.7	0.578
	Too low	%	11.7	4.2	
	ok	%	71.2	79.2	
	not applicable/not visible	%	2.7	0.0	
Are there sediments in the bowl?	yes	%	17.0	8.3	0.225
	no	%	51.8	70.8	
	not applicable/not visible	%	31.3	20.8	
How are the greasing points?	Very humid	%	48.2	70.8	0.022
	Some humid but some dry/hard	%	34.8	16.7	
	Very dry/hard	%	17.0	8.3	
	not applicable/not visible	%	0.0	4.2	
Can respondent show his/her greasing gun?	yes	%	76.6	75.0	0.274
	no	%	16.2	25.0	
	not applicable/not visible	%	7.2	0.0	

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
Does it work?	yes	%	72.6	73.9	0.901
	no	%	27.4	26.1	
Is grease in it?	yes	%	74.1	73.9	0.987
	no	%	25.9	26.1	
How is the radiator?	75-100% clean	%	34.8	20.8	0.168
	50-75% clean	%	47.3	66.7	
	25-50% clean	%	17.0	8.3	
	0-25% clean	%	.9	4.2	
	not applicable/not visible	%	0.0	0.0	
How is the felt bent?	Too tight	%	17.0	4.3	0.231
	Too lose	%	1.8	0.0	
	ok	%	81.3	95.7	
	not applicable/not visible	%	0.0	0.0	
How is the air filter?	Too dirty	%	1.8	12.5	0.000
	Dirty	%	7.2	0.0	
	Somehow clean	%	53.2	50.0	
	Very clean	%	36.9	20.8	
	not applicable/not visible	%	0.9	16.7	
Does tractor have roll bar or cabin?	Yes	%	4.5	0.0	0.414
	No	%	92.8	100.0	
	not applicable/not visible	%	2.7	0.0	
Engine hours		hour	3227.1	6816.2	0.581
Are any warning lights on when engine turns?	Oil pressure of transmission	%	6.9	0.0	0.846
	Pressure of engine oil	%	6.9	0.0	

Particulars		Unit	State-imported	Privately-purchased	Statistical difference
	indicator of alternator	%	0.0	0.0	
	indicator of air filter	%	0.0	0.0	
	Transmission oil filter	%	3.4	0.0	
	Others, specify	%	82.8	100.0	

Most of the tractors visited had no roll bars or cabins. Tractors owned by government program beneficiaries ran half the time of those privately-purchased tractors (Table 27). When the tractor engines were turned on, the warning lights were off for 82.8% of government-support owners (GSOs) and 100% of private tractor owners (PTOs).

Discussion

There are two types of tractor owners in Mali, as earlier explained: those who benefited from a government-subsidized program (or governemtn-support owners, GSOs) and those that are private tractor owners (PTOs). They have some common characteristics, such as level of literacy, age, status in the community and land owned and farmed. The also have a similar motivation to own a tractor, but their main sources of information on tractors are different. The government provided limited choices on subsidized tractors, while the private sector had open choices. Both groups, however, use horsepower (HP) as first criteria in choosing a tractor-this was, however, more important for PTOs. Most of the funding was from government GSOs, while PTOs used personal fund. GSOs waited 16 months to complete the credit process, but PTOs had only 4 months to pay for a tractor, even with higher interests.

In several cases, tractors were accessible to the enumerators because they had been sold to other users or broken prematurely or the owner had not fully paid. The results also showed that many of the GSOs were civil servants, traders, politicians, etc. (and not farmers), but because of their positions and closeness to those in government, they were able to secure a tractor. Tractor owners/operators also had very limited knowledge of tractor operation, as they were had no training on the subject in most of cases. The highest constraints to tractor operation were the high cost and unavailability of spare parts.

The small family farms in Mali are characterized by their low level of mechanization, poor production practices and links to markets. Other challenges are: the land tenure system, a poorly qualified and scarce workforce in rural areas, limited access to credit, ineffective

management of producers' organizations, low valuation of agricultural produce, inadequate training for producers, and fluctuations in commodity prices. In 2015, Syngenta Foundation for Sustainable Agriculture (SFSA) started the pilot project of CEMA (Center for Mechanized Services) with the farmers' cooperative SOCOUMA in the administrative region of Ségou, Kouroumari. The objective of the project was to increase the income of producers in the area.

SOCOUMA provided mechanization services and training to rice producers through CEMA, in order to increase production and productivity, as well as quality of rice. This acted as a business center for individuals and associations involved in the rice value chain in the area, fostering the emergence of a focal point for development at the local level. To achieve the objectives of the project, SFSA worked closely with SOCOUMA, Office du Niger, IER (Agricultural Research Institute of Mali), AfricaRice, National Bank for Agricultural Development and the cooperative of blacksmiths of the Office of Niger (SOCAFON). In 2018, the project intended to expand the area of intervention and work with the Office of Rice-Ségou and CPEA (Cell for the Promotion of Agricultural Entrepreneurship).

Between 2015 and 2017, the project supported more than 2000 people (members of the cooperative and their families) on 450–490ha and more than 1300 non-members on 130ha. The impact of this project on the lives and livelihoods of farmers included:

- Access to prompt and appropriate inputs
- Implementation of agricultural activities at the optimum date due to availability of equipment
- Rice sales to traders at a good price resulting in increased revenue for producers

Since 2001, government policy and strategies on rural development have been focused on withdrawal from production, trade, transport, processing functions and their transfer to the private sector (individual producers and professional organizations). A serious challenge of agricultural mechanization in Mali is the indebtedness crisis.

Moreover, the government has initiated several policy instruments related to mechanization and youth development. A pilot project aiming to equip youth organizations (or Economic Group Interest (GIE)) for agricultural services was tested in the rice producing areas. The objective was to provide timely quality services at relatively low costs to vulnerable farmers, especially women. Five groups were settled at the Office Riz zone; the evaluation proved the project profitable. However, the management of the associations or groups was a constraint.

Furthermore, the government endorsed regional texts (OHADA) for creating and managing cooperatives through the Law n01-076 AN-RM of July 18th 2001. By this law, cooperatives were eligible for bank credit. The government also elaborated the Agricultural Development Policy to favor the emergence of a modern agricultural sector development, which is economically and socially profitable. The government enhanced access also to secured lands by identifying and registering all farmers in the country. This increased investments in agriculture and attracted more youth to agricultural activities.

Sampling, data collection and study sites

For the sampling, the study considered all actors (direct and indirect) in mechanization development (youth, farmers' organizations, technical extension services, NGOs, donors, government representatives, researchers and agricultural schools). In each cercle studied, interviews were carried out with actors or questionnaire administered to them. This was done with individuals and groups. About 80 interviews were conducted.

Results

General

When taking into account your organization's effort to influence the national policy in all areas - such as agricultural policy, social and labour policy, etc. - what percentage of this total effort is directed towards agricultural policy? Present average numbers:

Table 28: Efforts and their influence on agricultural policy

Particulars	Farmer organization	Youth association	national government	Donor	Research
Percent funded donor		100,00	42,50	98,00	10,00
Percent of organizational influence on agriculture policy	95,00	100,00	71,67	57,50	15,00

Research is an area with inadequate donor funding in Mali in recent years, as donors emphasize development actions rather than innovations. In other word, donors support more innovation dissemination than innovation generation in developing countries; their focus is on improved production and food sufficiency, as well as actions related to youth in agriculture.

Although research help generate technologies for agricultural development, the study found that they have low level of influence on agricultural policy, while youth associations and farmer organizations highly influence agricultural policy.

Table 29: Agricultural allocations to specific programs by actor

Particulars	Farmer organization	Youth association	national government	Donor	Research
Input subsidies	10,00	20,00	44,00	12,50	30,00
Extension services	10,00	60,00	35,00	49,50	25,00
Agricultural mechanization	30,00	10,00	15,00	10,00	20,00
Youth	20,00	10,00	3,50	7,50	3,00
ICTs in Agriculture	10,00		4,00	3,00	1,00
Environmental Sustainability	20,00		10,00	7,50	1,00
Others			16,50	20,00	20,00

The data in Table 29 show that only farmers organization leaders ranked mechanization as top priority of government expenditures; for the youth association and donor agencies, extension services were government's priority investment, while government workers and researchers indicated that input subsidies had the most priority expenditures.

Farmers' organizations made money from rentage services on agricultural equipment, such as motor-pumps, threshers, rice dehullers, millers, motorcultors and tractors. They procured this equipment through bank loans, or the support of NGOs, project or donor.

Youth and donor agencies indicated that more expenditure should be directed at informing, training and supporting agricultural actors. The youth associations expressed their need for more government funding of their agricultural enterprises, while extension agents and researchers wanted support to immediately improve production and productivity.

Agricultural mechanization

Table 30: Attitude of actors towards agricultural mechanization

Particulars	Farmer organization	Youth association	national government	Donor	Research
	%	%	%	%	%
Pro-mechanization	100	100	100	100	100

The data in Table 30 show that all the actors surveyed had a positive attitude towards agricultural mechanization, perhaps in the conviction that agriculture is is paramount to the overall development of the economy.

Table 31: Preference for animal draught and motorized traction

Particulars	Farmer organization	Youth association	national government	Donor	Research	Table total
Mechanical traction	60.00	47.50	26.67	25.00	60.00	38.33
Animal draught	40.00	52.50	73.33	75.00	40.00	61.67

The survey results also showed that 61.67% of the respondents preferred that more mechanization resources be allocated to animal traction than to mechanical traction, which had 38.33% (Table 31. The responses varied according to the different actors; for instance, farmers organizations and researchers preferred that emphasis be put on mechanical traction, while youth associations, government agents and donors preferred that allocations be more directed at animal draught.

