



## Understanding the mechanisms of access and management of agricultural machinery in Benin



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### ABSTRACT

Agriculture in Benin represents a strategic asset for the country's socio-economic progress, however, there is low productivity and competitiveness within the sector. This is owing to the difficulties in accessing new technologies such as agricultural machinery. This study investigated the mechanisms of access and management of agricultural machinery in Benin. The study was conducted in 13 villages across the seven Agricultural Development Poles (PDA). It used a mixed-method approach involving semi-structured interviews and focus group discussions. Respondents were selected using a multi-stage sampling technique. A sample size of 129 farmers and 66 food processors were interviewed in the entire study area. Moreover, 26 focus group discussions were conducted; two discussions with men and women in each village. Content analysis method was adopted to analyse the data obtained from the focus group discussions while the Statistical Package for Social Sciences (SPSS) version 23 was used to analyse the primary data collected through semi-structured interviews espousing descriptive statistics, Kendall W test, and Chi-square test. The findings indicate that the access strategies to agricultural machinery were based on social integration, farm management, and social loyalty whereas the enabling perceived factors for accessing agricultural machinery includes the donation of agricultural machinery to farmers' organisations, the subsidisation of agricultural machinery, and the promotional offer of equipment. However, the respondents preferred the provision of services by farmers' organisations and individual ownership as the main management mechanisms. Therefore, the study recommends the government motivate farmers through the provision of incentives, subsidies in hiring agricultural machinery, promote service centres to facilitate access to repair and maintenance of machine parts, and support extension programs to educate farmers on the benefit of using agricultural machinery in their farming activities.

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## Introduction

Over the last 50 years, global food demand has tripled to a point where human consumption is 30 times greater than nature's regenerative capacity [1]. The increment may be due to population growth in the world. The world population has grown from 2.53 billion to 7.79 billion from 1950 to 2020 and recent forecasts have indicated a rise up to 9.6 billion by 2050 [2]. Hence, global food production is expected to increase up to 98% to meet the world's population food demand by 2050 [3]. In sub-Saharan Africa, the situation will be more alarming, with much higher food demand. This region is much threatened concerning food security because it has the highest population growth rate in the world. Moreover, the demand for cereals, which constitute the primary staple food of people in this region is expected to increase while current consumption levels are mostly dependent on imports [4,5].

Despite the economic importance of agriculture to many sub-Saharan African countries, its productivity has remained stagnant over the past sixty years [6]. This could be due to unavailability and/or low access to agricultural machinery by small-scale farmers in this region. However, there is great potential for agricultural development in the region if there is a total transformation from subsistence farming to mechanised farming, improving the productivity of existing farmland through fertilisation, irrigation, adopting new methods, and technologies [7]. Because of this, many stakeholders have called for the introduction of appropriate agricultural machinery to improve land productivity and encourage sustainable agricultural intensification [8,9]. Indeed, such agricultural machinery can benefit small-scale farmers by enabling them to reduce production costs and drudgery while replacing manual ploughing and traditional tools with efficient agricultural machinery [9,10]. Such agricultural machinery can also facilitate the conservation of agricultural resources [11]. It is, therefore, necessary to understand the characteristics of the different actors using agricultural machinery, particularly farmers and food processors in developing countries. In contrast to the predominant pattern of large-scale machine ownership and use in developed countries, in developing countries in general and Benin in particular, very few farmers and processing units own agricultural machinery. Some owners of agricultural machinery provide services to other farmers on a fee-for-service basis that allows greater access to agricultural machinery to the most vulnerable smallholder farmers [12,13]. Due to the high initial cost of purchasing some agricultural machines, most smallholder farmers prefer customised hiring arrangements [14]. While much research in developing countries including South Asian countries, has addressed issues on access to mechanisation, very little research in sub-Saharan Africa has addressed issues of access to agricultural machinery for farmers and processors [15–17].

Benin, a coastal country in West Africa is no exception to the rule and deserves to be studied for several reasons. Agriculture in Benin plays a strategic role in social and economic development and contributes an average of 47% gross domestic product (GDP), 75–90% of export earnings, 15% of government revenues and employs more than 70% of the working population [18,20]. Thus, agriculture is the best asset for stimulating economic growth in rural areas and improving food security. However, despite its importance, the sector is still characterised by the predominance of traditional small and medium-sized farms, which alone produce 95% of national agricultural production [19], with low productivity [21]. This low productivity is attributed to the fact that many smallholder farmers have limited access to inputs and new technologies introduced, such as agricultural machinery [21,22]. As a result, the agricultural sector in Benin cannot yet meet the food demand of the population.

Over the last two decades, the country has initiated the development and dissemination of agricultural machinery for production and processing through development programs (e.g. PADSA: Agricultural Sector Development Support Programme). More recently, with the former Programme for the Promotion of Farm mechanisation (PPMA), now Agricultural Development and Mechanisation Agency (ADMA), the country has invested billions of CFA francs in promoting agricultural mechanisation through the development and importation of agricultural machinery such as tractors, power tillers, and their accessories, as well as the establishment of processing units [23]. This new policy is expected to reduce the labour force and the time required to establish crops, increase the area of land when available, and improve overall productivity per family asset.

Although policies to promote the development of farm mechanisation have been implemented, the results of several years of action are still mitigated [22,24]. The sector is less competitive because many farmers prefer the use of rudimentary tools to the detriment of those introduced, with the consequences of making work very arduous, wasting time and energy, devaluing the crops produced [19]. Moreover, it was found that agricultural machinery is parked in public services and are left in deteriorated conditions due to their low level of use. This implies that new technologies related to agricultural machinery are still not adapted to the social and cultural realities of the environment. On the other hand, strategies for accessing and managing these technologies are not always appropriate and are subject to social inequalities [24].

