RESEARCH ARTICLE

Financing and agricultural equipment services for seed production cooperatives in Benin (West Africa)

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Seeds are an important factor of production and play an essential role in food security. This study examines the feasibility of providing agricultural equipment services to seed farmers in the municipalities of Savè and N'Dali in Benin. Using purposive sampling, 140 actors involved in the seed value chain were selected in the two municipalities. Data were collected using from focus group discussions and a structured questionnaire. We performed descriptive statistics and regression model to analyze seeds farmers' willingness to pay for machinery services. The study found that microcredit institutions are the primary source of financing for seed production for the majority of respondents (86%). However, seed credit needs are still largely unmet, and the use of modern farm equipment remains low. There is a strong demand for agricultural equipment services, such as mechanized plowing, threshing/shelling, sorting by size and seed cleaning, and transport services, all of which can be provided profitably. Seed farmers are the target for the provision of agricultural equipment services for soil preparation, plowing of seedlings, harvesting, threshing/shelling, storage, transport etc. in the two municipalities. However, willingness to pay for a machinery service depends on the number of agricultural workers, secondary economic activities, the years of farming experience, age, household size and gender. These results suggest that there is scope for developing the supply side of agricultural equipment service for efficient and sustainable agricultural production.

Key Words: *Agricultural mechanization; Seeds producers; Financing; Profitability; Benin*

INTRODUCTION

Agriculture is one of the main avenues for economic growth and poverty alleviation in Sub-Saharan African (SSA) countries. This region continues to experience high levels of poverty. Around 27-40 million new poor people were added due to the COVID-19. Investing in agriculture for economic growth and food security is one of the main drivers of poverty reduction and improving the quality of life in SSA countries [1].

In Benin, agriculture is one of the economy's most important growth sectors, employing more than 70% of the economically active population and accounting for about 36% of the country's GDP. These statistics show that there is a significant need for improvement in this sector to enhance productivity. The performance of the agricultural sector in Benin depends largely on products such as maize and soybeans, which contribute significantly to food security and poverty reduction. Various actors are positioning themselves to promote these crops, which were revealed as strategic for the country's economic growth. However, these two crops still face several constraints such as access and availability of quality seeds, low levels of agricultural mechanization and financing. It is necessary to take these constraints into account when defining agricultural development policies.

Effective public-private partnerships are encouraged for specific interventions in the agricultural sector. According to the Strategic Development Plan for the Agricultural Sector in Benin, structuring agricultural investments through the Public-Private Partnership (PPP) is essential to boost agricultural development in the country. In addition, supporting farmers through agricultural cooperatives is becoming more and more important as a model for reducing poverty and maintaining food security [2]. Formal agricultural organizations facilitate farmers' access to the factors of sustainable production [3]. For example, financial credit is a tool capable of transforming these farmers into micro-entrepreneurs [4]. Needs for financial services vary depending on farmers and according to various forms of credit [5]. These agricultural credits are generally used to support small variable production costs, while the need for modern agricultural equipment requiring costly investment often remains unmet [6].

The development of agricultural mechanization service provision would be a laudable alternative to support farming operations and encourage sustained agricultural intensification [7]. These mechanized services give farmers access to agricultural mechanization without investing in equipment, and for equipment owners to increase the use and profitability of their investments [8]. Climate change is often manifested by the late arrival and short duration of rains. This limits the window for soil preparation, which often generates a demand for machinery services for rapid plowing and planting [9].

Rental services (machine hire) is a particularly suitable model because few farmers have the capacity to invest in buying agricultural machinery and equipment [10]. Thus, agricultural equipment rental services exert a leverage effect on agricultural development because they increase the productivity of land, and labor while reducing some of the most tedious, backbreaking tasks [11]. However, research on agricultural equipment service provision is limited [12,10]. This study aims to address this knowledge gap by focusing on seed farmers in the municipalities of Savè and N'Dali in Benin. It is structured around the following questions:

- How do seed farmers manage to finance their activities?
- What are their needs and willingness to pay for the provision of agricultural equipment services?
- What factors influence the demand for agricultural equipment supply services?

MATERIALS AND METHODS

Study area

This study was carried out in the municipalities of Savè and N'Dali. Savè is in the Collines department in central Benin, and covers an area of 2,228 km^2 with a population of nearly 100,000 inhabitants [13]. Agriculture, the main activity of the population, faces challenges in accessing financing and

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suitable equipment. However, the municipality of Savè is an important source of services such as plowing, transport, distribution of agricultural products and inputs [14].