Table 32: Respondents' perception on how agricultural budget should be distributed

Particulars	Farmer organization	Youth association	national government	Donor	Research
Machinery imports, distribution and subsidies	20.00	42.50	43.33	50.00	25.00
Supportive infrastructure (e.g. knowledge and skills development)	80.00	57.50	56.67	50.00	75.00

The data in Table 32 show that 75% of the respondents opined that allocations should be more directed at supportive infrastructures, while the remaining 25% preferred the allocation should go to machinery imports, distribution and subsidies. On individual basis, only donors preferred that allocation be split equally between the two.

Table 33: Beliefs of respondents

Particulars	Farmer organization	Youth association	national government	Donor	Research
Agricultural mechanization is the best way to make farming attractive for the youth.	7,00	7,00	7,00	5,50	5,00
Overcoming hoe and cutlass types of farming should be a top priority.	7,00	6,50	7,00	5,50	6,00
As modern tractors are robust, easy to handle	1,00	1,00	1,00	1,00	1,00

Particulars	Farmer organization	Youth association	national government	Donor	Research
and require little maintenance, no knowledge and skills development programs for tractor operators and technicians are needed.					
The private sector has failed to promote mechanization. Therefore the state needs to import/distribute machinery.	6,00	3,00	2,00	3,50	5,00
The life time of machinery imported during past government programs was typically short.	6,00	1,50	4,67	4,50	7,00
Given the challenges of government efforts to import/distribute machinery, the private sector should lead mechanization	7,00	5,50	6,33	6,00	6,00
Providing knowledge and skills for tractor operators and technicians should be done by the private sector because they make profit selling machines and equipment	6,00	6,50	5,00	4,00	6,00
The private sector has no incentive to provide knowledge and skills development for mechanization, therefore the government should do these activities	6,00	4,00	6,33	6,00	2,00
Current government efforts to provide knowledge and skills development for mechanization are sufficient	4,00	2,00	3,33	5,50	6,00
Pushing agricultural mechanization too much will cause rural unemployment	1,00	1,00	1,00	2,00	2,00
Using tractors and ploughs has led to big problems with regard to soil erosion.	5,00	4,50	3,00	2,00	6,00
It is very easy to develop business models by which smallholder farmers can also benefit	7,00	5,50	7,00	5,50	6,00
Strategies that allow farmers to buy tractors without subsidy are possible	5,00	7,00	7,00	4,00	2,00
Banks do not offer enough and good ways to finance mechanization	6,00	7,00	6,33	6,00	6,00

The data in Table 33 show that all the respondents agreed that to develop and encourage the youth in agriculture, it is necessary to develop mechanization. They also noted that there are many constraints to the achievement of full mechanization in Mali: these include credit for investment and the fact that the private sector could not supply the needed equipment in time and at relatively lower costs.

Table 34: Perception on means of promoting smallholder mechanization

Particulars	Farmer organization	Youth association	national government	Donor	Research	Total
Cooperatives	2,00	6,00	3,00	6,00	7,00	4,67
Machinery hiring markets	7,00	4,50	5,00	6,00	2,00	5,00
Machinery associations	7,00	4,50	6,00	5,50	6,00	5,67
Land consolidation	6,00	3,00	4,67	1,50	2,00	3,44
ICT based solutions like apps	3,00	1,00	5,00	2,50	4,00	3,50

The data show that machinery associations, machinery hiring markets and cooperatives ranked the highest the promotion of smallholder mechanization in Mali (Table 34). The government made many attempts to encourage smallholders' access to mechanization, especially women and youth, using pilots projects; but none recorded sufficient successful. Through these pilot projects, however, many smallholders executed their farm work in time.

Rural youth

Table 35: Respondents' assumptions on the youth and agriculture

Particulars	Farmer organization	Youth association	national government	Donor	Research	Total
The youth finds farming unattractive under current conditions	7,00	7,00	6,67	5,00	7,00	6,44
Designing the right policies would make farming attractive to the youth	7,00	7,00	7,00	6,50	1,00	6,22
We should not be concerned if the youth leave farming for work in urban areas	2,00	3,50	3,00	3,50	6,00	3,44
Youth are not involved enough in agricultural policy processes	7,00	3,50	6,00	5,00	6,00	5,33
Youth lack role models in agriculture	6,00	6,00	6,00	6,00		6,00
Providing too much education unnecessarily raises the aspirations of the youth, which can become dangerous when not enough jobs are created for them	6,00	4,00	4,67	2,00	2,00	3,75
Today's education system prepares the youth well for the job market	1,00		3,33	2,00	1,00	2,29

The respondents in Table 35 can categorized into two: beneficiaries and facilitators. The beneficiaries are farmer organizations, and youth associations, while facilitators are donors, researcher, and government agents. The data show that both groups agreed on the attractiveness of agriculture to the youth; and they also assumed that the education system was not relevant to the job market. They also preferred to discourage the youth from jobs in urban areas, but that the youth should create jobs for themselves.

Table 36: Perception on how to attract the youth to agriculture

Particulars	Farmer organization	Youth association	National government	Donor	Research	Total
Agricultural mechanization	7,00	7,00	6,50	5,50	7,00	6,50
ICTs	6,00	7,00	5,75	3,50	6,00	5,60
Education and skills training programs	6,00	6,50	6,50	5,00	6,00	6,00
Active labor market programs (e.g. public work)	6,00	6,00	5,00	5,00	4,00	5,22
Access to land	5,00	6,50	6,67	5,00	6,00	6,00
Access to credit	5,00	5,00	6,67	4,00	6,00	5,44
Improved rural infrastructure	6,00	6,50	7,00	5,00	6,00	6,22

To make agriculture more attractive to youth, the general perception of respondents was that mechanization, improved rural infrastructure, education and skills training programs and access to land should be promoted. Development of ICT, access to credit and active labor market programs came second (Table 36).

ICT in agriculture

Table 37: Agreement of different actors on statements

Particulars	Farmer organization	Youth association	National government	Donor	Research	Total
ICT applications and mobile services provide tremendous opportunities for agricultural development	6,00	7,00	6,67	6,00	6,00	6,44
Low connectivity still limits the possibilities of many households to use ICT applications and mobile services	6,00	7,00	7,00	5,00	6,00	6,33
We need more quality control of ICT applications and mobile services	7,00	6,50	6,00	6,50	2,00	5,89
ICT applications and mobile services are already helping farmers	6,00	7,00	6,00	5,00	5,00	5,89
Wealthy and educated households benefit more from ICT applications and mobile services	7,00	6,00	6,33	4,50	6,00	5,89

Particulars	Farmer organization	Youth association	National government	Donor	Research	Total
ICT applications use personal and sensitive data and we should care more about data privacy and sovereignty	7,00	6,50	3,67	5,50	6,00	5,33
ICT applications may help to increase good governance by improving the management of agricultural agencies and by empowering farmers to demand better services	7,00	7,00	6,67	6,50	7,00	6,78

All the respondents agreed on the importance of ICT in agriculture; that that ITC applications would enhance good governance by improving the management of agricultural agencies and empowering farmers to demand better services. Youth associations and farmer organizations mostly wanted support in ICT for agriculture.

Table 38: Evaluation of the ICT potential in agriculture; 1 = low potential, 7 = high potential

Particulars	Farmer organization	Youth association	national government	Donor	Research
Mobile payments and mobile saving	1,00	6,50	4,67	6,50	6,00
Credit provision	1,00	6,50	4,33	5,50	6,00
Insurance	1,00	6,50	3,00	5,50	6,00
Whether and price data	7,00	6,50	6,33	6,50	5,00
Agricultural extension service	5,00	6,00	6,00	5,00	4,00
Machinery rental markets	5,00	6,00	5,00	3,00	4,00
Marketing	5,00	5,00	6,33	4,00	4,00

Farmer organizations rated mobile payment and mobile saving, credit provision and insurance as low in potential for ICT, perhaps because most of them were illiterate and found it difficult to understand ITC matters. The youth, being more open to innovations and ICTs, rated ICT development as having potential for agricultural development. Government actors and donors were also not keen on the potential of ITC in machinery rental markets and marketing.

General information

Table 39: General information on respondents

Particulars		Youth association	National government	Donor	Research	Total
Age		31	60,00	58,50	60,00	52,00
Sex	Male (%)	100,0	100,0	100,0	100,0	100,0
origin	Rural (%)	100,0	100,0	100,0	100,0	100,0

Particulars		Youth association	National government	Donor	Research	Total
if_rural_grown in farm	Yes (%)	0,0	100,0	33,3	50,0	100,0
	No (%)	100,0	0,0	66,7	50,0	0,0
Farm possession	Yes (%)	0,0	0,0	0,0	50,0	100,0
	No (%)	100,0	100,0	100,0	50,0	0,0
Education level	Cycle engineer (%)	100,0	0,0	0,0	0,0	0,0
	Master (%)	0,0	100,0	66,7	0,0	100,0
	Doctorate (%)	0,0	0,0	33,3	100,0	0,0
if_etudied_context	Agriculture (%)	100,0	50,0	50,0	100,0	100,0
	Engineer (%)	0,0	0,0	50,0	0,0	0,0
	Agricultural Mechanization (%)	0,0	50,0	0,0	0,0	0,0
Country_of diploma	Country of origin (Africa) (%)	100,0	0,0	33,3	0,0	0,0
	Country of origin (outside Africa) (%)	0,0	0,0	0,0	50,0	100,0
	Both (country et abroad) (%)	0,0	100,0	66,7	50,0	0,0
Number_article_note_read_last year			32,50	60,00	20,00	41,00
No of representative				30,00		30,00
Number of lectures last one year		3,00	10,00	7,50	5,00	6,60
Rules of the interaction				3,00	30,00	12,00
Private interaction		10,00		1,50	15,00	7,00
Interaction with the civil society				1,00	10,00	4,00
Farmer Association		5,00	10,00	4,00	20,00	8,60
Development Organization		4,00	5,00	10,00	30,00	12,25

The characteristics of the respondents are presented in Table 39 The overall age mean was 52 years; which means they were experienced in agriculture and related activities. Half of the respondents had at least a farm; members of youth associations had a degree in agricultural engineer; government workers had a master's degree in agriculture, while researchers had a doctorate. No respondent had a degree in mechanization. Also, 33% of the donor and 50% of the researcher respondents got a diploma outside Mali.. Moreover, only the donor respondents read an article or policy brief related to mechanization the previous year. There was poor interaction with regard to mechanization among all the respondent categories (researchers, government, private sector, farmer association and development organizations).

