Insight into Agricultural Mechanization in Cameroon: Case of Farm Operators, Users of Agricultural Equipment and Machines

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Abstract— *Cameroon has an economy strongly dominated by the agricultural sector and despite this domination as well as the fact that this sector is backed by several policy documents and statements, investments in the sector is still grossly underdeveloped. Many farm operators in the different agro ecological environment still rely to an overwhelming extend on the use animate power to achieve their agricultural production goals. This power source and the tools used have implicit limitation in terms of energy and operational output. Cameroon government persistently carry out some initiative to inverse the tendency such as the providing modern agricultural equipment and machinery to farm operators, training complex farm machinery users. However, these solutions are not part of a common though and so far have produced mixed results without a significant improvement on the field. This paper permits to appreciate the challenges faced by users of farm technology in agricultural mechanization via four main crops of significant importance to Cameroon: Maize, Cassava, Sorghum and Cocoa.*

Among others, it was observed that 75% of farmers involved in cultivation of sorghum, maize, cassava have land surfaces less than 2%. These small farm sizes are a serious handicap to the effective mechanization due to sparse and scattered cultivated lands. Also, only 13% (112) of farm operators have access to credit from micro finance institutions. This low access to credit contributes to the reluctance of farm operators to invest in agricultural machinery acquisition with only 3% owing a land with a land title.

Keywords— Adoption, Challenges, Farm operators, Insight, Mechanization.

I. INTRODUCTION

Cameroon by its sociocultural diversity is a gift of nature, more so, in terms of agriculture and agronomy. It is characterized by a very dynamic population, a profusion of variety of crops that all do well throughout their respective agro-ecological zones, diverse climatic patterns suitable for various agricultural practices, just to name a few.

Agriculture (farming) is an activity carried out by a vast majority of Cameroonians (70%) with some enrolled in it as their main activity and others carrying it out as a secondary activity. Those that practice it as a main activity are organized as individuals or constituted in groups or associations with a common interest such as Common Initiative Groups, Cooperatives, etc. ([1] [2]).

However, animate power (human muscles or draft animals) constitute the main technology used to attain most of the agricultural objectives set by farm operators. Meanwhile mechanical power (internal combustion engines and/or electric motors) is still reluctant to dominate the agricultural field in Africa in general and in Cameroon in particular [3]. Agricultural mechanization is not an end in itself but a means that can help to bridge the gap that separates developed countries from agricultural developing countries sharing similar challenges like Cameroon [4].

According to [5], "Mechanization of agriculture and farming process connotes application of machine power to work on land, usually performed by bullocks, horses and other draught animals or by human labor." This definition goes in straight line with [6], as ''it chiefly consists in either replacing, or assisting or doing away with both the animal and human labor in farming by mechanical power wherever possible".

However, to make it more complete, the term agricultural mechanization equally embraces the manufacture, distribution and operation of all types of tools, implements, machines and equipment for agricultural land development and farm production as well as for harvesting and primary processing of agricultural produce [7].

Agricultural Mechanization is as such well placed to address most of the fundamental farming challenges in Cameroon in a profound manner. Indeed, agricultural Mechanization "removes the drudgery associated with agricultural labor, overcomes

time and labor bottlenecks to perform tasks within optimum time windows and can influence the environmental footprint of agriculture leading to sustainable outcomes ([8] [9]).

The African Union Commission (AUC) and the Food and Agriculture Organization of the United Nations (FAO) view agricultural mechanization in Africa as an urgent matter and an indispensable pillar for attaining the Zero Hunger vision by 2025, as stated in the Malabo Declaration of 2014, Goal 2 of the Sustainable Development Goals, and the Prosperous Africa We Want, as indicated in Agenda 2063. Doubling agricultural productivity and eliminating hunger and malnutrition in Africa by 2025 will be no more than a mirage unless mechanization is accorded utmost importance.