It is, therefore, necessary to examine strategies for accessing agricultural machinery by farmers and food processors in rural communities to provide better agricultural services. Understanding strategies developed by farmers will help to improve access to agricultural machinery and increase its adoption rates by farmers and food processors. Furthermore, the factors that enable access to agricultural machinery in rural communities need to be examined as well as the preferences of farmers and processors for agricultural machinery and management methods. This will help development planners and policy-makers, including legislators who allocate public funds, as well as national and international banks to target investments in agriculture more appropriately. This paper falls within this framework and aims specifically to (i) identify the access strategies of farmers and processors to agricultural machinery, (ii) examine the factors that promote access to agri-

cultural machinery, and (iii) examine the preferences of farmers and processors for the management methods of agricultural machinery.

### Theoretical framework

The theory of access [25] and the theory of collective action [26] were applied to understand the mechanisms of access and management strategies of agricultural machinery by farmers and food processors.

At the end of the 1990s, epistemic communities, international organisations, interest groups, multinationals, and States began to use terms such as “universal access”, “access to essential goods and services”, “access to knowledge”. As a result, development actors are now linking the idea of access to essential goods and services. In theory, access means “the ability to benefit from something” [25]. For instance, access to agricultural machinery is defined as the ability of the farmer or the processor, to benefit from agricultural equipment and materials. On the other hand, agricultural mechanisation includes the production, distribution, and use of a variety of tools, machinery, and equipment for farmland management, planting, harvesting, and primary processing [27,29]. It includes human, animal, and mechanical energy. It extends to mechanisation-related services such as financing, manufacturing, distribution, repair, and maintenance of agricultural equipment, as well as training, advice, and research [30]. It also includes economic and institutional policies with direct or indirect effects on agricultural machinery. Through mechanisation, farmers save labour and improve the quality of work [8]. In general, they increase their cultivated area, increase yields in some cases, and reduce post-harvest losses, resulting in an overall increase in productivity [31].

If agricultural mechanisation involves the use of agricultural machinery, access to machinery consists of a variety of mechanisms. Accordingly, Ribot and Peluso [25] identified two types of key mechanisms of access. The first is rights-based, and the second is based on structures and relationships. Overall, structural and relational mechanisms include technology, capital, markets, labour, knowledge, authorities, identities, and social relations. For example, factors including political, economic, social, and cultural can either limit or enable an individual to benefit from agricultural equipment and machinery [31,32]. Besides, Peluso and Ribot [33] consider access mechanisms as “power relations” which emerge from social relations. These relationships can influence an individual or groups’ access to resources and are manifested through cooperation, competition, conflict, and negotiation. On the other hand, rights-based mechanisms include custom or convention [25]. Milgroom et al [34]. also added customary institutions as a separate rights-based mechanism to differentiate informal rights. All these mechanisms are interdependent and can operate sequentially, simultaneously, or in opposition to each other [25,33]. The existence of informal access rules and norms can determine who can access agricultural machinery as well as the processes by which the machinery is accessed [26]. Moreover, the mechanisms of access to agricultural machinery by farmers and processors may vary according to the type of equipment [27,28], the user, the rainy season, or the circumstances [35]. One of the advantages of informal rules and standards is that they adjust to changing economic, environmental, social, and political conditions, including formal policies and laws [36,37]. Therefore, access to agricultural machinery might be a dynamic and continuously renegotiated process [33,35]. Also, it can be specific to each case because each rural community has its realities. However, it is possible to identify models that apply beyond a particular case, especially if specific dynamics are considered.

To analyse how collective action influences access to agricultural machinery, the theory of collective action has been considered [26]. This theory posits that at the basis of a group, there is an interest, and until this interest is materialised through action, the group does not exist. In theory, collective action is the coordinated behavior of groups of individuals towards a common interest [38]. In these groups, collective interest takes precedence over individual interests. According to Wynne-Jones [39], the experience of cooperation influences the way actors prioritise individual and collective objectives. These groups to which the individuals belong to can therefore be a solution to their economic, social, and cultural equilibrium [40].

Again, the formation of such groups is linked to social capital [41,42]. Social capital describes the structure of the relationships between the actors who promote productive activities [43,44]. Social capital facilitates collective action by giving people the confidence to invest in collaborative activities with the expectation that others will do so as well. Key aspects of social capital formation include (i) relationships of trust; (ii) reciprocity and exchange; (iii) standard rules, norms, and sanctions; and (iv) connectivity, networks, and groups [45]. The basis of relationships between actors about collective action is established through social learning. Social learning involves the transition from multiple cognition to collective cognition, meaning that individuals collectively move from separate cognitive agents with various perspectives to a group with shared attributes such as values and collective action [37].

