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Socio-environmental Analysis and Financial Profitability of the Efficiency of Agricultural Machinery on Rice and Maize Fields in Benin

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Agriculture requires sustainable mechanization in Benin to increase production. This study analyzes the socio-environmental impact and financial efficiency of mechanized agricultural equipment. We adopted a methodology that integrated bibliographic research, observations, in-depth analyses and surveys in Lalo. Data analysis indicates that agricultural mechanization improves soil permeability

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and reduces the greenhouse effect. Socially, it contributes to the reducing of poverty, working time and labour costs. However, constraints such as the unavailability of tools, breakdowns, and negative impacts such as soil depletion and air pollution are noted. It causes unemployment and requires significant investments. The majority (88.89%) of the machines were mainly rented, costing 70,000 FCFA for small equipment and 50,000 FCFA for heavy equipment per hectare. For rice production, the income of a producer using motorized tillers far exceeds (109,400 F) that of using traditional tools (43,632 F). An increase of 60.12% (65,768 F). The income of a producer using tractors for corn production is higher (80,700 F) than that using traditional tools (48,599 F). We observe an increase of 39.78 per cent (32,101 F). Repairs are complex. Recommendations, such as access to agricultural credit, improved access to equipment, and the training of producers, aim to promote sustainable mechanization.

Keywords: Agricultural machinery-equipment; performance; efficiency; tillage; impact; economy; environment.

1. INTRODUCTION

Agriculture in developing countries such as Benin, faces major challenges difficulties : Great independence from natural rainfall, which is increasingly unpredictable ; a deficit in energy power that does not make it possible to considerably reduce the arduousness of agricultural work, to intensify production and thereby reduce the effect of the first difficulty in this region of the world [1,2,3,4]. These difficulties have led to problems including food insufficiency because with population growth, demand exceeds supply. Each country has found some solution to intensifying production. To revitalize agricultural growth, the Ministry of Agriculture has developed a strategic plan for the revival of the agricultural sector (PSRSA). This plan, adopted by the Council of Ministers in June 2008, aims to make Benin an agricultural power [5,6,7,8,9,10,11] and [12,13,14]. Therefore, with the arduous nature of farmers' work, the Beninese government opted for a first campaign between 2008-2009 to mechanize its agriculture and acquire various agricultural equipment [12,13,14,15,16,17]. To modernizethe agricultural sector in Benin, structures were created and the National Society of Agricultural Mechanization (SoNaMA) was created on April 28, 2021. This development resulted from the transformation of the National Agency for Agricultural Mechanization created in 2019. With the introduction of agricultural machines in recent years, there is reason to be interested in the consequences and the reaction of the population to progress Bodiguel, 1975, agricultural machines have impacts, whether positive or negative, on the area in which they are used. It is in this context that we chose Techno Agro-Industrie (TAI), a company manufacturing agricultural equipment which intervenes with the structures created by the government to intensify agriculture. So, we ask ourselves several questions : What socio-environmental impacts are linked to the use of machines and what efficiencies impact financial profitability ? This work offers potential for knowledge building regarding the link between theory and practice regarding agricultural mechanization. Thus, during this study, it was a question of assessing the use of agricultural machinery by farmers from a socio-environmental and economic point of view; to collect their perceptions from them and to finally analyze and propose sustainability approaches for the better efficiency of agricultural machinery.

2. METHODOLOGY

2.1 Study Environment

The Municipality of Lalo is located in the southeast of the Couffo department and covers an area of 432 km². The commune has a total cultivable area of approximately 30,000 ha, including around 1,300 ha of lowlands. Its capital, Lalo-centre, is 150 km from Cotonou, the economic capital of Benin, 42 km from Aplahoué, the capital of the department, and 42 km from the historic capital (Abomey). It is located at 6°55'00'' North latitude and 1°53'00'' East longitude. The Municipality of Lalo (Fig. 1) is limited to the north, by the Municipalities of Klouékanmè (Couffo) and Agbangnizoun (Zou); to the south, by the Municipality of Bopa (Mono); to the west, by the Municipalities of Dogbo and Toviklin and to the east, by the Municipalities of Zogbodomè (Zou) and Toffo (Atlantique).