However, the results of the current levels of commitment by various actors in Cameroon in order to promote agricultural mechanization still remain comparatively low. In fact, notwithstanding its fundamental importance and potentially beneficial role, Agricultural Mechanization is the neglected waif of agricultural and rural development in Cameroon ([7] [10]).

Increased agricultural production and improved rural livelihoods cannot be achieved without the adoption and use of increased levels of farm power and mechanization. However, agricultural mechanization is not quite as straightforward an input as fertilizer or seed; in order for farmers to have access to farm tools, machinery and equipment, there needs to be in place a whole complex system of manufacture, importation, retail outlets, support, provision of spare parts - the so-called supply chain - as well as the availability of advice and guidance for farmers (([11] [12]).

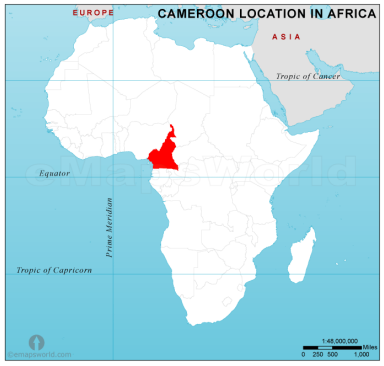
The purpose of this paper is to assess the situation of agricultural mechanization in Cameroon with a particular focus on the type of tools used currently by farm operators, the level of mechanization with regard to the importance of the power source and the various challenges that comfort the low adoption of agricultural mechanization.

II. METHODOLOGY

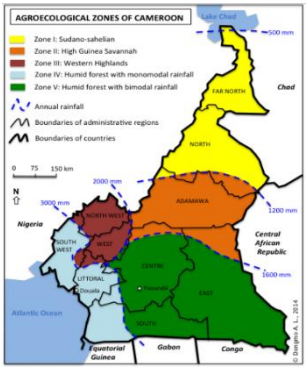
2.1 Description of the study area

Cameroon is a country located in Central Africa (Fig 1) with a total land area of 475,440 km2 and a population of about 24 million inhabitants [13]. It is bordered by Nigeria to the West, Chad to the Northeast, the Central African Republic to the East and Equatorial Guinea, Gabon, and the Republic of Congo to the South. Cameroon's coastline lies on the Bight of Bonny, which is part of the Gulf of Guinea and the Atlantic Ocean. Cameroon is sometimes described as "Africa in miniature," because it exhibits all the major climates and vegetation of the continent: mountains, desert, rain forest, savannah grassland, and ocean coastland. Cameroon can be divided into five agroecological zones (TABLE 1) distinguishable by dominant physical, climatic, and vegetative features. The climate varies with terrain, from tropical along the coast, to semi-arid and hot in the north. The coastal belt is hot and humid; it includes some of the wettest places on earth, such as Debundscha, located at the base of Mount Cameroon, which has an average annual rainfall of about 10,287 mm.

(a) Location of Africa in the world



(a) Location of Cameroon in Africa



(c) Agro-ecological zones and administrative regions of Cameroon

FIGURE 1: Presentation of Cameroon

Agriculture is the backbone of Cameroon's economy, employing 70% of its workforce and providing 44% of its gross domestic product and 30% of its export revenue. Cameroon produces several agricultural commodities for export and domestic consumption [14]. The most important of these, which vary by agroecological zone (TABLE 1), are cocoa, coffee, cotton, banana, rubber, palm oil, sugarcane, tobacco, tea, pineapple and peanuts for cash crops, and plantains, cassava, corn, millet, sorghum, yams, potatoes, sweet potatoes, dry beans, and rice for food crops. Animal husbandry is practiced throughout the country and is particularly important in the sahelian part of Cameroon.