Furthermore, the interaction that takes place during collective action also affects the social learning process and changes the nature of social capital over time. Collective action is more likely to emerge when a farmer’s ability to access agricultural machinery individually is limited. On the other hand, the willingness of individuals to take collective action depends on their level of interconnection, motivation, and capacity [40]. Therefore, it is argued that collective action is a social balance element in accessing agricultural machinery. Moreover, the logic of collective action explains why groups with a common interest may do nothing to initiate joint action. In contrast, others may develop strategies in the direction of the common interest. For Olson Mancur, the participation of an individual in a collective action implies some contributions (time, labour, or even money) [46]. Thus, a condition of access to agricultural machinery for the members of the farmers’ organisation would be, for instance, their participation in the organisation’s initiatives, allowing each member to access agricultural ma-

**Table 1**  
Sampling of the respondents.

PDA	Municipalities	Villages/sites	Sample	
			Farmers	Processors
<b>PDA 1:</b> Vallée du Niger	Karimama	Birni-Lafia	10	5
	<b>PDA 2:</b> Alibori Sud-Borgou Nord-2KP	Péhunco	Soadou	10
<b>PDA 3:</b> Atacora Ouest	Gogounou	Badou	10	5
	<b>PDA 4:</b> Borgou Sud-Donga-Collines	Boukombe	Kouya	10
<b>PDA 5:</b> Zou et Couffo	Dassa-Zoumé	Miniffi	10	5
	Ouaké	Awanla-Kpéloudè	10	5
	Ouèssè	Gbanlin	10	5
	Bantè	Akatakou	10	5
<b>PDA 6:</b> Plateau	Aplahoué	Eglimey	9	6
	Djakotomey	Zouzouvou	9	6
<b>PDA 7:</b> Ouémé-Atlantique-Mono	Kétou	Adakplamè	10	5
	Sakété	Saharo-Nagot	10	5
<b>Total</b>	Tori-Bossito	Hayakpa	11	4
			<b>129</b>	<b>66</b>

chinery. However, there might be inequalities in access between members. On the other hand, a farmer only participates in a collective action if he or she derives a personal benefit from such participation that is greater than the benefit to the group, which would be greater than the individual cost. Moreover, in small groups, where people are exposed to the benefits of collective action, farm machinery is used effectively by their organisations. However, this may depend on the type of technology and the revenues it generates. The smaller the group, the better the management, and the more revenue each group member is likely to earn as income.

## Materials and methods

### Study area

The study was conducted in Benin. Benin is located in West Africa in the tropical zone between the equator and the Tropic of Cancer (between the parallels 6°30' and 12°30' North Latitude and the meridians 1° and 30°40' East Longitude), bordering Nigeria to the east and Niger to the north, Togo to the west and Burkina Faso to the northwest, with a total area of 114,763 km<sup>2</sup>. The country has 77 municipalities and 07 Agricultural Development Poles (PDA) administered by Territorial Agencies of Agricultural Development (ATDA). The Agricultural Development Pole is the framework for the operational implementation of agricultural development policies, programmes, and projects. It represents a development territory organized on a limited number of priority sectors, driving the economic development of a group of municipalities. The country's main crops are maize, cassava, cotton, palm, groundnuts and beans (See Fig. 1).

### Sampling

Respondents were selected using a multi-stage sampling technique. In the first stage, a reasoned sampling was performed. Out of the twenty-three (23) Research-Development sites of the National Agricultural Research System (NARS) that constitute homogeneous units representative of the seven Agricultural Development Poles, thirteen (13) Research-Development sites (villages) were selected. Two main selection criteria were used: (i) the representation of all agro-ecological zones in relation to the Agricultural Development Poles and (ii) the existence of agricultural mechanisation constraints identified from the diagnosis carried out on all Research-Development sites [47]. These sites are considered representative of Benin's Agricultural Development Poles and were chosen based on agricultural mechanisation constraints identified from the diagnosis carried out on these sites by the National Institute of Agricultural Research of Benin. At the second stage, on average, fifteen (15) actors including at least 60% of farmers, were randomly selected from a list of farmers and processors provided by the agricultural extension officer in each village. In total, 129 farmers and 66 processors were interviewed in the entire study area, with a breakdown by development pole and municipality as shown in Table 1.

### Data collection

This study used a mixed-method approach and relied on a combination of quantitative and qualitative data collection methods. Indeed, the integration of quantitative and qualitative data in the form of a mixed-method study has great potential to enhance rigour and enrich the analysis and results [48].

Firstly, data were collected through a semi-structured interviews schedule based on semi-structured interview guides. In addition to socio-economic information, questions were asked such as: What are the strategies for accessing agricultural