Discussion

The results showed that more emphasis was on development activities by donors than on research, due to challenge of food and nutrition insecurity facing Mali and the need to solve it sustainably and in the short-term. This explains why donors supported youth association activities and government initiatives in agriculture rather than mere research.

The policy of government is to withdraw from production, trade, transport and processing activities and leave them for the private sector.

Consequently, government expenditure in agriculture is directed mostly to extension, mechanization and subsidies, towards achieving food security for the country. But these efforts face challenges related to low level of mechanization, poor extension methods, and poor link to farmers. To achieven food security, the study respondents suggested that agricultural mechanization should be prioritized over animal traction. During land preparation, manual labor and animal traction still dominated, while motorized land preparation with tractors was only popular among cotton farmers and motorized cultivation was used monly by rice farmers particularly in the Office du Niger. The implication is that tractor-powered land preparation has proved highly effective on cotton fields. There was also the prevalence of rental markets for both animal and motorized traction. Farms with animal traction equipment prepared their fields with such equipment; hence, there was high rate of animal traction rental. Since equipment owners prepared their own fields first, risks of late planting and weeding were high among farmers without equipment.

All the actors agreed on the critical need for the development of agriculture mechanization, but also stated that farmers could not procure mechanized equipment because of poor access to bank credit. It is important therefore to facilitate the establishment of mechanization associations, as well as assist farmers to manage them. The youth, although willing to invest in agriculture, are more attracted to urban conditions, which explains the growing number of young people emigrating from rural areas. When mechanization, training and land, as well ICT applications in agriculture are made accessible to the youth, the agricultural sector would be attractive to them.

Study 3: State of Skills Development for Mechanization

The importance of skills development for agricultural mechanization

Building the skills and knowledge of farmers on how to use machinery and implements along the agricultural value chain is essential. Establishing training opportunities to build these skills, however, still remains a major bottleneck for agricultural mechanization. This section provides evidence on the opportunities and challenges related to skills development to promote agricultural mechanization.

Sampling, data collection and study sites

The study used snowball approach to build the sample; different schools were identified in a locality within the study area for the purpose of information gathering; 30 schools and universities where mechanization is taught where sampled. Paper-based survey, using questionnaire, was thus carried out among heads and staff of schools (and universities). The survey instrument was left for a week with the respondents and retrieved thereafter. The area

covered by the survey comprised places where private and government purchased tractors had been studied.

Results

Data on the sampled institutions and respondents are presented in Table 40. The data show that several institutions in Mali were involved in agricultural mechanization activities. These institutions included university, national agricultural research institute, technical high school, secondary school and blacksmith cooperatives. These were both public and private institutions. The results show that type of institution was significantly different at 5% level between public and private institutions. The public institutions included 20% universities and 20% research centers.

Table40: Data the surveyed institution

Particulars	Unit	Public	Private	Statistical difference
Type of institution:				
a. University	%	20.0	0.0	0.029
b. Research institute (mechanization program Unit)	%	20.0	0.0	
c. Mid-Level School (Agricultural High School)	%	40.0	14.2	
d. TVET (secondary school and company of handsmith and blacksmith cooperatives.)	%	20.0	85.7	
Age of institution (years)?	Year	28.0	13.565	0.000
Number of branches (including head branch)	-	-	-	-
Years worked in the institution	Year	8.5	8.79	0.939
Respondent's post/role in this institution:				
a. Management	%	0.0	15.4	0.633
b. Administrative	%	75.0	69.2	
c. Teaching	%	25.0	7.7	
d. Support staff	%	0.0	7.7	

About 40% of the research institutes were technical high schools, and 20% were professional training centers, such as *Centre Père Michèle* and the *Centre d'Apprentissage Agricole* (Agricultural Learning Center). Table 40 shows that private institutions were essentially professional training centers and constituted about 86% of the sample, while 14% was for technical high school. The private institutions were recently established, with an average age of

13.5 years, while the public ones were averagely 28 years old. The age of institution was significantly different at 1% level for public and private institutions. Some of the the public institutions sampled were established at the country's independence and had carried out mechanization programs long before the survey.

The respondents for both public and private institutions were not much different in terms of work experience, with 8.5 and 8.79 years respectively; a higher proportion of them (69.2% and 75.0% respectively) occupying administrative positions, while 15.4% and 25.0% of them respectively were managers and teaching staff. Moreover, 7.7% of the respondents from private institutions were support staff. Many of the respondents played multiple roles in their institutions, combining management and administrative roles.

The data in Table 41 show that the number of university staff and students increased between 2014 and 2018; the number of staff increasing by 72%, from 90 in 2014 to 155 in 2017. These workers included teachers and support staff, such as secretaries and clerks. The number of lecturers also increased by 50%, from 80 in 2014 to 120 in 2018. The data did not, however, categorized the lecturers to part-time or full-time.

Table 41: Average Number of Staff and Students from the sampled University

Category 1: Universities			**2018**	**2017**	**2016**	**2015**	**2014**	**Year of establishment**
Number of people (irrespective of designation) work /worked in this institution in:		Number	155	145	133	100	90	-
Number of teachers/lecturers work/worked in institution in:		Number	120	110	108	90	80	-
Number of male students are/were enrolled in institution in:		Number	420	307	241	100	103	-
Number of female students are/were enrolled in institution in:		Number	165	141	100	80	67	-
Have a vision and/or mission statement	Yes	%	100					
	No	%	0.0					
Number of years since the vision and/mission statement was updated		Year	1					
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done		Year	1					
Have a strategic plan	Yes	%	100					
	No	%	0					
Number of years before current strategic plan run out?		Year	1					

Moreover, the number of female and male students from the sampled university increased from 67 to 165 and from 103 to 420 respectively between 2014 and 2018. The male students were more than their female counterparts in all the institutions studied.

The result shows that the sampled university recently updated its vision and mission statements and developed a strategic plan. It is noteworthy that, although the study had sampled two public universities running mechanization programs, only one university completed copies of the questionnaire administered. This university has an institute with a specific program on mechanization.

Table 42 presents data on the number of workers and students running the mechanization program in the institute (domiciled in the sampled university). The data show that the number of support staff in mechanization program unit increased from 5 in 2014 to 8 in 2018. Conversely, the researchers decreased from 3 to 2 in the same period; the number of students on internship in the unit varied from one year to another, depending on area of interest. The needs assessment of the program unit with regard to knowledge and skills was last conducted two years before the survey. And although the institute shared the overall goal of the university, it did not have a strategic plan of its own.

Table 42: Average Number of Staff and Students in the sampled Research Institute

Category 2: Research institute			2018	2017	2016	2015	2014	Year of establishment
Number of people (irrespective of designation) work /worked in this institution in:		Number	8	8	7	5	5	-
Number of researchers/lecturers' work/worked in institution in:		Number	2	2	3	3	3	-
Number of male students are/were enrolled in institution in:		Number	24	20	7	20	3	-
Number of female students are/were enrolled in institution in:		Number	1	0	0	0	0	-
Has a vision and/or mission statement	Yes	%	100					
	No	%	0.0					
Number of years since the vision and/mission statement was updated		Year	-					
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done		Year	2					
Has a strategic plan	Yes	%	100					
	No	%	0					
Number of years before current strategic plan run out?		Year	0					

The data on TVET respondents (staff and students) are presented in Table 43. The data show that the average number of workers, lecturers and students in the institution increased between 2014 and 2018. The number of workers increased from 13 to 28 in the period, while that of lecturers increased from 11 to 26. However, while the number of female students increased from 87 to 124, that of male students remained unchanged at 110.

Table43: Average Number of Staff and Students for Mid-level School

Category 3: Mid-level school (Agricultural High School)			2018	2017	2016	2015	2014	Year of establishment
Number of people (irrespective of designation) work /worked in this institution in:		Number	28	23	20	14	13	-
Number of reseachers/lecturers work/worked in institution in:		Number	26	19	18	11	11	-
Number of male students are/were enrolled in institution in:		Number	110	143	115	88	110	-
Number of female students are/were enrolled in institution in:		Number	124	104	92	70	87	-
Have a vision and/or mission statement	Yes	%	75					
	No	%	25					
Number of years since the vision and/mission statement was updated		Year	2					
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done		Year	1					
Have a strategic plan	Yes	%	50					
	No	%	50					
Number of years before current strategic plan run out?		Year	1					

The data also show that, for this type of institution, 75% of them had a vision or mission statement, while 25% had none. But the 75% of those with vision statement only updated them 2 years before the survey. Only 50% of TVET institutions had a strategic plan, but which was to run out a year after the survey.

Table 44 presents data on the number of workers, lecturers and students of the sampled local training centers, comprising handsmith and blacksmith cooperatives company (SOCAFON) and secondary professional schools. SOCAFON is located in Niono zone, where the agricultural system is based on rice crop; it only offers short training on mechanization. It is also specialized in manufacturing of agricultural equipment, such as rototiller and threshers.