TABLE 1
CHARACTERISTICS OF THE AGROECOLOGICAL ZONES

Agroecological zones	Surface Area (km^2)	Main crop and animal used for farm work
Sudano-Sahelian	100 353	Maize, millet-sorghum, rice, cowpea, soybean, onion, sesame, cotton, cattle, horses, donkeys
High Guinea Savanna	123 077	Maize, millet-sorghum, yam, cassava, sweet potatoes, rice, cotton, cattle, horses
Western Highlands	31 192	Maize, cocoa, beans, sweet potatoes, rice, Irish potatoes, ground-nuts, tomatoes, okra, sweet pepper, avocados, green vegetables, coffee, cassava, water melon
Mono-modal Humid Forest	45 658	Maize, banana, plantain, cassava, pepper, sweet potatoes, groundnuts, egousi, yam, vegetables, cocoa, coffee, oil palm, rubber
Bimodal Humid Forest	165 770	Maize, plantain, cassava, banana, cocoyam, cocoa, oil palm, rubber, coffee, maize, cocoa, oil palm, pineapples,

The study used both qualitative and quantitative methods in collecting and analyzing data. Quantitative methods formed the backdrop of the research while the qualitative data provided a detailed explanation of the findings.

2.2 Secondary data collection

This study started by a deep literature review of the records found within the Ministry of Agriculture and Rural Development (MINADER) which is the main institutional stakeholder that organizes, supports and accompany in various aspect other actors involved in agricultural mechanization such as farmer operators who are users of agricultural equipment and machinery, local agricultural equipment and machinery manufacturers, agricultural machinery suppliers, etc. Specifically, the secondary data were collected from projects and programs (under MINADER) that host the crops that were targeted for this study. However, documents from other ministerial departments with related competencies were scrutinized.

This permitted to identify all the stakeholders involved in the four (04) crops (maize, cocoa, cassava, sorghum) under investigation in agricultural mechanization as well as the role they play in this field but most importantly, it permitted to collect and appreciate data on previous level of mechanization of farm operators.

2.3 Primary data collection: sampling and target crops

Primary data collection was done through administration of questionnaire, interview and field observations. The questionnaire which was designed taking into consideration the various elements identified in the previous phase (literature review) as well as the specificities of the areas under investigation.

Four (04) crops were identified to assess the issues of agricultural mechanization in Cameroon (TABLE 2). These crops are very important for income generation and food security for the country but more precisely, maize was chosen because it is the most important (production and consumption) cereal crop in Cameroon, grown predominantly by smallholder farmers in the five agro-ecological zones of the country (TABLE 1). Cassava is one of the most important root crops in Cameroon. Cocoa is the main export commodities. Sorghum is the most important cereal grown in the northern Cameroon.

Their corresponding regions which were targeted for this study are among the main production basins of these crops.

TABLE 2
PRESENTATION OF CROPS AND REGIONS UNDER INVESTIGATION

Surveyed Region	Crop
West	Maize
Centre	Cocoa
South	Cassava
Far North	Sorghum

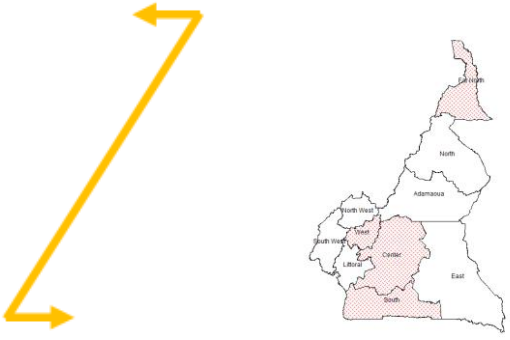


FIGURE 2: Mapping of surveyed regions

As highlighted in the introduction, more than 70% of the workforce in Cameroon is localized in the agricultural area, as such the population size of farm operators is significant. In order to collect qualitative data from the population and taking into consideration the important density of farm operators in rural areas, a sample size was calculated.

Simple random sampling was used to determine the sample size for this research. Due to the difficulty to have the exact population size, the researchers used 100,000 as the population size reason being that the sample size doesn't change much for populations larger than this figure.

$$Sample\ size, n = N * \frac{\frac{Z^2 * p * (1-p)}{e^2}}{[N-1+\frac{Z^2 * p\,(1-p)}{e^2}]} \quad (1)$$

Proposed by [15]

Where N = Population size; Z = Critical value of the normal distribution at the required confidence level (95%=1.96); p = Sample proportion (0.5); e = Margin of error (3%)

In order to increase the probability of collecting the maximum information, the responds rate was estimated at 90% to add on the total sample size a potential 10%. The data obtained from the survey research was compiled in an excel sheet and necessary filtration process was applied for further analysis.