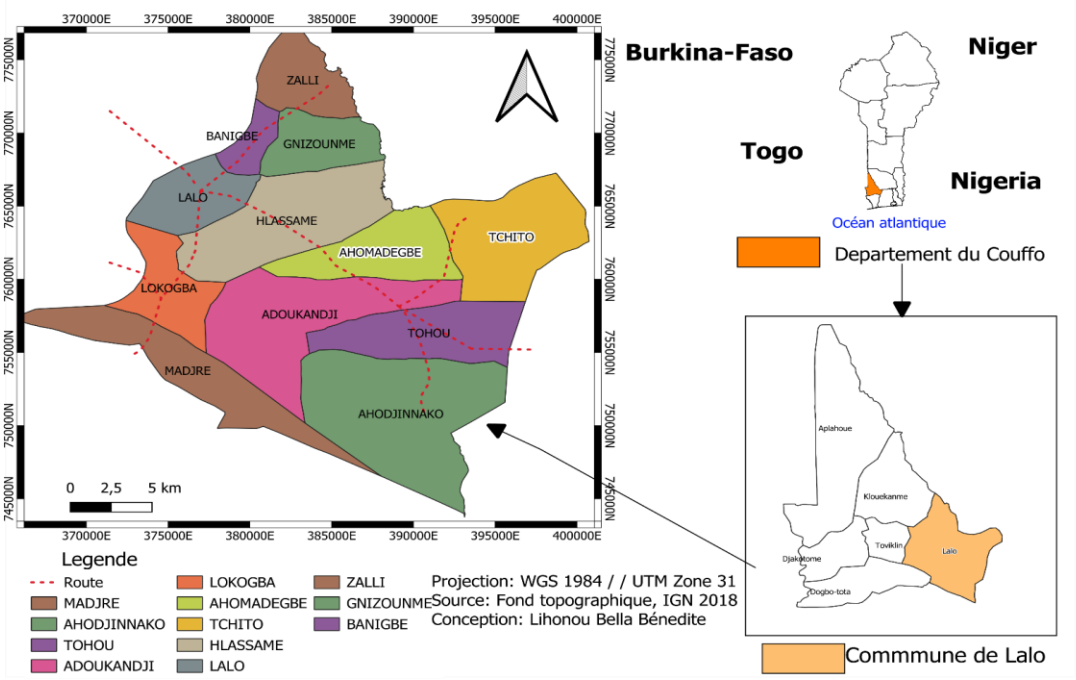

Fig. 1. Situation of the commune of Lalo and location of the study sites in Benin

3. MATERIALS AND METHODS

The different materials used in carrying out this study consisted of equipment such as measuring materials (survey questionnaires and the interview guide to collect data in the field; a tape measure for the different measurements; a magnifying glass for analyze the porosity; a GPS to record the geographical coordinates to create the map of the site) and soil, plant and masonry materials (cutter for mowing and trimming the vertical part of the layers; a shovel to be able to dig; a auger to drill the soil and a field sampler (sampling tube and bags for samples).

The working methodology adopted as part of this study is as follows : the preparatory phase, documentary research, data collection and finally the processing of the collected data.

3.1 Collecting Data in the Field

Choice of sites : The sites were chosen based on the donation status and use of the machines over the past decades. In-depth observations were made at each site.

Interviews based on questionnaires : Interviews with people specialized in the environmental field and agricultural mechanization initially made it possible to develop the questionnaire following criteria. Then, questionnaires were prepared on cards to collect information from village producers, agricultural households, machine owners, drivers and others in the village. It takes into account the following aspects : the use of mechanized agricultural equipment ; the cost linked to the use of mechanized equipment (maintenance, fuel, etc.) and other indirect costs linked to the agricultural campaign (labour, provision of services), the producers' perception of the use of agricultural machines on the environment and their social life, the evaluation of producers' income with mechanization by making a pre- and post-mechanization evaluations. Thus, we selected the districts of Tchito and Ahomadégbé in the commune of Lalo, given that they are the only ones to benefit from mechanized agricultural equipment in recent years of the Beninese State. We carried out direct interviews from door to door and questioned some of them during their visits to the board of directors and presidents of the cooperative unions of rice farmers in the area. In total, 106 people were attended, mostly men. It should be noted that a limited number of women use these machines.