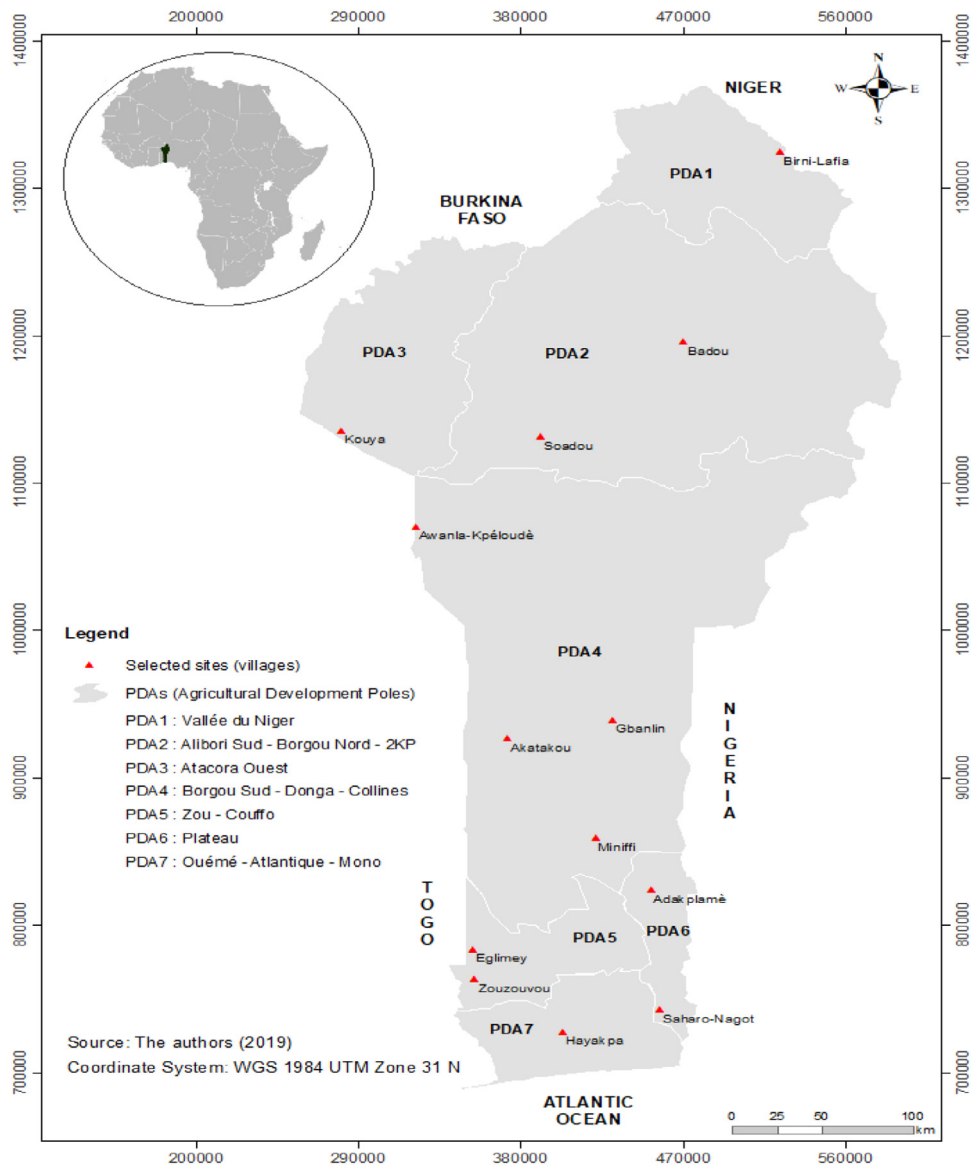


Fig. 1. Map of the study area.

machinery? This general question was structured in terms of the three levels of social integration, farm management and social loyalty. At each level, the existing strategies were identified and prioritized. For example, for social integration, the respondents were asked the following questions: Do you adopt family proximity (recourse to parents), collective solidarity (recourse to peers), membership in a group, mediation by a third party to access agricultural machinery? Similarly, social loyalty was assessed through questions such as: Do you resort to pre-financing of the service provision? Do you overbid on service costs or do you use several service providers simultaneously? Do you socially support the service provider or the equipment owner? Respondents were also asked to provide information on factors that can promote access to agricultural machinery as well as their preferences for agricultural machinery management.

Secondly, based on issues that emanated from semi-structured interviews, clarity, and depth of understanding were sought through FGDs. Indeed, an FGD is a qualitative data collection that systematically obtains information about participants through facilitated discussion. It thus allows for a majority decision on the experiences, beliefs, and values of participants that underlie certain phenomena. FGDs were based on a comprehensive interview guide. The Focus Group Discussions took place at the village level with farmers (farmers, processors) of all categories including resource persons, traditional and customary leaders, and village chiefs. In each village, two FGDs were conducted with men and women as the issue of mechanisation is approached differently depending on the links within the production chain. Besides, technology adoption is often determined by culturally defined roles and divisions of labour between men and women in Benin's agricultural

**Table 2**  
Socio-economic characteristics of respondents.

Characteristics		Farmers			Chi <sup>2</sup>	Processor			Chi <sup>2</sup>
		Non-user (%)	Users (%)	Total (%)		Non-user (%)	User (%)	Total (%)	
Existence of mechanisation	<i>No never</i>	65.10	24.40	38.00	43.79***	60	14.30	21.20	10.76***
	<i>Does not work anymore</i>	23.30	3.50	10.10		0	5.40	4.50	
Sex	<i>Works well</i>	11.60	72.10	51.90		40	80.40	74.20	
	<i>Female</i>	14	12.80	13.20	0.03	80	96.40	93.90	4.02**
	<i>Male</i>	86	87.20	86.80		20	3.60	6.10	
Education		46.50	44.20	45.00	0.06	10.00	16.10	15.20	0.24
Literacy		25.60	45.30	38.80	4.72**	10	10.70	10.60	0.00
Contact farmer/processor trained		32.60	46.50	41.90	2.29	30	53.60	50.00	1.87
Access to credit		18.60	33.70	28.70	3.20*	60	32.10	36.40	2.84*
Membership in a farmer/processor organisation	<i>Never</i>	67.40	40.70	49.60	8.37**	60	35.70	39.40	2.10
	<i>Passive</i>	9.30	20.90	17.10		20%	30.40	28.80	
	<i>Active</i>	23.30	38.40	33.30		20	33.90	31.80	
Contact with structures	<i>Agricultural advisory services</i>	34.90	41.90	39.50	0.58	10	21.40	19.70	0.70
	<i>Project / Program</i>	32.60	17.40	22.50	3.76*	20	26.80	25.80	0.20
	<i>Research</i>	51.20	45.30	47.30	0.39	90	25.00	34.80	15.79***
	<i>NGO</i>	7.00	15.10	12.40	1.75	40	7.10	12.10	8.6***
	<i>MFI</i>	11.60	11.60	11.60	0.00	20	19.60	19.70	0.00
	<i>CUMA</i>	2.30	1.20	1.60	0.25	0	0	0	
	<i>FOs</i>	2.30	17.40	12.40	6.03**	0	10.70	9.10	1.18

\*\*\* Significant at 1% level.