Table 44: Average Number of Staff and Students for TVET

Category 4: TVET		2018	2017	2016	2015	2014	Year of establishment
Number of people (irrespective of designation) work /worked in this institution in:	Number	19	18	17	18	18	-
Number of researchers/lecturers work/worked	Number	16	16	15	15	15	-

in institution in:								
Number of male students are/were enrolled in institution in:		Number	111	143	147	153	154	-
Number of female students are/were enrolled in institution in:		Number	69	74	75	68	72	-
Have a vision and/or mission statement	Yes	%	62					
	No	%	38					
Number of years since the vision and/mission statement was updated		Year	4					
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done		Year	1					
Have a strategic plan	Yes	%	50					
	No	%	50					
Number of years before current strategic plan run out?		Year	1					

The secondary professional schools are mostly the local training centers which offer courses in agriculture, including mechanization. The data show that the average number of teachers and other workers in these training centers increased marginally, from 15 to 16 and 18 to 19 respectively between 2014 and 2018. On the other hand, the average number of female and male students decreased by 4% and 28% respectively. The decrease in the number of students was due to a recent policy of the Ministry of Education on increasing enrolment in public schools. Also, 62% of these institutions had a vision statement, updated on an average, 4 years. Needs assessment was carried a year before the survey. Moreover, 50% of them had a strategic plan, but which had elapsed also a year before the survey.

Data on the average number workers in sampled universities are presented in Table 45. The data show that only public universities had mechanization programs; The number of all workers increased by 72%, while that of teachers was by 50% from 2014 to 2018.

Table 45: Average number of workers and students in universities

Category 1: Universities	Unit	Public	Private	Statistical difference
Number of people (irrespective of designation) working in 2018	number	155	0	-
Ave. number of people (irrespective of designation) working in 2017	number	145	0	-
Ave. number of people (irrespective of designation) working in 2016	number	133	0	-
Ave. number of people (irrespective of designation) working in 2015	number	100	0	-
Ave. number of people (irrespective of designation) working in 2014	number	90	0	-
Number of teachers/lecturers working in 2018	number	120	0	-
Ave. number of teachers/lecturers working in 2017:	number	110	0	-
Ave. number of teachers/lecturers working in 2016	number	108	0	-
Ave. number of teachers/lecturers working in 2015	number	90	0	-
Ave. number of teachers/lecturers working in 2014	number	80	0	-
Number of male students are enrolled in 2018	number	420	0	-
Ave. number of male students are enrolled in 2017:	number	307	0	-
Number of male students enrolled in 2016	number	241	0	-

Ave. number of male students enrolled in 2015		number	100	0	-
Ave. number of male students enrolled in 2014		number	103	0	-
Number of female students enrolled in 2018		number	165	0	-
Number of female students enrolled in 2017		number	141	0	-
Number of female students enrolled in 2016		number	100	0	-
Number of female students enrolled in 2015		number	80	0	-
Number of female students enrolled in 2014		number	67	0	-
Have a vision and/or mission statement	Yes	%	100	0	-
	No	%	0	0	
Number of years since the vision and/mission statement was updated		number	1	-	-
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done		number	1	-	-
Have a strategic plan	Yes	%	100	-	-
	No	%	0	-	
Number of years before current strategic plan run out?		number	1	-	-

The number of students increased by 59% for female and 75% for male. There was no statistical difference between the number of workers and students because only a public university filled the questionnaire. The sampled university had a vision statement, which was updated a year ago before the survey. It also had a functional strategic plan. The research institute surveyed was also a public one (see details in Table 46). The data show that the number of administration workers increased, while that of researchers decreased from 3 to 2. The average number of students depended on their areas of research. A common vision statement existed for the university and the research institute which ran the mechanization program.

Table 46: Average number of workers and students in the sampled research institute

Category 2: Research institute	Unit	Public	Private	Statistical difference
Number of people (irrespective of designation) working in 2018	number	8	0	-
Ave. number of people (irrespective of designation) working in 2017	number	8	0	-
Ave. number of people (irrespective of designation) working in 2016	number	7	0	-
Ave. number of people (irrespective of designation) working in 2015	number	5	0	-
Ave. number of people (irrespective of designation) working in 2014	number	5	0	-
Number of teachers/lecturers working in 2018	number	2	0	-
Ave. number of teachers/lecturers working in 2017:	number	2	0	-
Ave. number of teachers/lecturers working in 2016	number	3	0	-
Ave. number of teachers/lecturers working in 2015	number	3	0	-
Ave. number of teachers/lecturers working in 2014	number	3	0	-
Number of male students are enrolled in 2018	number	24	0	-
Ave. number of male students are enrolled in 2017:	number	20	0	-
Number of male students enrolled in 2016	number	7	0	-
Ave. number of male students enrolled in 2015	number	20	0	-
Ave. number of male students enrolled in 2014	number	3	0	-
Number of female students enrolled in 2018	number	1	0	-
Number of female students enrolled in 2017	number	0	0	-

Category 2: Research institute		Unit	Public	Private	Statistical difference
Number of female students enrolled in 2016		number	0	0	-
Number of female students enrolled in 2015		number	0	0	-
Number of female students enrolled in 2014		number	0	0	-
Have a vision and/or mission statement	Yes	%	100	-	-
	No	%	0	-	
Number of years since the vision and/mission statement was updated		number	-	0	-
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done		number	2	0	-
Have a strategic plan	Yes	%	0	-	-
	No	%	0	-	
Number of years before current strategic plan run out?		number	0	0	-

Mid-level schools exist in both public and private sector, but the data in Table 47 show there was no significant difference between the two categories, perhaps due to the limited sample size of the mid-level schools in the study. The results indicate that the number of all workers of public mid-level schools increased between 2014 and 2018.

Table 47: Average number of workers and students in mid-level school

Category 3: Mid-Level School		Unit	Public	Private	Statistical difference
Number of people (irrespective of designation) working in 2018		number	39	17	-
Ave. number of people (irrespective of designation) working in 2017		number	33	12	-
Ave. number of people (irrespective of designation) working in 2016		number	33	8	-
Ave. number of people (irrespective of designation) working in 2015		number	26	2	-
Ave. number of people (irrespective of designation) working in 2014		number	24	2	-
Number of teachers/lecturers working in 2018		number	31	20	-
Ave. number of teachers/lecturers working in 2017:		number	26	13	-
Ave. number of teachers/lecturers working in 2016		number	26	10	-
Ave. number of teachers/lecturers working in 2015		number	19	4	-
Ave. number of teachers/lecturers working in 2014		number	18	4	-
Number of male students are enrolled in 2018		number	166	55	-
Ave. number of male students are enrolled in 2017:		number	219	67	-
Number of male students enrolled in 2016		number	196	34	-
Ave. number of male students enrolled in 2015		number	172	4	-
Ave. number of male students enrolled in 2014		number	203	18	-
Number of female students enrolled in 2018		number	203	45	-
Number of female students enrolled in 2017		number	155	52	-
Number of female students enrolled in 2016		number	153	31	-
Number of female students enrolled in 2015		number	136	4	-
Number of female students enrolled in 2014		number	159	15	-
Have a vision and/or mission statement	Yes	%	50	100	-
	No	%	50	0	
Number of years since the vision and/mission statement was updated		number	3	2	-
Number of years since the last needs (knowledge, skills, & attitudes)		number	1	2	-

assessment was done					
Have a strategic plan	Yes	%	50	50	-
	No	%	50	50	
Number of years before current strategic plan run out?		number	2	0	-

The number of workers increased by 62% (from 24 to 39) for public and by 750% (from 2 to 17) for private schools. Note that this difference between public and private is important in percentage but not in numbers, as private Mid-Level schools were created in 2014 with only 2 workers; as the number of students increased, the institution recruited more workers to meet the needs. This increasing trend for all workers was the same for the lecturers and students. The average number of lecturers increased by 72% for public and 400% for private institutions, while that of students enrolled in private Mid-Level School increased by 22% and 200% respectively for male and female between 2014 and 2018. On the other hand, the number of male and female students in public Mid-Level School increased by 4% and 28% respectively in the same period. The results showed that 50% of the sampled public and 100% of private Mid-Level Schools had a vision statement. These vision statements has been updated 2 to 3 years before the survey and assessed 1 to 2 years before the survey. Only 50% of both schools had strategic plan.

The data in Table 48 show that the average number of workers and students of private TVET is greater than that of the public one. The former only recruited workers in 2017. The average number of workers and students of private TVET did not change much from 2014 to 2018. All the public TVET institutions surveyed had a vision statement, which was updated 2 years before the survey. Moreover, 58% of private TVET had a vision statement, which was updated and assessed a year before the survey. None of the two types of TVET had a strategic plan.

Table 48: Average number of workers and students in TVET institutions

Category 4: TVET	Unit	Public	Private	Statistical difference
Number of people (irrespective of designation) working in 2018	number	18	20	-
Ave. number of people (irrespective of designation) working in 2017	number	14	19	-
Ave. number of people (irrespective of designation) working in 2016	number	3	18	-
Ave. number of people (irrespective of designation) working in 2015	number	0	18	-
Ave. number of people (irrespective of designation) working in 2014	number	0	18	-
Number of teachers/lecturers working in 2018	number	12	16	-
Ave. number of teachers/lecturers working in 2017:	number	9	16	-
Ave. number of teachers/lecturers working in 2016	number	0	15	-
Ave. number of teachers/lecturers working in 2015	number	0	15	-
Ave. number of teachers/lecturers working in 2014	number	0	15	-
Number of male students are enrolled in 2018	number	14	120	-
Ave. number of male students are enrolled in 2017:	number	12	156	-
Number of male students enrolled in 2016	number	0	147	-
Ave. number of male students enrolled in 2015	number	0	153	-

Category 4: TVET		Unit	Public	Private	Statistical difference
Ave. number of male students enrolled in 2014		number	0	154	-
Number of female students enrolled in 2018		number	10	75	-
Number of female students enrolled in 2017		number	10	93	-
Number of female students enrolled in 2016		number	0	64	-
Number of female students enrolled in 2015		number	0	67	-
Number of female students enrolled in 2014		number	0	80	-
Have a vision and/or mission statement	Yes	%	100	58	0.411
	No	%	0	42	
Number of years since the vision and/mission statement was updated		number	2	1	-
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done		number	0	1	-
Have a strategic plan	Yes	%	0	-	-
	No	%	100	-	
Number of years before current strategic plan run out?		number	0	1	-

Data on the average number of people working in public and private universities are presented in Table 49. The data show that only public universities had mechanization program. The average number of workers increased by 72% for (all workers) and 50% for teachers or lecturers between 2014 and 2018.