Sampling

- Sample characteristics
- Location of the surveyed sample

Thus, from the survey, 106 agricultural households were retained, i.e. approximately 5 per cent of the total households in the villages, comprising of 20,110 households for the two districts. Including 61.3 per cent of people surveyed in Ahomadégbé village, located in the district of Ahomadégbé and 38.6 per cent from the villages of Hessa and zouhomè in the district of Tchito. Of the 106 people surveyed, only 36.76 per cent were registered. 36.76 per cent of the machine users belong to a group, that mainly produces rice. In addition, 79.48% of these users have an education (higher level : 10.80%, 3rd to tld : 7.69%, 6th to 3rd : 33.33%, CI to CM2 : 28.20%), which contrasts with those who do not use it and are not part of groups. This demonstrates that access to education influences agricultural mechanization, thus highlighting the importance of access to information and knowledge.

Primary study in the field : After identifying the site, we searched for areas where ploughing was performed using tractor, tiller and hoes to carry out the first soil analyses.

Sampling method : The samples were taken using a manual auger, and a tube to dig a 50 cm mini ditch and a tube was used to observe the rooting, porosity, level of turning, colour and texture of the ground.

Rooting and color : We used the sense of observation to identify the presence of roots at each level. Therefore, using a tape measure, we measured the levels of large roots, fine roots and levels of absence of roots ; and for the colour, it was done by eye.

Soil porosity : In the field, the presence of pores visible to the naked eye in the unstructured mass of the horizon or in the structural units was evaluated following the standards based on magnifying observations [12,13,14,15].

Texture : The texture of the horizon was determined by crushing and rolling a sample between fingers in dry and wet conditions.

3.2 Data Processing

At this stage, we applied two approaches :

- The analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT) made it possible to understand the problems of using agricultural machinery for production, its efficiency and to identify the positive and negative effects and constraints linked to mechanization to to take inventory of strengths, weaknesses, opportunities and threats.
- The use of word and data processing software such as : Word 2019, Excel 2019, QGIS and Google Forms used to process, describe and analyze statistical data relating to various calculations, the creation of flowcharts, diagrams and maps.

All these methodological tools made it possible to obtain the different results presented.

4. RESULTS AND DISCUSSION

4.1 Constraints, Advantages and Disadvantages of Agricultural Mechanization in Benin

Some authors worked on agricultural machinery which they published in articles. From the articles consulted, we collected information on the reasons for non-use of machines and some advantages of mechanization. The study identified major obstacles to agricultural mechanization in Benin. The main reasons for the non-use of agricultural machinery are the high cost of rental, non-grubbing, scarcity of tractors available for rental and the lack of information on these machines [18,19,20]. In addition, agricultural machinery is rarely used for sowing, weeding, fertilizing and harvesting. The unavailability of spare parts is also a major concern for farmers in southern Benin. In addition, the poor implementation of agricultural policy, the predominance of small producers and the lack of monitoring are responsible for the lack of agricultural credit that stimulates agriculture. The lack of outlets can be attributed to the lack of market protection and the absence of a price stabilization policy according to producers. The advantages of tractors recognized by producers include task speed, yield improvement and adaptation to large farms. To encourage the use of tractors, producers suggest granting credit at low interest rates and promoting stump removal [21,18,19,20,9,10]. The authors have worked on the financial profitability of agricultural machinery. Thus, from the documents collected, we retained that : the use of mechanized agricultural equipment has had positive impacts, such as an increase in cultivated areas, accumulated production and improved yields, particularly for crops such as corn and rice. The use of inputs has also promoted adaptation to climate change. But despite mechanization, farmers' agricultural

Table 1. Location of households

Pole	Department	Municipality	Borough	Village	Workforce	Percentage
05	Couffo	Lalo	Ahomadegbé Chito	Ahomadegbé Hessa Zouhome	65 41	61.3 38.6
Total workforce					106	100