\*\* significant at 5% level.

\* significant at 10% level.

sector. In total, twenty-six (26) FGDs were conducted. During FGDs, participants discussed issues surrounding the different mechanised operations, the typology of farmers by the level of prosperity, the interventions of projects and programmes related to mechanisation, individual and collective strategies for access to agricultural machinery, the management of existing equipment as well as constraints related to agricultural mechanisation.

### Data analysis

The analytical approach for the qualitative interviews (FGDs) involved content analysis. The content analysis method was used to provide an accurate report of the respondent's discourse in the most objective possible way. It involves three consecutive stages: pre-analysis; exploitation of the material, and processing of the results, inference, and interpretation. Through content analysis, we extracted key themes from the participants' discourse. These themes were further evaluated and matched with data collected during the semi-structured interviews. The data collected from both sources were compared to create a more in-depth picture of the mechanisms of access and management of agricultural machinery. All FGDs were audio-recorded, translated into French, and transcribed. Moreover, direct statements illustrating various thematic areas were quoted in the main text. Care was taken not to reveal the identity of participants due to confidentiality.

Furthermore, the primary data collected through semi-structured interviews were analysed using the Statistical Package for Social Sciences (SPSS) version 23. Data analysis includes descriptive statistics (relative frequencies and means) and non-parametric tests (Kendall W test, and Chi-square test). Chi-square tests were performed to compare variables between users and non-users of agricultural machinery. The chi-square test was preferred to the t-test for proportions because the data are expressed as percentages, and the usual statistical procedure recommended would be a chi-square test. The chi-square test is a widely employed method for measuring whether a significant association or similarity exists between two categorical or nominal variables. Kendall's concordance coefficient (W) was used to rank the main strategies for accessing agricultural machinery, factors that enable access to agricultural machinery, and the preferred management methods of agricultural machinery by farmers and processors. The rankings are from one being the most important variable to the maximum number of variables being the least important. Therefore, a lower mean rank indicates that the variable is more important.

## Results

### Socio-economic characteristics of the respondents

The socio-economic characteristics of farmers and food processors according to their status of usage (User/Non-user) of agricultural machinery, are presented in Table 2. The existence of agricultural machinery in the area of study is perceived



**Table 3**  
Access strategies based on social integration.

Social integration	Farmer		Processor	
	Average rank	Rank	Average rank	Rank
Collective solidarity/peer use	2,11	1	1,89	1
Membership of the group	2,65	2	2,45	2
Third-party mediation/relationship approach	3,3	3	2,83	3
Family proximity/reliance on parents	3,66	4	4,2	4
Professional mediation	4,3	5	4,35	5
Denominational mediation	4,98	6	5,27	6
<b>Kendall W</b>	<b>0,318***</b>		<b>0,484***</b>	

\*\*\* Significant at 1% level.

differently among farmers and processors. More than 75% of the users acknowledged the existence of well-functioning agricultural machinery in their village. The users of agricultural machinery are mainly men in production (87.2%) and women in processing (96.4%), with low levels of education and literacy. Few respondents reported having attended at least one training session on agricultural mechanisation. This result implies that the majority of respondents lack access to knowledge and skills on agricultural mechanisation, which could be a major constraint to the success of mechanisation programmes. However, about 42% of farmers and 50% of processors reported that they have come in contact with a farmer/processor who had received training in agricultural mechanisation. Only 29% of farmers and 36% of processors had access to farm credit in the last five years, with a significant difference between users and non-users. This implies that access to agricultural credit remains a constraint for agricultural production in the study area. Moreover, an average of one-third of respondents declared belonging to a farmer's organisation, and the majority made use of agricultural machinery. However, few farmers and processors were linked to development structures (projects/programs, NGOs, agricultural advisory services), cooperatives (Farmers' Organisations and Cooperative for the Use of Agricultural Machinery (CUMA)), financial institutions, and research.

#### *Access strategies to agricultural machinery*

##### *From social integration to access to agricultural machinery*

The issue of social integration of individuals is increasingly recurrent in the social sciences and involves both the desire to live together and solidarity. Several factors foster social change as well as the transition from social integration to access to agricultural machinery among farmers and processors. The Kendall concordance test conducted to assess the importance of the strategies developed by farmers to access agricultural machinery revealed highly significant results at the 1% level. This implies that there is a concordance in the prioritisation of the access strategies developed by respondents (Table 3).

Overall, it appears that collective solidarity, membership of a group of farmers/processors, and mediation by a third party are the main strategies to access agricultural machinery. The use of these strategies denotes the integration of farmers and processors into a social system. By integrating into the social system, farmers and processors share common values and norms which allow them to develop absolute solidarity. Such solidarity corresponds to the set of social ties that bind individuals or groups together. On the other hand, these social ties are established through the various interactions that attach to individuals or groups. For instance, the results also showed that family or parental proximity represents a strategy developed by farmers to access agricultural machinery. This proximity indicates the existence of social ties between farmers/processors and their parents. Thus, farmers and processors can benefit from access to agricultural machinery-related services through the social system. These services often include facilitating access to mechanisation, provision of services but also equipment loans. Moreover, professional or religious mediation is also a strategy developed by respondents to access agricultural machinery. In fact, in cases where there are inter-individual disagreements involving the owners and non-owners of agricultural machinery, particularly women and young people who are the most vulnerable segments of society, the use of professional mediation (farmers' delegate, peer), or religious (dignitaries, traditional chief) appears to be an access strategy to agricultural machinery. Indeed, sometimes, both parties may be blocked for emotional (anger, ideology, high or low-risk tolerance), financial (need for money, ability to tolerate defence costs or exposure of the verdict), or other reasons. Thus, the use of mediation helps farmers and processors overcome these barriers to access agricultural machinery.