III. RESULTS AND DISCUSSION

3.1 Sample size

In the four (04) regions surveyed, 865 questionnaires were filled among rural households from 186 subdivisions redistributed as presented on TABLE 3.

TABLE 3
SAMPLE SIZE PER REGION PER CROP UNDER INVESTIGATION

Region	Crop	Number of farm operators investigated
West	Maize	312
Centre	Cocoa	201
South	Cassava	108
Far North	Sorghum	244
Total		865

3.2 Farm sizes

According to CENEEMA and FAO (2011), the farming system in Cameroon is characterized by small farm operators who are found in majority and are involved in fair-trade average have farm sizes less than 2 hectares. About 20 years after, the reality is still the same. Indeed, the results from this survey showed that 75% of farmers involved in cultivation of sorghum, maize, and cassava have land surfaces less than 2%. A difference was observed for cocoa farmers that have relatively larger pieces of farmland because cocoa is a perennial crop own by the middle class population. It was found out that just 10% have land sizes less than 2ha, the largest proportion of farm operators in this field have farm sizes between 5 and 10 ha as presented in Fig 3.

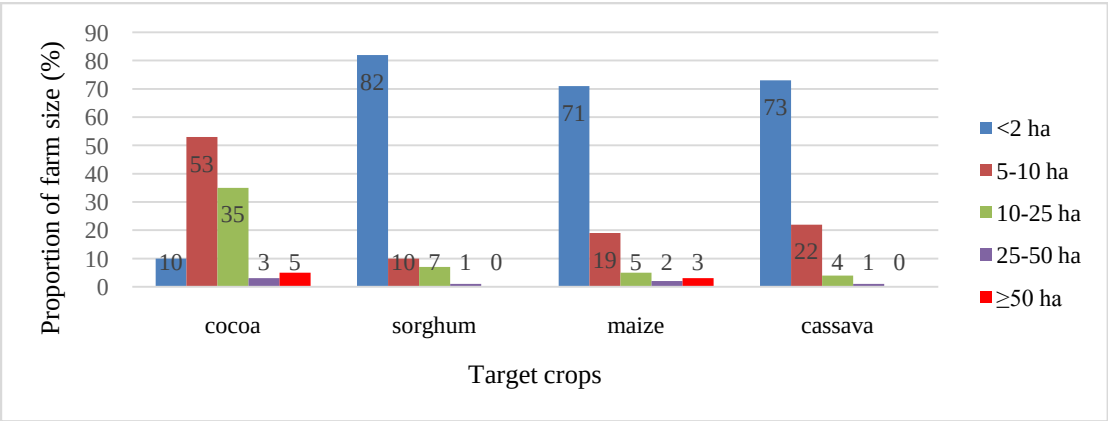


FIGURE 3: Farm sizes of farmers cultivating cocoa, sorghum, maize and cassava

These small farm sizes are a serious handicap to the effective mechanization due to sparse and scattered cultivated lands. In fact, the traditional cropping system is the legume-cereal rotation. Indeed, 80% of the farmers find it economically unsuitable to mechanize their farms regarding at the high cost of the modern agricultural equipment and machines compare to the farm output. Also, the quasi absence of specialized mechanization service providers makes it difficult for farm operations to be mechanized.

3.3 Access to credit and rural finance

The agricultural and rural sector is the driving force behind Cameroon's growth. Notwithstanding the fact that the fight against rural poverty is a national priority, its development is hampered by the limited access to financial services.