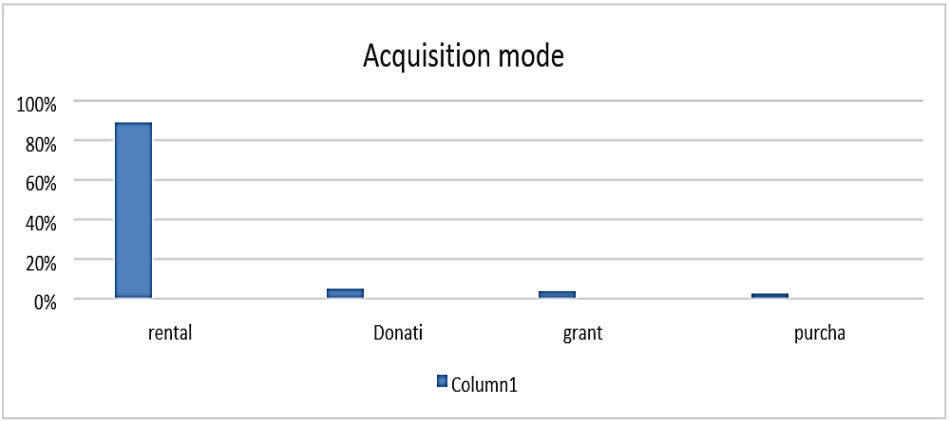

Fig. 2. Machine acquisition method

incomes remain low, and agriculture remains mainly subsistence. Costs related to equipment maintenance, labour and inputs impact farmers' net incomes [21,18,19,20].

4.2 Acquisition of Machines

For the 81 people surveyed who used the machines, the most common method for acquiring them was rental, which was 88.89 per cnet. For the other modes, the rates were very low, so we have 2.47 per cent for payment by own funds, 3.70 per cent by subsidy and donations by 4.94 per cent.

This grouping of producers facilitates good collaboration in terms of paid services for agricultural operations. Thus, they encourage national support funds and save time.

4.3 Comparison of the Impacts of Agricultural Machinery on the Village's Agro-Pedological Land in Terms of Mechanization and Traditional Ploughing

The land was dug up to a depth of 50 cm.

- ➢ Land ploughed by tractor
- ➢ Land ploughed with the tiller
- ➢ Land ploughed with traditional tools

From observations made in the field, we note that the places where ploughing was carried out with machines, the ploughing is deeper, the soil is more disturbed at a great depth. This allows the roots to develop well and the plants to absorb enough organic matter and water for growth. This is not the case with traditional work tools that are shallow.

4.4 Socio-Environmental Impacts of the use of Agricultural Machinery

➢**Positive effect** : Mechanization has many advantages. We can quote on:

The Social plan : Mechanization makes it possible to reduce the working time because using a machine makes the work faster. It compensates for labour shortages caused by immigration to cities with the most active workforce populations. It actually reduces labour costs because instead of paying several people for agricultural work, this work is carried out by only a tractor driver or technician. It reduces the arduousness of ploughing for the producer who must constantly bend down for ploughing. It reduces poverty because, with machines, we can produce a lot of crops and attract more young people to agricultural production because there are no longer too many difficult tasks to perform and youth unemployment is reduced. As far as health is concerned, mechanization makes it

Table 2. Data collected from the tractor field

Depth	Typology	Colour	Observation
At 18 cm	Sandy clay permeable	Dark/black	Big root
20 cm (from 18 cm to 38 cm)	Clay less permeable	Dark/black	Fine roots
11 cm (from 38 cm to 49 cm)	Clay Compact	Less dark	No roots

*Noticed : *Observation of soil overturning up to a depth of 35 cm*
** After 40 cm depth, there are no more roots*
** Water drainage porosities are noted up to a depth of approximately 38 cm.*

Table 3. Data collected from the tiller field

Depth	Typology	Colour	Observation
At 18 cm	Permeable	Dark/black	Large and fine root
From 19 cm and a little deep	Less permeable	A little dark	Thin roots and not enough roots deeper

*Noticed : * Observation of soil overturning up to a depth of 32 cm*
** After 38 cm, there are no more roots*
** Water drainage porosities are noted up to a depth of 35 cm.*

Table 4. Data collected usingtraditional tools

	Depth	Typology	Colour	Observation
Tools Traditional Functional	At 12 cm	Sandy clay Permeable	Dark	Large and fine roots
	11 cm (from 12 cm to 23 cm)	Sandy clay Less permeable	A little dark	Rare root
	12 cm (from 23 cm to 35 cm)	ClayCompact	A little light and elastic	No roots
	+ Depth	Clay- silt	Clear	No roots

Noticed : *Observation of soil overturning up to a depth of 23 cm ; The roots are not too deep ; Water drainage porosities are noted up to a depth of approximately 24 cm*

possible to avoid certain illnesses, such as hip pain linked to ploughing work and other traditional illnesses; it prevents certain infections linked to the body's sensitivity to certain insects and avoids accidents, such as bites from snakes and other animals during fieldwork.