The municipality of N'Dali is located in the Borgou department, in the northeast of the country, between 2° and 2° 40" East longitude; 9° and 10° North latitude. It covers 3748 km^2 and has 113,604 inhabitants (INSAE, 2016). Like much of rural Benin, the economy of N'Dali is dominated by agriculture. The crops include cereals, cotton, roots and tubers, legumes and vegetables [15].

It is clear that agriculture remains the main activity in these two municipalities and constitutes an income-generating activity for many households. In the Borgou department, maize is mainly grown in the municipality of N'Dali. On the other hand, soybean is particular grown in the municipality of Savè of Collines department [16,17]. As a staple food crop in these municipalities, maize and soybean production is limited by quality of seed which represents an important factor in food production. Use of quality seed contributes around 30% to the crop yield. However, availability of quality seeds in Benin is one of the major constraints on the intensification of sustainable crop production [18,19]. Thus, farmers are faced problems of supplying quality of seed which is linked to agricultural credit and equipment [20,19]. Faced with these challenges, the project Services et plaidoyer pour les organization's Paysannes (SEPOP) implemented by AFDI (Agricultures Français et Development International) and funded by the AFD (Agence Française de Development) has been operating since 2020 in the municipalities of N'Dali and Savè. This project supports seed production cooperatives by developing business plans for campaign credit and agricultural equipment services in the municipalities of N'Dali and Savè.

These two municipalities were chosen for this study because of their level of agricultural production and the existence of some initiatives to provide agricultural equipment services.

Data collection

Data collection was carried out in two successive phases from September to October 2022. The exploratory phase consisted in making contact, and becoming acquainted with the study environment. During this phase, an interview guide was used to collect initial data from 5 key actors in each municipality. These actors were the person in charge of the Territorial Agency for Agricultural Development (ATDA), the Chief of the village, the cooperative seed farmers, independent seed farmers and the agricultural equipment service provision representative. Discussions with these actors were organized in the form of exchanges on the financing and agricultural equipment service provision in each municipality.

In the second phase, the purposive sampling method was used to select 140 respondents, including 74 in Savè and 66 in N'Dali for the in-depth survey. Respondents included seed farmers, agricultural extension officers, presidents of soybean and maize cooperatives and farmers (Table 1). Data were collected using a structured interview, conducted *via* a questionnaire that was administered individually to the selected respondents. The data concerned was mainly credit access opportunities, the various agricultural equipment services provided, the types of equipment requested, willingness to pay for agricultural equipment services provision, etc.

TABLE 1
Research sample structure

Actors	Municipality/crop		Total
	Savè (Soybean)	N'Dali (Maize)	
Cooperative seed farmers	12	10	22
No cooperative seed farmers	55	45	100
Agricultural extension officer	1	1	2
Agricultural equipment service provider	2	9	11
Presidents of agricultural cooperatives	4	1	5
Total	74	66	140

Data analysis

Collected data was analyzed using the descriptive statistics. The annual net margin was used to assess the performance of agricultural equipment service provision. This net margin is obtained by deducting the product of costs, made up of variable and fixed costs [21,22]. The activity is profitable when the net margin is positive [23]. The fixed costs of providing mechanized services are invariable, whatever the level of service provided. They include depreciation of equipment, rental of premises or facilities, insurance, interest payments and workforce (salaries). Variable costs, however, are linked to the level of services provided, and may increase or decrease with the level of service.

The binary logit model was used to identify the determinants of willingness to pay for agricultural equipment provision services. The variables introduced into the model to identify the determinants of willingness to pay for equipment rental services according to each cropping operation include age, household size, gender, number of farm assets, and secondary activity, and production experience, level of education, land tenure and total area (Table 2). As mechanized and digital technologies are more attractive to young people, they show more intention to adopt mechanization [10]. Older farmers are often more comfortable with their habits of a lifetime [24]. This could explain some farmers' reluctance towards new technologies. A negative sign is then expected concerning the effect of age on willingness to pay for agricultural mechanization services.

The years of farming in agriculture can influence positively or negatively the consent to use a mechanized service. Agricultural experience facilitates the adoption of innovations by reducing the perceived risk [25]. Gender can influence willingness to pay for a machine service. Men have more access to information and are more likely to adopt technologies. The arduousness of manual work could make machinery attractive to women, if they can afford it. A positive or negative sign is expected regarding the effect of gender on willingness to pay for mechanization services.