This research permitted to find out that the supply of financial services still remains very insufficient in rural areas, while the penetration rate of micro finance institutions, particularly among the poorest, especially women and young people, remains particularly low. The results of this surveyed showed that only 13% (112) of farm operators mostly constituted as farmer organization such as common initiative groups and cooperatives have access to credit from micro finance institutions. This low access to credit contributes to the reluctance of farm operators to invest in agricultural machinery acquisition.

3.4 Land tenure

In Cameroon, access to land title is a thorny issue as most farmers find it very difficult to access land titles. The study shows that 55% of farmers own their land without titles, while just 3% owns with title (Fig 4). Despite the fact that land titles can be obtained, the procedures are very lengthy and discourage several farmer operators. Also, cultural aspects such heritage makes land acquisition more complex as most families with a patriarchal background provide ownership to their descendants based on inheritance preferences. This point is worthy to highlight as most youths find themselves limited in the process of land acquisition thus, limiting farm mechanization. About 35% of farmers rents their land in order to overcome this issue of land tenure.

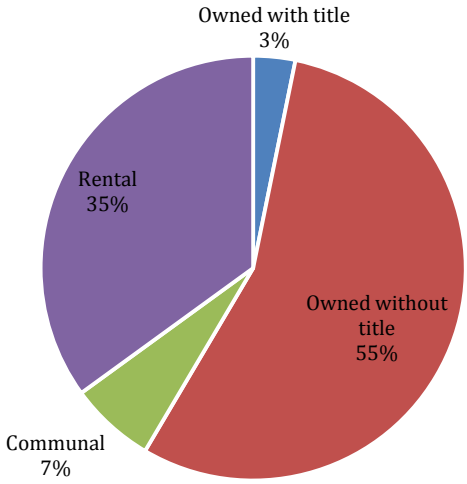


FIGURE 4: Land tenure ownership

3.5 Level of mechanization

Farm power is an essential input in agriculture for timely field operations for operating different types of farm equipment and for stationary jobs like operating irrigation equipment, threshers/shellers/cleaners/graders and other post-harvest equipment.

Despite some progress observed in the field of agricultural mechanization, this research showed that animate power is still very dominant in Cameroon. Indeed, manual tools constitute the essential tools used by farm operators regardless of the crop (under study) i.e. 89,8%. The tools used for draught animal farming are more dominant in the North Region of Cameroon than in the rest of the regions under investigation. However, they are timidly present in the West region (<1%). Motorization on the other hand, affects only 6.25% of farm operators (TABLE 4). From a global point of view, most of the modern tools used in specialized crop production can be identified on the field but their density, their frequency and quality of usage are still far from desired level.

TABLE 4
MAIN AGRICULTURAL EQUIPMENT AND MACHINES USED FOR FARM OPERATION AND POWER SOURCE

	Farm operation						
Crop	**Soil preparation**	**Planting**	**Plant control**	**Harvest**	**Transport**	**Conservation**	**Processing**
Maize	*Hoe *Cutlass *Tractor (+ plough; mower; harrow) *Rototiller (+plough) *Pair of oxen (+plough)	*Cutlass *Daba *Hoe *Tractor (+ cereal planter)	*Hand *Knapsack sprayer *Motorized sprayer *Fertilizer distributor	*Hand *Harvesters (+combine)	*Men's back *Wheelbarrow **Pousse pousse* *Tricycle *Motorcycle *Tractor (+ trolley) * Truck	*Cribs *Attic *On the ground *Biomass house dryers *Solar dryers	*Sheller *Mill
Power source	*manual (87%)*				*animal 1%*	*mechanical (12 %)*	
Cassava	*Hoe *cutlass *Tractor (+ plough;ridger; harrow)	*Cutlass *Hoe	*Knapsack sprayer *Motorized sprayer *Fertilizer distributor	*Hand *Digger *Cutlass	*Men's back *Wheelbarrow **Pousse pousse* *Tricycle *Motorcycle	*Nothing to report*	*Mill *Cassava press *Cassava graters
Power source	*manual (93%)*				*animal 0%*	*mechanical (7%)*	
Cacao	*Axe *Cutlass	*Digger *Spade *Cutlass	*Knapsack sprayer *Atomizers *Pruner	*Cutlass	*Men's back *Wheelbarrow **Pousse pousse* *Tricycle *Moto *Tractor (+ trolley)	*Au sol *Dryer	*Pod breakers
Power source	*manual (96%)*				*animal 0%*	*mechanical4%*	
Sorghum	*Hoe *Cutlass *Daba *Pair of oxen, horses or donkeys (+ plough)	*Cutlass *Daba *Hoe	*Hand *Knapsack sprayer *motorize sprayer	*Hand Knives (+Combine)	*Men's back *Wheelbarrow **Pousse pousse* *Tricycle *Motorcycle *Pair of animals with trolley	*Attic *On the ground *Storage rooms	*mill
Power source	*manual (83%)*				*animal (15%)*	*mechanical 2 %*	