Table 5. Data collected on the surface area

Crops	Area before mechanization (in ha)	Area after mechanization (in ha)
Rice	80.8	117.6
Maize	29.9	41.2
Other cultures	3.3	8.5
Total	114	167.3

Environmentally : It allows the permeability of the soil because with machine ploughing, the soil is no longer too compact and it is stirred more deeply than for hoes which just plough the surface or rather the weeds at a small depth. It slightly reduces the greenhouse effect because certain crops absorb the gases; thus, mechanization works for abundant production.

Table 6. Collected performance data

Main crops	Yields per hectare before mechanization	Yields per hectare after mechanization
Rice	2 to 2.8 t	4 to 4.5 t
Maize	1.1 t	1.7 t

Negative effects : Information collected in the field shows that mechanization does not only have positive impacts

Social plans : As for the negative impacts on life and the environment, we have : unemployment because the active population that constitutes the workforce has been replaced by machines ; a lot of investment, very expensive repair and maintenance equipment, etc. (All that is the cost of mechanization inputs and others) ; which is not within the reach of peasant families. Several

debts are incurred due to the low yields of small farmers who cannot put aside money to pay for family expenses (food, health, travel, etc.) and the costs linked to mechanization. In terms of health, the impact is greater on the drivers of agricultural machinery. We have illnesses or muscle pain and fatigue from machine vibrations ; driving accidents due to terrain and lung diseases due to fumes entering the nostrils.

Environmentally : Regarding the environment, we have the impoverishment of the soil due to so-called intensive techniques ; air pollution by gases escaping from machines, which is of low intensity but will manifest itself in the long term and soil compaction due to machine tires. Damaged terrestrial ecosystem because machines increase the depth, which has affects on living beings in the environment ; the disappearance of certain species with the increase in surface areas leads to deforestation.

4.5 Comparison of Production Yields with or without Mechanization

Producers use tillers and tractors for work. Rice is the main crop because farmers use tillers for ploughing in mud and for tractors ; it is on dry land that they use it for ploughing other crops.

Evaluation of areas sown with mechanization : For all households surveyed, the total area sown for all crops combined was 239.2 ha (including 167.3 ha on which they use a machine and 71.7 ha where they do not use a machine) after mechanization compared to 185.7 ha before mechanization. An increase of 22.36% in recent years. Mechanization then had a positive impact on the sown area.

Comparison of crop areas before and after production : Of the 167.3 ha of land on which the machines are used, comparisons were made on the area of crops mainly produced. For the main products, we have rice and corn for sale. For other crops, we have : soya, beans, sweet potatoes etc. These crops are crops produced just for consumption.

From the analysis of this table, the area of crops such as rice, corn and other crops before mechanization are respectively 80.8 ha ; 29.9 ha ; 3.3 ha and after mechanization we have : 117.6 ha ; 41.2 ha ; 8.5ha. So we have an increase in rice ; but ; other crops at rates of 31.29% ; 27.43% ; 61.12%.

Comparison of crop yield before and after production : Every year, they produce twice, so we tried to give the yield for the first season.

- **Yield over one season**

The results of yields per hectare before and after mechanization highlight a considerable increase in the yield of both crops (rice and maize) in Benin after mechanization.

Performance evaluation of production : From the analysis made, we observe a considerable increase in the yield of both crops after mechanization. These facts demonstrate the importance of mechanization.

Evaluation of producer average income : It is necessary to determine the average income per hectare of a producer for a production campaign of 1 hectare with mechanization after the expenses incurred. Producers use motorized tillers for rice production and tractors on dry land for ploughing other crops such as corn, etc.

Rice production : We calculated producer income using tillers and traditional tools after production.