Table 49: Average number of workers and students in universities

Category 1: Universities		Unit	Public	Private	Statistical difference
Number of people (irrespective of designation) working in 2018		number	155	0	-
Ave. number of people (irrespective of designation) working in 2017		number	145	0	-
Ave. number of people (irrespective of designation) working in 2016		number	133	0	-
Ave. number of people (irrespective of designation) working in 2015		number	100	0	-
Ave. number of people (irrespective of designation) working in 2014		number	90	0	-
Number of teachers/lecturers working in 2018		number	120	0	-
Ave. number of teachers/lecturers working in 2017:		number	110	0	-
Ave. number of teachers/lecturers working in 2016		number	108	0	-
Ave. number of teachers/lecturers working in 2015		number	90	0	-
Ave. number of teachers/lecturers working in 2014		number	80	0	-
Number of male students are enrolled in 2018		number	420	0	-
Ave. number of male students are enrolled in 2017:		number	307	0	-
Number of male students enrolled in 2016		number	241	0	-
Ave. number of male students enrolled in 2015		number	100	0	-
Ave. number of male students enrolled in 2014		number	103	0	-
Number of female students enrolled in 2018		number	165	0	-
Number of female students enrolled in 2017		number	141	0	-
Number of female students enrolled in 2016		number	100	0	-
Number of female students enrolled in 2015		number	80	0	-
Number of female students enrolled in 2014		number	67	0	-
Have a vision and/or mission statement	Yes	%	100	0	-
	No	%	0	0	

Category 1: Universities		Unit	Public	Private	Statistical difference
Number of years since the vision and/mission statement was updated		number	1	-	-
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done		number	1	-	-
Have a strategic plan	Yes	%	100	-	-
	No	%	0	-	
Number of years before current strategic plan run out?		number	1	-	-

The average number of female and male students increased by 59% and 75%, respectively. There was no statistical difference between the number of workers and students, because only a public university participated in the survey. The university had a vision statement, which was updated and assessed only the year preceding the survey. It also had a functional strategic plan.

Data on the public research institute surveyed are presented in Table 50. The data show that the average number of researchers decreased from 3 to 2, while that of students depended on their research areas. The research institute shared same vision statement with its hosting university, but taking into account the mechanization program activities. This program's needs assessment in terms of knowledge and skills was carried out about 2 years before this survey; the institute had no strategic plan.

Program description (all programs)

Information on the university program and students is presented in Table 51. The Table shows that agricultural mechanization was taught as a complete and accredited program within the institute domiciled in the university; in the faculties of agronomy and animal medicine, mechanization is taught as a modular unit. The analysis is thus done using only the institute's data.

Table51: Agricultural mechanization program and number of students at the universities

S/N	List of programs offered in this institution	Total number of applicants		Total number enrolled		Number of those that completed the program (last graduation)		Number of those that dropped –out of the program in the last graduating group		Is this program accredited?	
		Male	Female	Male	Female	Male	Female	Male	Female	Yes	No
		number	number	number	number	number	number	number	number	%	%
1	Agricultural mechanization	29	6	29	6	22	5	7	1	100	0

The data show that there were 35 students enrolled in agricultural mechanization program. Of this total, there were 29 male and 6 female students; 76% of the male and 83% of the female had graduated at the time of the survey. Agricultural mechanization program was run as a short-term training course and demand-driven. Conversely, mid-level schools had several teaching programs (Table 52). The total numbers of applicants and enrolled students were different from one program to another.

Table 52: Programs and students of research institute

S/N	List of programs offered in this institution	Total number of applicants		Total number enrolled		Number of those that completed the program (last graduation)		Number of those that dropped – out of the program in the last graduating group		Is this program accredited?	
		Male	Female	Male	Female	Male	Female	Male	Female	Yes	No
		number	number	number	number	number	number	number	number	%	%
1	Agricultural Mechanization	-	-	-	-	-	-	-	-	100	0

The main programs, in terms of applications and enrolled students were agribusiness and zootechnics, followed by agronomy and agricultural mechanization. The data indicate that the number of female applicants was higher for agribusiness, zootechnics, and agronomy. All the applicants had not been enrolled; the least percentage of enrollees was for female (5%) in zootechnics, while the highest was 100% in agribusiness. The least percentage of male enrollees was 30%, while the highest was 100%. Thus, there were more male than female enrollees. The reason for this could be social and economic factors. The students who completed the program were 52% for male and 42% for female. All the programs listed were accredited.

For TVET institutions, the data in Table 53 show that the number of students of agronomy, agricultural mechanization and zootechnics was higher than those for other programs. But the male applicants were more than their female counterparts. . Moreover, the percentage increase of female students who completed their programs (51% to 62%) was higher than that for the male (39% to 45%) and depended on on individual programs.

Table 53: Programs and students of mid-level school

S/N	List of programs offered in this institution	Type of institution	Total number of applicants		Total number enrolled		Number of those that completed the program (last graduation)		Number of those that dropped – out of the program in the last graduating group		Is this program accredited?	
			Male	Female	Male	Female	Male	Female	Male	Female	Yes	No
			number	Number	number	number	number	number	number	number	%	%
1	Agronomy	Public	61	46	60	43	34	17	9	18	100	0
		Private	57	90	29	21	12	10	1		100	0
2	Zootechnics	Public	101	76	101	76	0	0	6	0	100	0
		Private	50	90	15	5			1		100	0
3	Aquaculture	Public	0	0	0	0	0	0	0	0	100	0
4	Agricultural Mechanization	Private	86	91	82	81	12	10	1		100	0
5	Agribusiness	Public	218	174	218	174	0	0	11	11	100	0
		Private	50	90	15	5			1		100	0
6	Environment Protection	Public	31	33	31	33	0	0	16	18	100	0
7	Forestry	Private	50	90	15	5			1		100	0
8	French	Private	50	90	15	5			1		100	0
9	ECM	Private	50	90	15	5			1		100	0

Table 54: Program and students of TVET

S/N	List of programs offered in this institution	Type of institution	Total number of applicants		Total number enrolled		Number of those that completed the program (last graduation)		Number of those that dropped – out of the program in the last graduating group		Is this program accredited?	
			Male	Female	Male	Female	Male	Female	Male	Female	Yes	No
			Number	number	number	number	number	number	Number	number	%	%
1	Agronomy	Private	139	60	123	51	48	26	7	2	100	0
2	Zootechnie	Private	72	70	55	45	25	28	3	1	100	0
3	Agric Mechanization	Public	-	-	-	-	-	-	-	-	100	0
		Private	72	64	72	64	22	15	2	2	85.7	14.3
4	Agribusiness	Private	0	0	63	43	19	11	8	5	100	0
5	Forestry	Private	60	58	60	58	22	10	-	-	100	0
6	Français	Private	40	20	35	15	-	-	-	-	100	0

Program description (agricultural mechanization programs only)

Table 54 presents data on agricultural mechanization program, as they existed in the institutions surveyed. the data show that the university and mid-level schools had complete mechanization programs, while others only taught the course unit in their existing programs.

Table 55: Details on agricultural mechanization program

S/N	Agricultural mechanization program	Number of months to complete the program	Number of teachers / lecturers for this program	How long does it take to complete? (months)	Number of years since last content change for courses (curriculum review) was done	Average number of years graduates of this program to get their first job
		number	Number	number	Year	Year
1.	Rural Handicraft	1	1	-	-	-
2.	Motorized Crop	1	1	-	1	-
3.	Agricultural Mechanization	8	16	-	2	2
4	General Mechanic	1	3	-	-	-
5	Tools and Equipment	3	1	-	-	-

The results show that there were 5 mains courses in mechanization: rural handicraft, motorized crop, agricultural mechanization, general mechanic and tools and equipment. Among these, agricultural mechanization had the highest number of months to complete the course and highest number of teachers or lecturers. This course curriculum was reviewed 2 years before the survey. The average number of years in getting a job after graduation was 2 years. There 39% likelihood of securing a job by a graduate of agricultural mechanization. Employment opportunities existed in both public and private sectors.

To meet job market demand, these training institutions should adjust their curricula; as more than 75% of the respondents recommended changes in training contents; 23.53% others were highly favorable to changes in the agricultural mechanization program itself. The changes suggested were, however, more focused on practical sessions (40%) and practical and internship sessions (about 27%).

Table 56: Data on employment sector of agricultural mechanization program

S/N	Agricultural mechanization program	Government employment	Private-sector employment	Self-employment	Gov, Private and self-empl.	Self and private	others
		%	%	%	%	%	%
1	Rural Handicraft	-	-	-	100	-	-
2	Motorized Crop	-	-	-	-	-	-
3	Agricultural Mechanization	16,67	16,67	16,67	38,89	11,11	-
4	General Mechanical	-	-	-	50	50	-
5	Tools and Equipment	-	-	-	-	100	-

Table57: Recommendations on program restructuring

S/N	Agricultural mechanization program	If you had the opportunity to restructure program, would you recommend change to content of courses of training within the program?		
		YES, highly recommend	YES, recommend	NO; not recommend
1	Rural Handicraft	0	0	0
2	Motorized Crop	0	0	0
3	Agricultural Mechanization	23,53	52,94	23,53
4	General Mechanic	0	0	100
5	Tools and Equipment	0	100	0

These results show that these institutions need to hold more practical sessions to enhance the quality of graduates and meet the job market demand. Many of these institutions had inadequate machines for practical sessions; these excluded institutions which benefited from subsidy programs or projects. Graduates mainly possessed skills in basic local machines. In most of the programs, therefore, respondents suggested more time and resources for agricultural mechanization program. The results in Table 57 indicate that almost 81% of the institutional respondents stated that the success of

mechanization program will depend on the amount of time allocated for it. In many private TVETs, the program ran about 2 hours in a week (or 72 hours in a year).