Education increases the sense of innovation, skills, and ease of appreciation of new technologies. The farmer's education level favors the adoption of innovations [26]. Household size and number of assets can also positively or negatively influence willingness to pay for mechanized services. Having a secondary activity can influence producers' willingness to use mechanized services for their farm operations. Farmers with larger areas will be more inclined to use mechanization [24]; hence the expected positive signs of this variable.

TABLE 2
Summary of the explanatory variables and expected sign of the farmer's willingness to pay for the provision of agricultural equipment services

Variables	Modality	Expected signs
Age	Quantitative variable	-
Crop	0=No 1=Yes	±
Household size	Quantitative variable	±
Sex male	0=No 1=Yes	±
Number of farm assets	Quantitative variable	+
Secondary activity	0=No 1=Yes	+
Farming experience	Quantitative variable	±
Access to education	0=No 1=Yes	+
Access to land	0=No 1=Yes	±
Farm size (Ha)	Quantitative variable	+

RESULTS AND DISCUSSION

Socio-economic and demographic characteristics of seed growers

Table 3 provides a detailed overview of respondents' socio-economic characteristics. Key findings reveal that a significant majority are men (88%), with an average age of 49 years, with farming as their main activity (93.75). Most respondents acquire land primarily through inheritance (72.5%), which suggests a traditional approach to land ownership. The average size of their seed farms is 4.80 (± 4.17) ha, with an average available area of 41.6 ha (± 79.33) for the seed production. This indicates farmers' potential to expand their productive areas if they have access to productive resources. The average number of dependents is 11.77 (± 13.65), with an agricultural workforce (salary) of 38.23%. This low rate could be explained by the unavailability of labor (workforce) as farmers are forced to rely on costly and scarce casual labor. Easy access to financial services is a prerequisite for making competitive investments.

TABLE 3
Socio-economic characteristics of respondents (%)

Variable	Modality	Cooperative seed farmers (n=22)		No cooperative seed farmers (n=100)		Average
		Maize (N'Dali)	Soybean (Savè)	Maize (N'Dali)	Soybean (Savè)	
Gender	Male	91	86	100	75	88
	Female	9	14	0	25	12
Age	-	50.3 (± 12.26)	48.33 (± 9.41)	52.09 (± 11.86)	48.85 (± 10.72)	49.22 (± 10.57)
Main occupation	Agriculture	90	92	95	98	93.75
	Other	10	8	5	2	6.25
Land access	Inherited	72	71.5	85	62	72.5
	Purchased	18	19.5	5	31	18.5
	Gift	10	9	10	7	9
Area of seed production	-	7.33 (± 6.50)	3.54 (± 1.58)	7.33 (± 6.50)	4.8 (± 4.17)	4.8 (± 4.17)
	-	7.33 (± 6.50)	3.54 (± 1.58)	7.33 (± 6.50)	4.8 (± 4.17)	4.8 (± 4.17)
Area available for seed production	-	23.75 (± 19.87)	23.75 (± 19.87)	23.5 (± 19.22)	4.16 (± 79.33)	41.6 (± 79.33)
Household size	-	16.2 (± 19.66)	8.08 (± 2.64)	14.18 (± 18.79)	11.95 (± 13.96)	11.77 (±13.65)
Education level	No formal	28	36	42	46	38
	Primary	37	35	30	33	33.75
	Secondary	23	21	22	18	21
	University	12	8	6	3	7.25

Financing opportunities for seeds production

Access to agricultural credit is a main constraint in the study areas. Microfinance institutions are the primary source of financing for most seed farmers (86%). However, they perceive that the credit they receive falls short of their needs by 50%. The estimated financing requirement for seed farmers to adequately invest in their farming activities is 1,473,076.92 FCFA. However, seed farmers' sources of productive resources are essentially

based on their income from growing other crops, off-farm income, tontines (revolving informal credit groups), and loans from friends, relatives, and loan sharks. The period for requesting and granting agricultural credit from microfinance institutions is usually between February and July each year. The interest rate ranges from 19 to 24%. Credit repayment deadlines also vary depending on the institutions and are generally quarterly, semi-annual, and annual. However, seed farmers are not yet satisfied with the credit opportunities offered by microfinance institutions since the credit system is not adapted to them.