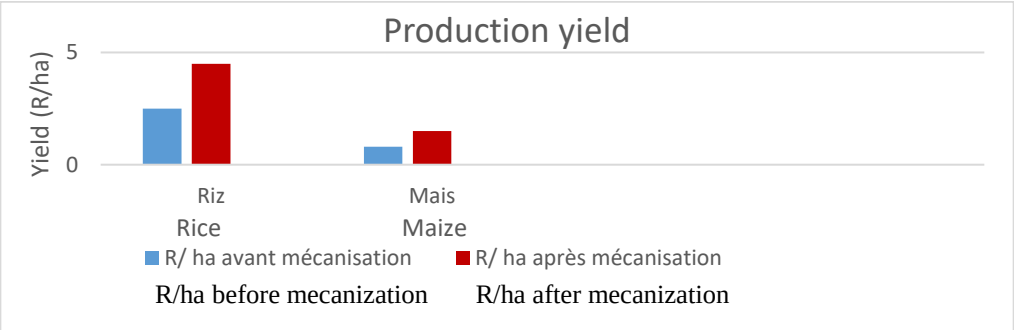

Fig. 3. Yields per ha
R/ ha : yield per ha

Small mechanized equipment (motor tillers) : Producers use mud tillers to grow rice. Thus, we calculated the average income of a producer for rice production.

Traditional tools : The income obtained using the traditional tools by producers for rice production.

From the analysis of Tables 7 and 9 we notice that, for rice production, the income of a producer using motorized tillers far exceeds (109,400 FCFA) that of a producer using traditional tools (43,632FCFA). An increase of 60.12% (65,768 FCFA).

Corn production : Comparison of a producer's income with the use of tractors and traditional tools after production.

Heavy mechanized equipment (tractors) : Tractors are used on dry land by most producers to produce corn. Thus, we calculated the average income of a producer for corn production.

Traditional tools : Income calculations for corn production using traditional tools.

From Tables 10 and 11 we notice that the income of a producer using tractors for corn production is higher (80,700 FCFA) to those using traditional tools (48,599 FCFA). We observe an increase of 39.78 per cent (32,101 FCFA).

Impact of mechanization on income : From all the analyzes carried out, we can say that regardless of the machines used to produce, the income is significantly higher than that obtained with the use of manual or traditional tools. Thus, we can say that mechanization has a positive impact on production areas and income, which have increased over the years.

Table 7. Evaluation of income with the motorized tiller

Activities	Unit price (FCFA)	Quantities	Amount (F CFA)
A-Charges			
Land-equipment			
Land rental	32,000	1ha	32,000
Motor cultivator rental	72,000	1ha	72,000
Total 1	104,000		
Inputs			
Seeds/Rice	500	30 kg	15,000
NPK	22,000	4 bags	88,000
Urea	22,000	2 bags	44,000
Pesticides	4,000	5L	20,000
Total 2	167,000		
Labour			
Herbicide	6,400	1ha	6,400
Mowing	25,000	1ha	25,000
Background fume	3,200	1ha	3,200
Transplanting	24,000	1ha	24,000
Spreading (1 and 2)	6,400	1ha	6,400
Maintenance of bunds	12,800	1ha	12,800
2nd Interview	6,400	1ha	6,400
Avian hunting	25,000	1ha	25,000
Harvest	60,000	1ha	60,000
Pickup	20,000	1ha	20,000
Winnowing	15,000	1ha	15,000
Total 3	204 200		
Other expenses			
Communication costs	15,000	1ha	15,000
Unexpected	30,000	1ha	30,000
Total 4	45,000		
Total A = 1+ 2+3+4	520 200		
B-Profitability			
Turnover	150	4,200kg	630,000
Net revenue	109,800		

Table 8. Evaluation of the depreciation of traditional tools

Designation	Quantities	Unit price (F CFA)	Amount (F CFA)	Lifetime (Year)	Amortization over one year (F CFA)	Amortization over 1 month
Hoe	4 tools	2,000	8000	2	4000	333
Daba	5 tools	2,500	12500	2	6250	521
Machete	3 tools	2,500	7500	2	3750	313
Total						1,167