##### *From farm management to access to agricultural machinery*

Access strategies to agricultural machinery by farmers and processors are also linked to the management of the farm or processing unit (Table 4). The significance of Kendall's concordance tests at 1% level implies that there is a concordance in the prioritisation of access strategies based on the farm management by the respondents. Overall, the strategies developed by farmers and processors include regular savings with the financial institution or service provider, the choice of land favourable to the use of agricultural machinery, the reduction or increase of cultivated land area, the spatial redefinition of crops, the choice of crops, crop diversification, and the processing of agricultural products. These strategies integrate various elements of the management process of the farm/processing unit. Therefore, agricultural mechanisation can help a farmer/processor to achieve his production goals. Moreover, it appears that reducing or increasing cultivated areas, saving

**Table 4**  
Access strategies based on the farm/processing unit management.

Farm/ Business management	Farmers		Processors	
	Average rank	Rank	Average rank	Rank
Regular savings/MFI deposits or at the service provider level	3,06	2	2,44	1
Choice of a site (lowland, plateau, etc.)	3,96	3	3,39	4
Reduction/increase in packaging/quantity	2,47	1	2,61	2
Redefinition of the spatial distribution of crops	4,58	5		
Choice of speculations	4,68	6	3,05	3
Agricultural diversification (livestock integration)	4,74	7	3,51	5
Processing of agricultural products	4,5	4		
<b>Kendall W</b>	<b>0,173***</b>		<b>0,089***</b>	

\*\*\* Significant 1% level.

**Table 5**  
Access strategies based on social loyalty.

Social loyalty	Farmers		Processors	
	Average rank	Rank	Average rank	Rank
Pre-financing of the service provision	3,34	2	3,05	2
Overbidding of service costs	4,87	6	4,22	4
Simultaneous use of several service providers	4	4	3,5	3
Respect for the rules of the game	2,28	1	2,65	1
Full support/motivation of service providers	3,84	3	4,47	5
Donation/offer of harvest products to service providers	4,6	5	5,03	6
Social assistance to providers/owners	5,08	7	5,08	7
<b>Kendall W</b>	<b>0,203***</b>		<b>0,195***</b>	

\*\*\* Significant at 1% level.

money regularly with a Microfinance Institution/service provider, and choosing land suitable for mechanisation operations are the strategies developed by farmers. On the other hand, most of the processors opt for savings. They also often increase the quantity of product to be processed and choose the crop to process accordingly.

#### *From social loyalty to access to agricultural machinery*

Kendall's concordance test reveals that there is coherence in the prioritisation of access strategies based on social loyalty, and it is significant at 1% level (Table 5). Overall, it appeared that compliance with the rules of the game, pre-financing of the provision of services, higher service costs, social assistance to service providers or machinery owners, full support or motivation of the service provider, and the donation of harvest products to service providers are strategies developed by farmers and processors to access agricultural machinery. Regardless of the actor, compliance with the contractual clauses between the applicant and the supplier/service provider, and pre-financing of the service are the major strategies.

However, the rules or clauses of the agreements may not always be respected by parties. In some cases, the proximity of the relationships drives some actors to deviate from the rule and the pre-established consent clause. By pre-financing the service, the farmer or the processor guarantees access to agricultural machinery. This pre-financing consists of the farmer or processor depositing cash in advance with the service provider, which in turn guarantees him access to the machinery whenever needed. Furthermore, the strategy of overbidding the costs of service provision to access agricultural machinery falls within the rationale of competition. This competition reflects a market situation in which several farmers or processors are competing to access agricultural machinery services. As a result, this strategy allows not only farmers and processors to have access to agricultural machinery but also to benefit from timely access to quality services. To explain this practice, a farmer stated:

*The service provider has no competitors; he is the only one offering this service to the entire community even at the peak of the season especially during the cropping period. As a result, one is forced to pay extra money than everyone to get the service at the needed time. This obliges the service provider to give priority to the service you ask for [MFGD5GOG].*

#### *Enabling factors for access to agricultural machinery*

The analysis of the factors that can enable access to agricultural machinery by the farmers and processors (Table 6) indicate that more than half of the farmers believe that subsidising agricultural machinery and donating machinery to farmers' organisations are very important to obtain access to agricultural machinery. By donating to the farmers' organisations, the agricultural machinery becomes the property of the whole organisation binding farmers together within the organisation. At the same time, about 50% of farmers and processors believe that setting a minimum price for the provision and payment



**Table 6**  
Enabling factors for access to agricultural machinery.

Favourable factors	Farmers					Processors				
	Not important (%)	Important (%)	Very important (%)	average rank	Rank	Not important (%)	Important (%)	Very important (%)	average rank	Rank
Promotional offer for equipment	8.50	48.80	42.60	3.58	3	13.60	33.30	53.00	3.26	3
Subsidy agricultural machinery	0.80	36.40	62.80	2.43	2	1.50	37.90	60.60	2.36	1
Donation of machinery to FOs	10.10	31.00	58.90	2.7	1	6.10	28.80	65.20	2.89	2
Fixing the minimum service costs	27.10	51.20	21.70	4.88	6	21.20	50.00	28.80	4.52	4
Local centre for farm mechanisation centre	20.90	45.00	34.10	4.54	4	28.80	40.90	30.30	4.59	5
Community shops / spare parts	11.60	41.10	47.30	4.82	5	13.60	43.90	42.40	5.23	7
Services delivery in the form of a fee	18.60	62.80	18.60	5.05	7	33.30	45.50	21.20	5.15	6
<b>Kendall W*</b>					<b>0.256***</b>					<b>0.288**</b>

\*\*\* Significant at 1% level.