Table 1: Recommended changes to mechanization program

S/N	Agricultural mechanization program	Type of content change would be recommended				
		More hand-on /practical sessions	More theoretical sessions	More internships	More linkages with industry etc.	More Pratical and Internships sessions
		%	%	%	%	%
1	Rural Handicraft	0.0	0.0	0.0	0.0	0.0
2	Motorized Crop	0.0	0.0	0.0	0.0	0.0
3	Agricultural Mechanization	40.0	13,33	13,33	6,67	26,67
4	General Mecanic	0.0	0.0	0.0	0.0	0.0
5	Tools and Equipment	100	0.0	0.0	0.0	0.0

Table 59: Allocation of time amount

S/N	Agricultural mechanization program	Recommended change to the amount of time allocated to this program		
		No change recommended	Allocate more time	Reduce time allocated
		%	%	%
1	Rural Handicraft	0	0	0
2	Motorized Crop	0	6,25	0
3	Agricultural Mechanization	6,25	81,25	6,25
4	General Mechanic	0	6,25	
5	Tools and Equipment	0	0	0

Information on the teaching/instruction staff

This section continues presentation of data on the teaching staff of the sampled institutions.

University

The data on university staff are presented in Table 59. The data shows that all the staff were 'others', which implies that the retired teachers were not replaced by means of recruitment. The average experience of teaching staff was 27 years generally, and 6 years at the university. With regard to the education level at the university, , Table 60 shows that teaching and

certification were at the diploma level or technical training; there was no mechanization program at bachelor's, master's or PhD level. The teaching staff should thus improve on the curriculum of the university in the area of agricultural mechanization (see Tables 61 and 62).

Table 60: Characteristics of the University Teaching Staff

Type of staff	Characteristics of the teaching/instructing staff			
	Ave. age	Gender (%female)	Years of teaching / instructing in current institute	Total years of teaching / instructing
Regular (long-term contracted / permanent)	0	0	0	0
Temporary (short-term contract) / part-time	0	0	0	0
Other	64.5	0	5.5	27

Table 61: Educational level of university teaching staff

Type of staff	Highest level of education				
	University post graduate (PhD)	University post graduate (Master or equiv.)	University graduate (bachelors or equiv.)	Technical training (higher diploma or equiv.)	Other
	%	%	%	%	%
Regular (long-term contracted / permanent)	0.0	0.00	0.0	0.0	0.0
Temporary (short-term contract) / part-time	0.00	0.0	0.00	0.0	0.0
Other	0.00	0.00	0.00	100.00	0.0

Table 62: Further Training Recommendations for the University Staff

Type of staff:	Would you recommend further training for the staff?			
	Highly recommend	Recommend	Indifferent	Not recommend
	%	%	%	%
Regular (long-term contracted / permanent)	0.0	0.0	0.0	0.0
Temporary (short-term contract) / part-time	0.0	0.0	0.0	0.0
Other	0.0	50.0	50.0	0.0

Table 263: Type of Training Recommended for the University Staff

Type of staff:	Type of further training recommend for the staff				
	core / course technical competencies	Hands-on skills equipment / machine	Curriculum development	IT, communication & interpersonal skills	Other
Regular (long-term contracted / permanent)	0.0	0.0	0.0	0.0	0.0
Temporary (short-term contract) / part-time	0.0	0.0	0.0	0.0	0.0
Other	0.0	0.0	100	0.0	0.0

Research Institute

Unlike the university, the research institute had both regular and temporary staff (Table 63). The average age of the regular staff was 47; 20% of them were female. The average age of temporary staff was 65; all of them were men. The total teaching years for the regular was 15; for temporary staff, it was 37. Staff of the research institute could teach at postgraduate level as well as bachelors and diploma level (Table 64).

Table 64: Characteristics of the Research Institute's Teaching Staff

Type of staff	Characteristics of the teaching/instructing staff			
	Ave. Age	Gender (% female)	Years of teaching / instructing in current institute	Total years of teaching / instructing
Regular (long-term contracted / permanent)	47	20	15	15
Temporary (short-term contract) / part-time	65	0	37	37
Other		0	0	0

Table 65 shows that 70% of the regular researchers were teaching at PhD and higher diploma levels and 60% at master's and bachelor's levels. Moreover, while 20% the temporary staff were for PhD and bachelor's levels and 30% to 50% of them were for master's and higher diploma levels respectively. Table 26 shows that 30% and 40% of the regular and temporary staff respectively recommended further training. Curriculum development was suggested by 60% of regular and 100% of temporary staff. Moreover, 30% of regular staff suggested technical competencies, 40% were for hands-on skills equipment or machine, while 60% suggested IT, communication and interpersonal skills.

Table 65: Education Level of the Research Institute's Teaching Staff

Type of staff	Highest level of education				
	University post graduate (PhD)	University post graduate (Master or equiv.)	University graduate (bachelors or equiv.)	Technical training (higher diploma or equiv.)	Other
	%	%	%	%	%
Regular (long-term contracted / permanent)	70.0	60.0	60.0	70.0	0.0
Temporary (short-term contract) / part-time	20.0	30.0	20.0	50.0	10.0
Other	0.0	0.0	0.0	0.0	0.0

Table 66: Further Training Recommendations for the Research Institute Staff

Type of staff:	Would you recommend further training for the staff?			
	Highly recommend	Recommend	Indifferent	Not recommend
	%	%	%	%
Regular (long-term contracted / permanent)	30.0	40.0	0.0	0.0
Temporary (short-term contract) / part-time	30.0	40.0	30.0	0.0
Other	0.0	0.0	0.0	0.0

Table 67: Type of Further Training Recommended for Research Institute Staff

	Type of further training recommend for the staff				
Type of staff:	core / course technical competencies	Hands-on skills equipment / machine	Curriculum development	IT, communication & interpersonal skills	Other
Regular (long-term contracted / permanent)	30.0	40.0	60.0	60.0	0.0
Temporary (short-term contract) / part-time	0.0	0.0	100.0	0.0	30.0
Other	0.0	0.0	0.0	0.0	0.0

Mid-Level School

All the mid-level school staff were regular (Table 67), with an average age of 48 years; and they were all male. The average year of teaching in the institute was 10 years, and a total of 14 years of teaching experience. Most of these types of institutions were public, with 100% of them teaching at higher diploma level.

Table 68: Characteristics of the Mid-Level School Teaching Staff

Type of staff	Characteristics of the teaching/instructing staff			
	Ave. Age	Gender (%female)	Years of teaching / instructing in current institute	Total years of teaching / instructing
Regular (long-term contracted / permanent)	47.50	0.00	9.50	13.75
Temporary (short-term contract) / part-time	0.00	0.00	0.00	0.00
Other	0.00	0.00	0.00	0.00

Mid-level schools did not teach agricultural mechanization at higher level; they stopped at technical training level (diploma). Table 69 shows that all the mechanization staff were recommended for further training in the areas of technical course competencies, hands-on skills equipment or machines, curriculum development, and interpersonal skills development.

Table 69: Education Level of Mid-Level School Teaching Staff

Type of staff	Highest level of education				
	University post graduate (PhD)	University post graduate (Master or equiv.)	University graduate (bachelors or equiv.)	Technical training (higher diploma or equiv.)	Other
	%	%	%	%	%
Regular (long-term contracted / permanent)	0.0	0.0	0.0	100.0	0.0
Temporary (short-term contract) / part-time	0.0	0.0	0.0	0.0	0.0
Other	0.0	0.0	0.0	0.0	0.0

Table 70: Further Training Recommendations for the Mid-Level School Staff

Type of staff:	Would you recommend further training for the staff?			
	Highly recommend	Recommend	Indifferent	Not recommend
	%	%	%	%
Regular (long-term contracted / permanent)	100.0	0.0	0.0	0.0
Temporary (short-term contract) / part-time	0.0	0.0	0.0	0.0
Other	0.0	0.0	0.0	0.0

Table 71: Further Training Recommendations for the Mid-Level School Staff

Type of staff:	Type of further training recommend for the staff				
	core / course technical competencies	Hands-on skills equipment / machine	Curriculum development	IT, communication & interpersonal skills	Other
Regular (long-term contracted / permanent)	25.0	25.0	25.0	25.0	0.0
Temporary (short-term contract) / part-time	0.0	0.0	0.0	0.0	0.0
Other	0.0	0.0	0.0	0.0	0.0

TVET

Among the different types of institutions, only TVET had regular, temporary and other staff (Table 71). Also, staff of TVET formed more than half of the survey sample. The average age of TVET temporary staff was 48 years, while that for regular staff was 40 years. There was, however, no female among staff of TVET.

Table 72: Characteristics of TVET Teaching Staff

Type of staff	Characteristics of the teaching/instructing staff			
	Ave. Age	Gender (%female)	Years of teaching / instructing in current institute	Total years of teaching / instructing
Regular (long-term contracted / permanent)	40	0.0	7.0	16.0
Temporary (short-term contract) / part-time	48	0.0	5.0	13.0
Other	35.5	0.0	5.0	6.5

The average year of teaching in the current institute was 7 for regular staff and at least 5 for temporary and other staff. The total years of teaching varied from 16 for the regular staff, 13 for temporary staff and 6.5 for other staff. The data in Table 72 show that regular and temporary staff taught at four levels of education, while other staff taught at the bachelor's and higher diploma levels.