Very few Cameroon farmers own, share, or rent modern agricultural machinery. In terms of density of tractors per thousand hectares, Cameroon not only lags behind the developed countries but also behind some of the developing countries of the world.

It was found out that farm operators who invested in the purchase and use of high capacity machines and equipment exploit them for three main operations:

- Ploughing
- Sowing
- Harvesting

However, more than 70% of farm operators very desire to obtain modern and appropriate machines and equipment for complementary farm operation to increase not only their total production but also the quality of the end product, such as dryers for cocoa seed, cassava processing machines, maize electric dryers, hand driven motorized cocoa harvesters, cleaning equipment for sorghum; etc.

3.6 Degree of satisfaction of farm operators

When asked if farm operators were satisfied with the performance of their equipment, 74% of respondents clearly indicated that they were not satisfied. TABLE 5 presents the redistribution of the responses per region and per targeted crop. Among

the most unsatisfied users are the farm operators from the North Region (93%), followed by the South Region (81%), Center and West Regions (68% and 61%).

TABLE 5
DEGREE OF SATISFACTION OF FARM OPERATORS

Region	Satisfied		Not Satisfied		Total	
	Number	*%*	*Number*	*%*	*Number*	*%*
Far North	17	7	227	93	244	100
Center	65	32	136	68	201	100
South	21	19	87	81	108	100
West	123	39	189	61	312	100
Total	226	26	639	74	865	100

Several reasons were given by users to justify their dissatisfaction. 51.05% cried the physical and financial inaccessibly to appropriate agricultural tools, equipment and machines; 40.95% mentioned the inadequacy of the equipment in relation to its conditions of use. Other reasons of noteworthy importance (8%) were also identified such as the absence of spare parts, the ageing of equipment, etc.

3.7 Possibilities of repair of agricultural machines and equipment

Correctly maintaining a tractor or agricultural machinery will add years to its useful life. Farm operators were asked on their possibilities to repair or have their equipment repaired. 71.35% of users of agricultural machinery and tools had the opportunity to repair them. On the other hand, 28.65% say they could not (TABLE 6). The high proportion of crude tools observed on the field, that can easily be repaired by local manufacturers could easily justify the high proportion of farm operators having access to maintenance and repair of their equipment.

TABLE 6
POSSIBILITY OF REPAIR OF AGRICULTURAL MACHINES AND EQUIPMENT

Region	Yes		No		Total	
	sample size	*proportion %*	*sample size*	*proportion %*	*sample size*	*proportion %*
Far North	169	69.3	75	30.7	**244**	100
Center	146	72.6	55	27.4	**201**	100
South	73	67.6	35	32.4	**108**	100
West	266	85.3	46	14.7	**312**	100
Total	**654**	75.6	**211**	24.4	**865**	100

3.8 Access to spare parts

Considering the simple type of equipment mainly used, spare parts do not constitute a handicap for users. As a result, 52.81% of respondents have no difficulties in finding spare parts (TABLE 7). It should also be noted that, with the exception of the Western Region, spare parts seem difficult to have for farm operators especially for modern complex tools.