\*\* significant at 5% level.

\* significant at 10% level.

**Table 7**  
Preferences of agricultural equipment management methods.

Preferences	Farmers		Processors	
	Average rank	Rank	Average rank	Rank
Individual ownership	3,41	3	3,08	2
Service provision by a farmer	3,68	4	3,77	4
Private company service provision	4,39	6	4,02	5
Provision of services by POs	2,87	2	3,33	3
Collective ownership/group ownership	2,65	1	2,45	1
Provision of services by public service	4	5	4,36	6
<b>Kendall W*</b>	<b>0,127***</b>		<b>0,137**</b>	

\*\*\* Significant at 1% level.

\*\* significant at 5% level.

\* significant at 10% level.

of services in the form of fees is also essential for access to agricultural machinery. Indeed, both farmers and processors reported that such strategies would enable the most vulnerable farmers, including women and youth, and processors of communities to access agricultural machinery. A farmer said:

*If these strategies can now be implemented, it will reduce corruption and nepotism. Also, if I have to wait for money before demanding services, the time for production will pass, and I will not be able to farm, so I prefer to use the machine and pay back with a crop product in case I do not have any money. [MFGD26APL].*

As for the processors, most preferred the establishment of a local agricultural mechanisation centre to address the constraints related to the unavailability and inaccessibility of agricultural equipment. Otherwise, the absence of spare parts will lead to the rejection of agricultural equipment.

Moreover, the prioritisation of factors favourable to access to agricultural machinery shows that the donation of equipment to farmers' organisations, the subsidy of agricultural equipment, and the promotional offer of equipment are the main ones (Table 6).

#### Preferences for agricultural machinery management methods

Kendall's concordance test revealed that there was a coherence in the prioritisation of farmers' and processors' preferences for agricultural management methods. The result was significant at the 1% level and therefore indicates agreement in the rankings made by the respondents (Table 7). Overall, the three main management methods preferred by both farmers and processors were: collective ownership, service provision by farmers or their organisation, and individual ownership. Indeed, the notion of the «collective» refers to the constituted social network involving interactions between individuals who

know each other, who share common principles of social life and therefore associate to appropriate the equipment. According to individuals, this management method would contribute to reducing conflicts and promote the use of equipment through collective action. A farmer explained this:

*If we get together, I think we can quickly have machines in this village; but if everyone says that he alone will find his money to buy, we will always be there without finding anything. Together, we will contribute and quickly find the funds to buy. Agricultural machinery is a tool that strengthens the links within our cooperative. Because each of us has an interest in the machine and each of us must contribute and, help with the maintenance of the equipment. If there was a disagreement, the machines could not continue to work until today. Initially, in our cooperative, we only meet for training and membership fees, but since we acquired machines, our meetings are now more frequent, and we help each other. If the machine is working today at X, next week it will be at Y. [FFGD18TOB].*

On the other hand, some agricultural machinery (tractors, animal traction, shredders/mills, etc.) require massive investment, and the respondents suggested the provision of services by farmers' organisations or private companies (among processors) and group ownership (among farmers). Some respondents mentioned the provision of services by a public structure. They believe that this method will ensure sound management of the agricultural machinery and avoid the marginalisation of specific social categories. For instance, a farmer declared:

*If the government itself deals with service delivery, people will be afraid of authority. On the contrary, if the machine is entrusted to a private service, there will be too much pride, and we will not benefit from it. The private service will first satisfy his relatives. Nevertheless, if the government is in charge, everyone can use it if the conditions are met. [MFGD13OUE].*

In addition, individual ownership was perceived by some farmers and processors surveyed as a way of promoting the proper management of farm mechanisation. Actors also perceive this appropriation as a means of asserting their own identity. A woman processor said:

*When you do not have your machine, people do not consider you, they dismiss you, and when there are activities that a project organises with the processors, they do not inform you. It is after the training sessions that you hear that there was training. [FFGD20DJK].*

## Discussion

### *Access mechanisms to agricultural machinery*

The study established that the ability of a farmer to access agricultural machinery is determined by his or her integration into a social system. Such social integration entails membership in one or more social networks where access to innovation or productive resources is a priority for the farmer/processor. Social networks (e.g., farmers' organizations, work or mutual aid groups, the agricultural innovation system) can play a negotiating role and even guarantee access to production resources such as agricultural machinery, as confirmed by Cossar [49,50]. The result further complements the work of Hall & Clark [51] and Spielman et al. [52]. They showed that the lack of sufficient interactions between farmers and other actors of the social system is a barrier to innovation, which would fail to the extent that farmers are either separated from appropriate sources of creativity and knowledge [51] or disconnected from networks that provide access to innovation and resources [52]. The results thus suggest that, alongside supporting structural investments in agricultural mechanisation in developing countries, it is also important to strengthen relationships and networks at the local level to enhance the social integration that facilitates access to agricultural machinery. Mechanisation programmes aimed at increasing farmer access to agricultural machinery must start by identifying the patterns of relationships that farmers or processors have with others in their social system that will further integrate him or her into the system, leading to greater exposure to people with experience with agricultural machinery. Yet, the fact that farmers are embedded in a social system does not guarantee equal access to farm machinery. As Eerdewijk and Danielsen [53] pointed out, access to agricultural machinery is associated with gender inequalities, as in most rural African communities, women already lack access to and control over resources, in addition to norms, values and beliefs. In addition rural communities have different cultures. These cultures are likely to influence the type of social relationship that affects the level of access.