Table73: Education Level of TVET Teaching Staff

Type of staff	Highest level of education				
	University post graduate (PhD)	University post graduate (Master or equiv.)	University graduate (bachelors or equiv.)	Technical training (higher diploma or equiv.)	Other
	%	%	%	%	%
Regular (long-term contracted / permanent)	6.38	2.13	0.00	36.17	0.00
Temporary (short-term contract) / part-time	10.64	4.25	8.51	21.28	0 .00
Other	0.00	0.00	4.25	2.13	0.00

The data in Table 74 show that more than 46% of all the staff were highly recommended for further training, while 23% of regular and temporary staff only were recommended. This means that 79% of the staff of TVET institutions were in support of further training. The recommended further trainings were in areas of technical course competencies, hands-on skills equipment or machine, curriculum development and interpersonal skills development.

Table 77: Further Training Recommendation for TVET Institution Staff

Type of staff:	Would you recommend further training for the staff?			
	Highly recommend	Recommend	Indifferent	Not recommend
	%	%	%	%
Regular (long-term contracted / permanent)	23.33	3.33	3.33	0.00
Temporary (short-term contract) / part-time	20.00	20.00	13.33	16.66
Other	3.33	0.00	0.00	3.33

Table75: Further Training Recommendations for Mid-Level School Staff

Type of staff:	Type of further training recommends for the staff				
	core / course technical competencies	Hands-on skills equipment / machine	Curriculum development	IT, communication & interpersonal skills	Other
Regular (long-term contracted / permanent)	9.09	18.18	9.09	9.09	0.00
Temporary (short-term contract) / part-time	9.09	27.27	4.54	4.54	13.64
Other	0.00	4.54	0.00	0.00	4.54

Program Content, Admission and Delivery (regular courses)

University

Table 76 shows that the mechanization program offered by the public university was compulsory, with an average number of 30 students. Forty (40) lecturers were available in the University for teaching the 15 unit courses that made up the program. About 91% of the students had completed the mechanization program; only 4 students dropped out of the program because they found it difficult. The University had both theories and practical skills; but the proportion of the hands-on course was 25%. Discussion with a respondent showed that the institution had an assembly workshop hall; but which lacked of the necessary materials and equipment. The estimated time of completing the mechanization program in the University was 10 months; and the course was 100% adequate in training graduates with the required knowledge and skills.

Table 76: Nature of the courses offer by the University

	Unit	Public	Private	Difference
Nature of the courses				
Compulsory (core)	%	100.0	0.0	0.0
Optional (selective)	%	0.0	0.0	0.0
Total number of students signed for the course	number	28.6	0.0	0,0
Total number of lecturers who can teach this course	number	3.0	0.0	0,0
Number of students that completed (last academic year)	number	26.0	0.0	0.0
Number of those that dropped–out of the course in the last graduating group	number	4.0	0.0	0.0
Reasons for dropping out:				
Lack of fees	%	0.0	0.0	0.0
Lack of interest	%	0.0	0.0	0.0
Program difficult	%	100.0	0.0	0.0
Program irrelevant	%	0.0	0.0	0.0
Proportion of the course that is hands-on (%)	%	25.0	0.0	0.0
time it takes to complete (months)	number	10.0	0.0	0.0
Adequacy of this course in terms of its ability to produce graduates with the required knowledge and skills?				
Excessive	%	0.0	0.0	0.0
Adequate	%	100.0	0.0	0.0
Inadequate	%	0.0	0.0	0.0

Research Institute

The research institute offered only short training course in agricultural mechanization for various professionals. Table 76 shows that the institute was a public one and had no student as

at the time of the survey. It took one week to complete short training course, with 65% of hands-on skills development.

Table 77: Nature of the course offered by Research Institute

	Unit	Public	Private	Difference
Nature of the course				
Compulsory (core)	%	100.0	-	-
Optional (selective)	%	0.0	-	-
Total number of students signed for the course	number	0.0	-	-
Total number of lecturers who can teach this course	number	0.0	-	-
Number of students that completed (last academic year)	number	0.0	-	-
Number of those that dropped–out of the course in the last graduating group	number	0.0	-	-
Reasons for dropping out:				
Lack of fees	%	-	-	-
Lack of interest	%	-	-	-
Program difficult	%	-	-	-
Program irrelevant	%	-	-	-
Proportion of the course that is hands-on (%)	%	65	-	-
time it takes to complete (weeks)	number	1	-	-
Adequacy of this course in terms of its ability to produce graduates with the required knowledge and skills?				
Excessive	%	-	-	-
Adequate	%	-	-	-
Inadequate	%	-	-	-

Mid-Level School

The course in the mid-level school was quite different from the University and research institute. In public and private mid-level schools, all unit courses were compulsory. The public school sampled gave information on students; it enrolled 498 students and had 4 lecturers, who taught 11 courses on agricultural mechanization. These data were cumulative for 2018 and 2019.

Table 78: Courses offered by Mid-Level School

	Unit	Public	Private	Difference
Nature of the course				
Compulsory (core)	%	100.0	100.0	-
Optional (selective)	%	-	-	-
Total number of students signed for the course	number	498	-	-
Total number of lecturers who can teach this course	number	4	-	-
Number of students that completed (last academic year)	number	51	-	-
Number of those that dropped–out of the course in the last graduating group	number	49	-	-
Reasons for dropping out:				

Lack of fees	%			-
Lack of interest	%	100	-	-
Program difficult	%			-
Program irrelevant	%			-
Proportion of the course that is hands-on (%)	%	51.6	32.4	-
time it takes to complete (days)	number	8.3	3.5	-
Adequacy of this course in terms of its ability to produce graduates with the required knowledge and skills?				
Excessive	%	0.0	9.0	-
Adequate	%	100.0	91.0	-
Inadequate	%	0.0	0.0	-

The data in Table 78 reveal that only 10% of the students graduated the previous year and almost 10% others abandoned the course for lack of interest. The hands-on skills proportion for the course was 52% for public mid-level school and 32% for the private one. The time of completing the course was 3.5 days or 8.3 days respectively for private or public school. It is important to note that this period was appreciably short. Perhaps, the data provided were only for a particular mechanization unit course. In general, this type of mechanization course was taught for 2 hours every week for 9 months per academic year, which is a total of 72 hours per year. The knowledge and skills acquired therefrom by students are 100% and 91% adequate respectively for public and private institutions.

TVET

Agricultural mechanization course is 100% and 85% compulsory in public and private TVETs respectively; for the private TVET, general agriculture, horticulture, livestock and agricultural product represent 15% of the courses, and these are optional. The total number of students registered for the course was 214 and 119 respectively for public and private TVET. The teachers who taught agricultural mechanization were 3 and 4, respectively; this number excluded teachers of other courses.

Table 79: Nature of courses offered by TVET institutions

	Unit	Public	Private	Difference
Nature of the course				
Compulsory (core)	%	100.0	85.0	-
Optional (selective)	%	0.0	15.0	-
Total number of students signed for the course	number	214.0	119.0	-
Total number of lecturers who can teach this course	number	3.0	4.0	-
Number of students that completed (last academic year)	number	214.0	69.0	-
Number of those that dropped–out of the course in the last graduating	number	0	13.75	-

group				
Reasons for dropping out:				
Lack of fees	%	-	66.7	-
Lack of interest	%	-	-	-
Program difficult	%	-	33.33	-
Program irrelevant	%	-	-	-
Proportion of the course that is hands-on (%)	%	60	50	-
time it takes to complete (months)	number	1.0	5.0	-
Adequacy of this course in terms of its ability to produce graduates with the required knowledge and skills?				
Excessive	%	0.0	18.2	-
Adequate	%	100	77.3	-
Inadequate	%	0.0	4.5	-

All the registered students completed the program in public TVET; while 69 of 119 students completed for private TVET, with about 14 students dropping out. The reasons students dropped out were: lack of fee (68%) and program difficult (33%). The hands-on or practical skills were important for public (60%) and private (50%) TVET. On the other hand, the time it took to complete the training varied, from 1 month for public TVET to 5 months for private TVET. The results show that most of the courses were adequate in terms of knowledge and skills requirement, from 77% for private to 100% for public. However, 18% of the courses was excessive in knowledge and skills; perhaps this indicates an error in the data provided by the institution and may, thus need further analsysis for better accuracy in private TVET.

Resources and finances

Budgets of all types of institutions were grouped into private and public for the purpose of comparison. Table 80 shows the significant difference at 5% between the 2018 budget and at 1% that of 2014 to 2017 cumulative budget for public and private institutions. This difference was due to government supports for public institutions. In the past, private institutions also received some levelo of financial support from the government; such support was discontinued a few years before the survey.

Table 80: Budget for Public and Private institutions

Category 1: Universities	**Public**	**Private**	**Statistical difference**
Total budget in 2018	71 250 000	22 009 417	0.006
Ave. Annual average total budget in 2014-2017:	184 501 417	20 590 865	0.000
Annual total budget for agricultural mechanization department/program in 2018	5 233 333	7 199 800	0.993

Annual average total budget for agricultural mechanization department/program in 2014-2017:	6 737 500	6 322 672	0.872
Sources of institute's finances (%)			
Government grants	-		-
Student fees/levies	33.7	61	0.416
Bank loans	37.5	35.33	0.195
Third-party funds (e.g. donors)	4.5	5.0	-
Own-sources (e.g. business)	7.0	19.5	0.385
Other	0.0	10	-
Agricultural mechanization program only			
Proportion of students (%) financing (paying fees) their studies by:			
Government grants	0.0	76.83	0.228
Other scholar-ships	0.0	0.00	-
Other	0.0	33.75	0.118

The data in showed no significant difference between the allocated budgets to the agricultural mechanization programs in public and private institutions. However, the amount allocated to private institutions on agricultural mechanization was greater than that to public institutions. The sources of the public and private institutions 'finance were mainly student fees and bank loans. For the private institutions, 61% of the budget was from student fees, while bank loans represented 37.5% of public institutions 'finance. Moreover, about 77% of the students in private institutions were on government grants.