TABLE 7
AVAILABILITY TO SPARE PARTS

Region	Availability to spare parts					
	Available		Not available		Total	
	sample size	*proportion %*	*sample size*	*proportion %*	*sample size*	*proportion %*
Far North	152	62.3	92	37.7	**244**	**100**
Center	84	41.8	117	58.2	**201**	**100**
South	36	33.3	72	66.7	**108**	**100**
West	183	58.7	129	41.3	**312**	**100**
Total	**455**	52.6	**410**	47.4	**865**	**100**

Most of the importer-suppliers are concentrated in two main cities (Regions) in Cameroon: Yaoundé (Center region) and Douala (Littoral region) having very few representatives in other Regions (production basins). A specific example is the case of EMEI Diesel who is the main importer supplier of agricultural machinery spare parts in Cameroon.

3.9 Possibility of training

More than 63.76% of farm operators don't have the opportunity to be trained in the use of their agricultural equipment (TABLE 8). This lack of opportunities is found in all regions of the country.

TABLE 8
POSSIBILITY OF TRAINING

Region	Opportunity		No Opportunity		Total	
	sample size	*proportion %*	*sample size*	*proportion %*	*sample size*	*proportion %*
Far North	76	31.1	168	68.9	**244**	**100**
Center	93	46.3	108	53.7	**201**	**100**
South	46	42.6	62	57.4	**108**	**100**
West	83	26.6	229	73.4	**312**	**100**
Total	**298**	34.5	**567**	65.5	**865**	**100**

However, the government shows clear willingness in assisting Cameroon Farm operators to not only adopt but equally, use modern adapted technology to become more competitive and contribute significantly to the achievement of food security (and sovereignty). Indeed, via some of the operational actors of the Ministry of Agriculture and Rural Development which are projects, the government provides training opportunities with specialized institutions on four wheel tractors driving and maintenance. This is the case of Agriculture Investment and Market Development Project (AIMDP), that has financed the training of 100 tractor drivers and mechanics from 45 farmer organizations mostly, farm cooperatives during 2019 on the best agronomic field uses and maintenance of tractors by the National Center of Studies and Experimentation in Agricultural Mechanization (CENEEMA) which is the only official institution in charge of farm operators training for various types of machinery use and maintenance.

3.10 Main challenges identified

The main challenges regarding agricultural mechanization as far as farm operators in various regions under investigation are concerned, were identified and are resume in Fig 5.