The credit system is not well-suited to the needs of seed farmers, as microfinance institutions offer credit with a maximum duration of one year, whereas the agricultural production and seed marketing often extend beyond this timeframe. Modern development theory [27,28] states that financial market imperfections influence decisions regarding the accumulation of human and physical capital. Thus, an adapted financial credit system is essential to support the establishment of seed production units that meet the necessary production and conservation standards for quality seed supply.

This study highlights the financing constraints affecting the seed sector. Several studies on other sectors have already mentioned these constraints [29,5]. These constraints are linked to access to credit, in the form of high interest rates, repayment conditions unsuited to agricultural activities and insufficient credit.

However, the agricultural sector operates within a risky environment, marked by challenges such as inadequate water management, uncertain market conditions and price instability. These risks limit investment in the agricultural sector [27]. To mitigate these risks, microfinance institutions incorporate land ownership into the politico-legal and institutional criteria of accessing formal credit [5]. Although microfinance institutions fall far short of meeting the needs of rural populations, they still offer a range of strategies for meeting their financial needs.

Farmers' constraints related to financing service access have a negative impact on hired agricultural labor because self-financing does not allow farmers to sow a large area [30]. Therefore, providing support for agricultural equipment is essential to reduce reliance on extensive production methods. However, public and private actions aimed at the development of mechanization in Benin are essentially consisting of providing agricultural equipment or services. These actions, although they meet farmers' needs are not based on an in-depth analysis aimed at identifying, characterizing and building a solvent demand.

Use of agricultural equipment in seed production

The level of agricultural equipment use differs not only between crop operations, but also between crops (Figure 1). The most mechanized pre-harvest operations are plowing and sowing. The most mechanized post-harvest operations include threshing/shelling, sorting by size and seed cleaning, packaging and transport with the highest proportions of mechanization for these tasks observed in the municipality of N'Dali. In contrast, seed sorting, cleaning, and packaging are still performed manually in Savè. However, soil preparation, maintenance, fertilizer spreading and harvesting are carried out manually by seed farmers in both municipalities. This aligns with a study by Hinou et al. [31] which showed that plowing, threshing/shelling and transport are also the most mechanized operations in agricultural activities, but that sowing operations are still manual. Our study found that soil preparation and harvesting operations remain manual. Investing in agricultural equipment will intensify farming production and improve farmers' income and their quality of life [24]. Post-harvest mechanization has a positive impact on the quality of agricultural product, which is a key element for the product differentiation to better satisfy the clients [32].

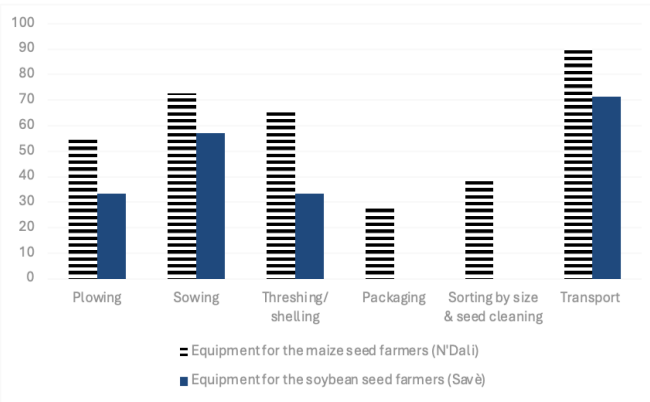

Figure 1) *Use of agricultural equipment in seed production*

The high cost of modern agricultural equipment, combined with difficult access to finance, explains why farmers own little equipment. Two seed farmers have tractors in a good condition in N'Dali, while no farmers have any such equipment in Savè. According to MAEP [33], N'Dali has only 4 power tillers and 48 privately-owned tractors. On the other hand, access to modern agricultural equipment in Savè is facilitated by service providers from Nigeria who come to offer plowing services on a short-term basis. Yet this supply of equipment services is unable to meet the demand, offering an interesting opportunity for local equipment rental initiatives in Savè.

Cooperative seed farmers' willingness to pay for agricultural equipment hire

Farmers demand equipment services for soil preparation, plowing, sowing, weeding, harvesting, threshing/shelling, sorting by size and seed cleaning, seed treatment/conditioning, packaging and transport. The prices that the cooperative seed farmers are willing to pay for equipment services vary from one activity to another and from one crop to another (Figure 2). The use of agricultural equipment services will allow cooperative seed farmers to be more efficient, limiting the drudgery of the work, so they can devote more time to other activities. According to Awo et al. [6], the development of agricultural equipment services is crucial for supporting farmers in the mechanization of agricultural activities, for all crops. The acquisition of agricultural equipment by seed cooperatives would be an opportunity to satisfy the demand of their members, and generate profits.