The data in Table 81 show that most of the institutions had adequate resources, such as physical infrastructure, tools, equipment, machinery, textbooks, etc. This summarized categorization of resources, however, hid the inadequacies of and disparities in infrastructures, tools and equipment, with regard to equipping students with required knowledge and skills.

Table81: Status of the resources

	Ranking of current status of the resources			
Type of resource:	Excessive	Adequate	Inadequate	Very inadequate
Physical infrastructure (e.g. classes, workshops)	11.10	72.20	11.10	5.60
Tools, equipment, machinery	5.30	52.60	21.10	21.10
Textbooks, print media	5.30	73.70	15.80	5.30
Audio-visual	6.30	56.30	31.30	6.30
Other	0.00	33.30	66.70	0.00

Linkages with other stakeholders (private sector, companies / organizations, NGOs)

Table 82 shows that only the link with the private sector was quite important in terms of number of years, perhaps due to the appreciable number of private institutions in the survey sample. Financial assistance was mainly done by development services (18.0%) and NGOs

(9.5%). The main linkage was student training, as many of the institutions collaborated with several stakeholders on training. Student financial support, internship and training were also important for stakeholders like research institutes, universities, NGOs and the private sector. The nature of collaboration between research institutes and universities was mainly student training and internship with financial support. But for NGOs, private sector and development services, the collaboration was on financial assistance and student training.

Table82: Stakeholders Linkages

	Ave. number of years of collaboration	Financial assistance	Providing students for training	providing attachment / internships	Employment of students	Providing students for training and internship	Both providing Financial assistance and students for training	Financial assistance, internship and students training
	number	%	%	%	%	%	%	%
Research institute	6,0	0.0	50.0	0.0	0.0	50.0	0.0	0.0
University	3,3	0.0	33.3	0.0	0.0	0.0	33.3	0.0
NGO	4,2	9.5	19.0	33.3	0.0	9.5	4.8	23.8
Development Services	5,7	18.2	27.3	18.2	0.0	18.2	9.1	0.0
Private sector	30,0	0.0	80.0	0.0	0.0	0.0	0.0	20.0

The data in Table 83 reveal that all the institutions received suggestions from their stakeholders to improve curriculum contents, methods of course delivering, or other areas. These were also considered by almost all the institutions sampled.

Table 83: Stakeholders' Suggestions

Category of stakeholders		Ever made suggestions on concerning study curriculum, delivery methods etc. (%)	Nature of Suggestion made			Considered their suggestions (%)	
			Curriculum contents	Course delivery	Other		
Research institute	Yes	50,0	0.0	100.0	0.0	Yes	100.0
	No	50,0				No	0.0
University	Yes	100,0	33,3	33,3	33,3	Yes	100.0
	No	0.0				No	0.0
NGOs	Yes	80,0	43,8	50,0	6,3	Yes	88.2
	No	20.0				No	11.8
Development services	Yes	81,8	50,0	25,0	12,5	Yes	88.9
	No	18,2				No	11.1
private sector	Yes	100,0	100.0	0.0	0.0	Yes	75.0
	No	0.0				No	25.0

Discussion

Although agricultural mechanization program was taught in many schools and universities within the country, only a few of them provided a diploma in agricultural mechanization. Among the sampled schools, several had not practical courses; and machines were not sufficient for students. The enrolment of female students was higher in public than private schools. Private schools had insufficient space and equipment/ infrastructure, compared to public schools.

Effects of agricultural mechanization on rural communities

Sampling, data collection and study sites

With regard to the sample used for the subsidized tractor survey in each cercle, a number of communes were selected based on private and subsidized tractor owners' availability. In each commune, 3 focus group discussions were conducted: (i) with tractor owners, (ii) users of tractor services and (iii) women. The total number of focus group discussions held was 78 (Table 84).

Table 84: Data on the study sample

Region	Tractors	Cercle	Number of communes surveyed	Number of Focus group by commune	Total of focus group discussions
KOULIKORO	214	KATI	3	3	9
		DIOILA	2	3	6
		KOLOKANI	2	3	6
Sub-total			7		21
SEGOU	70	SEGOU	3	3	9
		BLA	2	3	6
		NIONO	2	3	6
Sub-total			7		21
SIKASSO	526	SIKASSO	4	3	12
		KOUTIALA	5	3	15
		BOUGOUNI	3	3	9
Sub-total			12		36
TOTAL	810		26		78

The number of tractor owners was small in each commune; hence, they were grouped with drivers and mechanics to achieve at least 6 persons for a focus group discussion. Respondents for 2 other groups were those who volunteered to participate in the discussion. The number in each group varied between 10 and 12. Women were chosen among their associations (usually

group leaders) where there were several groups in a village; but where there was only one group, members were used as participants.

Results

Synthesis of change trees of tractor service demanders

Advantages : -Quick crop installation for the cropping season ; -Reduction of farm work drudgery; -Increase in arable land; - Reduced time for land preparation		**Disadvantages** : -Land cleared -Destroy the soil in Sahelian zones; -Cost of service very high for poor farmers;

Synthesis of change trees of tractor owners

Advantages: - Source of income; - Improvement of social relations; - Improvement of social status of the owner in the community; - Timely execution off-farm works.		**Disadvantages**: - Frequent breakdowns ; - High fixing cost; - Difficulties in following-up the machine; - Use of unskilled drivers; - Lack of specialized mechanics

Synthesis of change trees of women

Advantages : - Timely land preparation; - Reduction of farm drudgery; - Yield and income increase		**Disadvantages**: - High service cost and queuing for service; - Increased unemployment of youth; - Migration of the youth to urban areas

Table 85: Summary of positive impact of agricultural mechanization

Impacts	Percent of male groups identifying this impact	Percent of female groups identifying this impact	Quotes from the interviews that illustrate the perceptions of the community members
Agronomic			
Yield increase	75	90	Yield increase due to timely land preparation; water conservation in the soil and better plant rooting
Timely farm work	100	100	The tractor is able to plow large areas in a reduced time; which favor farmers and allow them to respect the crop calendar
Increased land area to farm	85	15	Because oft he tractor many farmers have increased their farming land; they couldn't before because of the labor demand and time required
Socio-economic			

Reduction of drudgery of farm work	100	100	Work was done by hand and it requires many labourers and time; with the tractor 'we don't have to spend several days for a work' it is done in some hours, living us time to do something else
Increased volume of crop sales	80	95	'many farmers have land that they can't farm, it is let as fallow'; with the tractor the land is farmed and produces volumes of crops beyond the consumption capacity of the household. The extra is sold
Increased of off-farm income	55	10	With the tractor the owner do transportation; threshing of crops like millet or sorghum; cut fire wood for selling. All these activities are off farm work which bring cash in the household.

Table 86: Summarized negative impact of agricultural mechanization

Impacts	Percent of male groups identifying this impact	Percent of female groups identifying this impact	Quotes from the interviews that illustrate the perceptions of the community members
Agronomic			
Degradation of natural resources (intensive tillage)	100	40	With tractor plowing there is a need of fertilizing the soil and many farmers don't have the capacity to put organic or mineral fertilizer in sufficient quantity in their fields. The deep tillage degrades soil quality and destroys the micro-organs. In the long run the land is degraded
Reduced tree density in the farm (biodiversity)	100	30	Tractor plowing requires land without obstacles; therefore trees are destroyed to enable the tractor to work confortably. This exposes the land and reduces the bio-diversification.
Reduced field	50	0	Many development actions

development (canal, diking)			take place in the field for water conservation, soil conservation, etc. the use of tractor will destroy all buildings in the field.
Socio-economic			
High maintenance cost	50	0	Spaire parts are very expensive on the market and when you order them from abroad it takes long time before they get to you. The mechanics are also not good for the tractor maintenance; owners spend huge money without getting satisfaction.
Increased farm unemployment	65	70	Before tractor, labourers were hired to do farm work; but with the tractor many labourers remain unemployed and move to urban areas.
Use of unskilled workers	75	20	Tractor drivers are not skilled, with no certificate or any kind of qualitification diploma. Because oft he lack of skill, drivers destroy the tractor and cause expenses tot he owner.

Results

In many areas of the Mali, the main constraint to improving crop production was not the lack of access to better seed quality, irrigation water/ equipment or fertilizers, but inadequate labor and equipment to make the best use of existing resources (FAO, 2013). The efficient selection, usage, and management of farm power resources are crucial factors in the agricultural production process. Additional farm power, or an increase in its efficiency, is in many cases required to eliminate labor shortage, especially in multiple cropping systems or areas of low or erratic rainfall (FAO, 2013). Consequently, increased output helps augment the total demand for labor in crop husbandry, harvesting and post-harvest-related work.

In Mali there are about 43.7 million hectares of arable land, but only 6% of this potential is farmed (FAO, 1994). One of the main reasons for this underutilization is the lack of power to till the land. For tractor owners, large increases in farm equipment, development and infrastructures are required to bring a significant area of this unused potential into production. Furthermore, increases in production require better post-harvest techniques and technologies (for example, for storage, drying and processing), particularly for multiple cropping systems and cash crop farming. Similarly, improved rural infrastructures are needed to properly store harvested crops.

The shortage of farm power has been identified by all groups as one of the major bottlenecks in increasing production, as it directly affects the areas cultivated and the timeliness of planting. Many farmers have to pay in advance increased fees for the tractor driver to accept to plow their farms. In some cases, there is a long queue; most time, the driver requires enough area (the daily capacity of the tractor) before accepting to service a farm or group of farms. Women with small and scattered plots often suffer the most with regard to tractor services. They face several constraints, such as small farm plots, poor soils and inadequate finance.

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