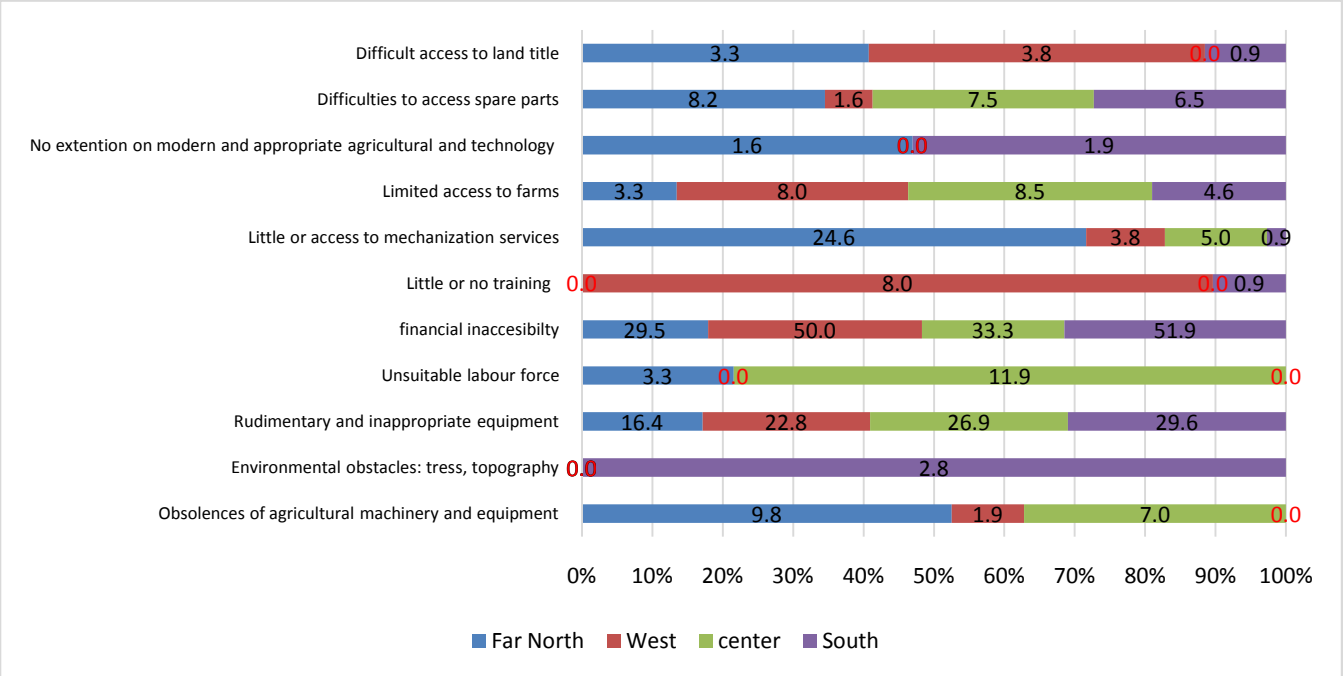


FIGURE 5: Main challenges of agricultural mechanization

The study shows clearly that the lack of institutions that finance agricultural activities is the main challenge for farmers in all the 04 regions (30% in far north; 50% in west; 33.3% in center and 51% in south). Secondly, the equipment used by farmers are inappropriate and rudimentary across the 04 regions of production (16% in far north; 23% in west; 27% in center and 30% in south), which undermine the productivity of the main crops. Hand tools are mostly used by farmers all over the

country (FAO, 2001). The far north region has little access to mechanization services compared to the three other regions despite the presence of departments of agriculture. The difficulty to access the spare parts of machines is a great challenge for the 04 regions and need to be handled by private sectors, otherwise, machines will be abandoned after the first year of use. Ngu et *al.,* 2019, has proposed some solutions to better manage the hardware and software weaknesses of mechanical tool technology in agricultural mechanization.

IV. CONCLUSION

Controversy continues to surround the issue of mechanization, especially with regard to the level of mechanization appropriate to developing countries. However, few would deny that increasing agricultural productivity is the cornerstone of rural development. Despite this potential impact of mechanization, its adoption is still very difficult to achieve especially by small scale farmers due to the financial investment required. Farm mechanization in Cameroon has seen a rather slow progress over the years. The demand of important agricultural equipment like tractors, power tillers, combine harvesters, irrigation pump sets, diesel engines, has shown an increasing trend. This paper permit to appreciate the situation of agricultural mechanization in Cameroon via four (04) main crops.

Indeed, it was observed that the farming system in Cameroon is characterized in a majority (75%) by small farm operators with farm sizes less than 2 hectares. Significant farm sizes were observed from farmers that farm cocoa. Also, it was found out that 55% of farmers own their land without titles, while just 3% had land titles.

Despite some progress observed in the field of agricultural mechanization, this research showed that animate power is still very dominant in Cameroon. Indeed, manual tools constitute the essential tools used by farm operators regardless of the crop (under study) i.e. 89,8%. Motorization on the other hand, affects only 6.25% of farm operators. Also, 74% of farm operators are still not satisfied with the type of tool or technology they use to achieve their agricultural production goals. The main reasons for these dissatisfactions are the physical and financial inaccessibly to appropriate agricultural tools, equipment and machines; the inadequacy of the equipment in relation to its conditions of use; the absence of spare parts, the ageing of equipment, etc.

This work permits to appreciate the current state of mechanization from four main crops with the various challenges faced by the users of farm technology which if tackled efficiently could significantly improve the impact of mechanization in Cameroon.

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