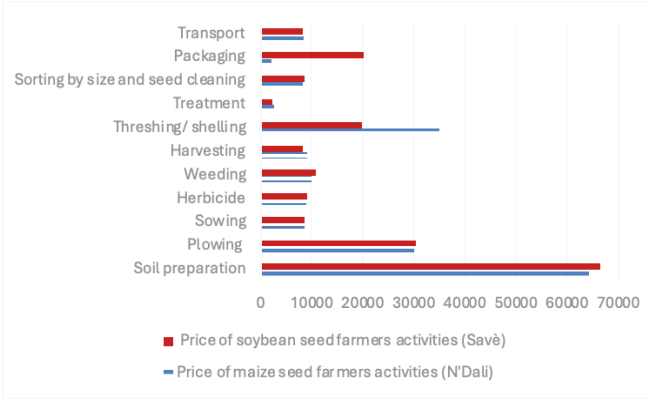

Figure 2) *Cooperative seed farmers' willingness to pay for agricultural equipment provision services*

No cooperative seed farmers' demand for agricultural equipment services

Seed farmers who are unaffiliated with cooperatives are another target group for agricultural equipment rental services in the study areas. Their main demands are for soil preparation, plowing, sowing, harvesting, threshing, storage and transport in both municipalities. Agricultural

mechanization would allow these farmers to work more land, and potentially increase their incomes [10]. The prices that independent seed farmers are willing to pay differ according to the agricultural activities. But soil preparation is the most expensive operation (60,000 FCFA or 92 USD).

Determinants of willingness to pay for mechanized soil preparation services

The regression model that identifies the factors determining willingness to pay for mechanized services is significant for soil preparation at the 1% level (Table 4). The results show that 6 variables: Age, household size, number of assets, number of years' experience in agriculture, gender and secondary activities significantly influence willingness to pay for mechanized soil preparation services. The positive marginal coefficients significant at the 1% level for the variables: Number of assets, secondary activity, number of years of experience, indicates that these variables positively influence willingness to pay for mechanized soil preparation services.

TABLE 4
Result of regression model

Variables	Coefficient	Standard error	Z	Sign
Age	-0.307**	0.008	-3.48	0.001
Household size	-0.437**	0.179	-2.44	0.015
Number of assets	1.190***	0.36	3.28	0.001
Farming experience (Years)	0.229***	0.082	2.77	0.006
Soybean crop	0.303	0.8	0.38	0.705
Gender	-3.035*	1.62	-1.86	0.062
Education level	-1.056	0.997	-1.06	0.29
Secondary activity	2.887***	0.923	3.13	0.002
Access to land	0.121	0.752	0.16	0.872
Constant	9.12	3.32	2.74	0.006
-2loglikelihood=-27.096				
Khi 2=79.56				
P=0.0000				
Pseudo R^2=0.5948; n=100				

The study showed that the farmers who have a secondary activity are more willing to pay for agricultural equipment services. Similarly, those with greater agricultural assets demonstrate a higher willingness to invest in these services. Farmers with more assets (including land) are probably more willing to pay for machinery to compensate for labor shortages. Nowadays, rural areas have an aging population as young people are losing interest in farming. This raises questions about the strategies needed to feed a rapidly growing population with fewer farmers [34]. The most experienced farmers have a favorable predisposition towards agricultural equipment services. Thus, agricultural experience facilitates the adoption of innovations reducing perceived risk.

Negative and significant marginal coefficients at thresholds of 1; 5 and 10% respectively for the variables age, household size and sex show that these variables negatively influence seed farmer's willingness to pay for the mechanized soil preparation service. However, younger farmers are more engaged in the use of mechanized soil preparation service those older farmers, who may be more comfortable with older technologies [24,35].

Findings also reveal that a large household size significantly increases farmers' expenses and limits their ability to make profitable agricultural investments. Gender has a significant effect on willingness to pay for a mechanized soil preparation, as women are more predisposed to pay for this service. These results suggest that the willingness of unaffiliated seed farmers' to pay for machine services depends on their socio-demographic and economic characteristics. Previous studies have shown that socio-economic characteristics influence farmers' decision towards innovations adoption [36].