The study further established that farmers and processors opt for strategies including regular savings with a Microfinance Institution (MI) or service provider; choice of a field where agricultural machinery can be used; reduction or increase in land area; the spatial redefinition of crops; the choice of speculation; agricultural diversification and the processing of agricultural products to access agricultural machinery. This suggests that applied farm management measures can address the issue of access to farm machinery and can be seen as a mechanism for access to farm machinery in rural areas, an issue often ignored in previous studies. This result is supported by Bonneville et al [54], who also mentions that good management of the farm or processing unit promotes farmers' control over the technical, economic and social opportunities and constraints inherent in their farm or processing unit. It is, therefore, necessary to strengthen the management capacity of farmers and processors.

### *Factors that enable access to agricultural machinery*

The study established that the donation of equipment to farmers'/processors' organisations can enable access to agricultural machinery. However, even if well-intentioned, donations of agricultural machinery to farmers' organisations may not be sustainable and may also distort the whole mechanisation system [55]. For instance, donated machinery may not be of the same brand as that available, and it may be challenging to access spare parts and skills for repair and maintenance. Besides, recent experiences in South Asia have shown that, since most smallholders do not own agricultural machinery, projects can focus on providing affordable services and leases to smallholders for broader access to agricultural machinery [13]. This mechanism is also considered to be essential for farmers' access to agricultural machinery by several authors [56,57] because not all farmers need to have a machine to extend its use. Other favourable factors for access to mechanisation are access to financial loans for machines, the skill of operators, and the availability of local service centres for maintenance of machines and access to spare parts [13].

### *Preferred agricultural machinery management methods*

The study established that management methods preferred by both farmers and processors include collective ownership, service provision by the farmer or their organisation, and individual ownership. The work of Herbel et al [32]. has also proven that farmers organisations in Benin can successfully provide mechanisation services to their members but also offer good economic returns with a subsequent positive impact on their social status. The results are also supported by Mrema and Mpagalile [58], who argued that medium-sized farmers providing agricultural machinery services create new opportunities for smallholder mechanisation. Additionally, the results also supported the observations of Mandal [57] who indicated that in an agricultural context where smallholder farmers' are dominant, farmers who own farm machinery tend to engage in small businesses to serve other farmers to generate additional income after tending their fields. This type of entrepreneurship is particularly common when farmer clients are clustered in the same village or a neighbouring village [12,57]. However, as the full utilisation of some agricultural machinery, including tractors, threshers, and tillers through service provision requires frequent movement within and between villages, as well as negotiations with farmer clients, women owners will be constrained. This is because of gender norms as in most developing countries in sub-Saharan Africa including Benin, the movement of women outside the household, particularly without male supervision is restricted to some extent [59]. Besides, the authors explained that farmers would prefer individual ownership because tractor owners are reluctant to offer services to smallholders because of the transaction costs and the risk of non-payment.

Although this paper provides an initial overview of mechanisms of access and management of agricultural machinery by farmers and processors in Benin, further research is needed to draw more complete conclusions, for instance by investigating the influence of farmers' socioeconomic characteristics on the choice of access mechanism for agricultural machinery. A study can also be developed to examine how social inequalities affect the access mechanisms as well as preferred agricultural machinery management options and the level of access to agricultural machinery.

## **Conclusion**

The findings highlighted farmers' strategies for accessing agricultural machinery, the factors that enable access, and the preferences for agricultural machinery management methods. Indeed, the study observed that the strategies of access to agricultural machinery developed by farmers and processors in the Agricultural Development Poles of Benin are linked to social integration, management of the farm or production unit and also to social loyalty. Thus, improving farmers' and processors' access to agricultural machinery requires the establishment of mechanisms for the sustainable development of social capital at both individual and organisational levels to gradually achieve the integration of farmers and processors in their communities. Such integration is essential for the large-scale adoption of agricultural machinery. Moreover, through good farm management practices, farmers can also improve their access to agricultural mechanisation services. Furthermore, according to the respondents, the donation of agricultural machinery to farmers' organisations, the subsidisation of agricultural equipment, and the promotional offer of equipment are the main factors that can enable access to agricultural machinery. In addition, management methods preferred by both farmers and processors for the management of agricultural machinery included collective ownership, provision of services by farmers' organisations, and individual ownership.

The study further makes some keys recommendations to improve access to agricultural machinery. The government should (i) encourage and support taxes and subsidies for access to machinery, (ii) promote service centres to facilitate access to repair, maintenance, and rental services at a lower cost, (iii) encourage the private sector, cooperatives, and farmers' unions, where small farmers can access mechanisation in their locality. In addition, low-literate farmers need the training to acquire the skills needed to use and manage farm equipment and earn an income. They can then serve as models for other farmers. As the access to agricultural machinery integrates different elements of farm management, it is thus important to strengthen the capacities of farmers and processors in terms of farm management. Agricultural extension has a critical role in farmers' capacities in farm management. All of these policy options need to be actor-centred with better visibility of their needs.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## CRedit authorship contribution statement

**Léonard Cossi Hinnou:** Conceptualization, Data curation, Formal analysis, Methodology, Supervision, Writing – review & editing. **Esdras Abréwa Rêmilokoun Obossou:** Conceptualization, Methodology, Writing – original draft. **Nestor René Ahoyo Adjovi:** Conceptualization, Supervision, Writing – review & editing.

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