Income and expenses for agricultural equipment provision services

Table 5 shows the income and expenses linked to the plowing service. Analysis of this table shows that annual income from plowing service represents respectively 3,696,000 FCFA and 3,000,000 FCFA in N'Dali and Savè. Expenses represent respectively 2,294,400 and 2,200,000 FCFA in N'Dali and Savè. The difference between revenues and expenses in each municipality is positive, indicating the profitability of the plowing service. Table 5 also presents the income and expenses linked to the threshing/shelling service in the municipalities of N'Dali and Savè. It appears that the income linked to the threshing/shelling service represent respectively 2,000,000 FCFA and 1,000,000 FCFA for maize and soybeans production. The difference between income and expenses is positive; which states that the threshing/shelling service generates profit.

TABLE 5
Income and expenses from plowing and threshing/shelling services

N°	Items	Plowing		Threshing/Shelling	
		Maize/N'dali	Soybean/Savè	Maize/N'dali	Soybean/Savè
1	Machine acquisition cost (FCFA)	10,904,000 (± 1 427 187,4)	10,000,000	600,000	500,000

2	Income				
	Price of service provision (ha)	38,000 (± 4000)	30000	40000	20000
	Area (ha)	97,4 (± 35,3)	100 ha	-	-
	Quantity (ton)	-	-	50	50
	Total of income (FCFA)	3,696,000 (± 1 453 844,6)	3000000	2000000	1000000
3	Expenses				
	Fuel	352000 (± 96 000)	400000	100000	75000
	Maintenance and repairs	362000 (± 140627,2)	300000	120000	60000
	Workforce (salary)	490000 (± 77717,4)	500000	160000	200000
	Depreciation (over 10 years)	1,090,400 (± 142718,7)	1000000	120000	100000
	Total of expenses (FCFA)	2,294,400	2,200,000	500000	435000
4	Annual income (FCFA)	1,401,600 (± 1535289,6)	800000	1,500,000	565000

Table 6 shows the income and expenses which are respectively 1000000 FCFA and 515000 FCFA and related to the sorting by size and seed cleaning service. The difference between income and expenses is positive, which shows that the calibration service generates a profit. Table 6 also presents the income and expenses related to the transport service. The difference observed between income and expenses is positive. This indicates the profitability of the transport service.

TABLE 6

Income and expenses from sorting by size/seed cleaning and transport services

N°	Items	Sorting by size and seed cleaning (Maize and Soybean)	Transport (Maize and Soybean)
1	Machine acquisition cost (FCFA)	1000000	1200000
2	Income		
	Price of service provision (ton)	10000	10000
	Quantity (ton)	100	100
	Total of income (FCFA)	1000000	1000000
3	Expenses		
	Fuel	150000	150000
	Maintenance and repairs	65000	200000
	Workforce (salary)	100000	250000
	Depreciation (over 10 years)	200000	120000
	Total of expenses (FCFA)	515000	720000
4	Annual income (FCFA)	485000	280000

Table 7 shows the income and expenses associated with a seed treatment/ conditioning. The difference observed between income and expenses is positive (1,075,000) and shows the profitability of the activity.

TABLE 7

Income and expenses from seed treatment/conditioning services

N°	Items	Price
1	Income	
	Price of service provision (bag of 110 kg)	1500
	Quantity of bag	3000
	Total of income (FCFA)	4500000

2	Expenses	
	Fuel	325000
	Maintenance and repairs	50000
	Work force (salary)	3000000
	Insurance	50000
	Total of expenses (FCFA)	3425000
3	Annual income (FCFA)	1075000

CONCLUSION

Investment to encourage agricultural mechanization is an essential factor for improving farmers' income. However, financing opportunities available in the study areas through microfinance institutions do not meet farmers' credit needs for agricultural equipment purchase. Thus, the level of accessibility and use of agricultural equipment remains low in the municipalities of Savè and N'Dali in Benin. Nevertheless, the demand for agricultural equipment service exists in the municipalities, given the excessive needs of farmers in terms of agricultural mechanization. Seed farmers' cooperatives are the main target for providing agricultural equipment services. Farmers who are not affiliated with cooperatives also demand these services. This external demand offers an opportunity for seed production cooperatives to diversify the supply of services to non-members to earn additional income.

The study also showed that respondents' willingness to pay for an agricultural equipment service is a function of the farmers' socio-economic and demographic characteristics, e.g., number of assets, secondary activites, and years of farming experience positively influence willingness to pay for equipment service. Financing of modern agricultural equipment by seed cooperatives could guarantee improved agricultural production and productivity.

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