Table 9. Income assessment using traditional tools

Activities		Unit price (F CFA)	Quantities	Amount (F CFA)
A-Charges				
Land-equipment				
Land rental		32,000	1ha	32,000
Small tools depreciation		1,167	4 months	4,668
Total 1		36,668		
Inputs				
Seeds/Rice		500	25 kg	12,500
NPK		22,000	2 bags	44,000
Urea		22,000	1.5 bags	33,000
Pesticides	Selective herbicide	4,000	1.5 L	6,000
	Total herbicide	5,000	2 L	10,000
Total 2		105,500		
Labour				
Ploughing		35,000	1ha	35,000
Herbicide		6,400	1ha	6,400
Mowing		25,000	1ha	25,000
Background fume		3,200	1ha	3,200
Transplanting		24,000	1ha	24,000
Spreading (1 and 2)		6,400	1ha	6,400
Maintenance of bunds		12,800	1ha	12,800
2nd Interview		6,400	1ha	6,400
Avian hunting		25,000	1ha	25,000
Harvest		50,000	1ha	50,000
Pickup		15,000	1ha	15,000
Winnowing		10,000	1ha	10,000
Total 3		219,200		
Other expenses				
Communication costs		5,000	1ha	5,000
Unexpected		10,000	1ha	10,000
Total 4		15,000		
Total A = 1+ 2+3+4		383 368		
B-Profitability				
Turnover		150	2,800 kg	420,000
Net revenue		43,632		

Table 10. Evaluation of income with the tractor

Activities	Unit price (FCFA)	Quantities	Amount (F CFA)
A-Charges			
Land-equipment			
Land rental	20,000	1ha	20,000
Tractor rental	50,000	1ha	50,000
Total 1	70,000		
Inputs			

Activities	Unit price (FCFA)	Quantities	Amount (F CFA)
A-Charges			
Land-equipment			
Seeds/Maize	200	15 kg	3,000
NPK	22,000	2.5 bags	55,000
Urea	22,000	1.5 bags	33,000
Pesticides	4,000	4 L	16,000
Total 2	107,000		
Labour			
Sowing	14,000	1ha	14,000
Herbicide	12,800	1ha	12,800
Harvest + Collection	15,000	1ha	15,000
Degraining	1,000	17 bags/100kg	17,000
Drying	500	17 bags/100kg	8,500
Total 3	67,300		
Other expenses			
Communication costs	5,000	1ha	5,000
Unexpected	10,000	1ha	10,000
Total 4	15,000		
Total A = 1+ 2+3+4	259,300		
B-Profitability			
Turnover	200	1,700kg	340,000
Net revenue	80,700		

Table 11. Income assessment using traditional tools

Activities		Unit price (F CFA)	Quantities	Amount (F CFA)
A-Charges				
Land-equipment				
Land rental		20,000	1ha	20,000
Small tools depreciation		1167	3 months	3,501
Total 1		23,501		
Inputs				
Seeds: Corn		200	15 kg	3,000
NPK		22,000	1.5 bags	33,000
Urea		22,000	1 bag	22,000
Pesticides	Selective herbicide	4,000	1.5L	6,000
	Total herbicide	5,000	2L	10,000
Total 2		74,000		
Labour				
Ploughing		20,000	1ha	20,000
Sowing		14,000	1ha	14,000
Herbicide		6,400	1ha	6,400
Harvest + Collection		10,000	1ha	10,000
Degraining		1,000	11 bags/100kg	11,000
Drying		500	11 bags/100kg	5,500
Total 3		66,900		
Other expenses				
Communication costs		2,000	1ha	2,000
Unexpected		5,000	1ha	5,000
Total 4		7,000		
Total A =total 1+ 2+3+4		171,401		
B-Profitability				
Turnover		200	1,100 kg	220,000
Net revenue		48,599		

4.6 Some Avenues or Approaches to Solutions to Overcome the Negative Impacts of Agricultural Mechanization in Benin

Due to the various constraints and difficulties faced by producers, as well as the few negative impacts linked to mechanization, we have proposed, with the help of producers and resource people, some possible solutions. We then retain the following to reduce these difficulties. This will involve : training producers to use agricultural equipment efficiently because each type of soil and each crop corresponds to an appropriate ploughing speed and depth ; establishing local outlets for spare parts at affordable prices in localities ; training mechanics to maintain agricultural machinery ; subsidising producer groups so that they can acquire agricultural machinery.

4.7 Sustainability Approach to Efficient use of Agricultural Machinery

Stakeholders in the agricultural sector must understand that agricultural mechanization is not an end in itself but rather, a means of supporting sustainable agricultural development. The use of agricultural equipment is part of a complex agricultural system, and its usefulness must be verified by social, economic and environmental factors. Agricultural mechanization must be the optimal combination of human, animal and motorized energy, depending on the political, economic and social contexts. The government should create a favourable environment for actors in agricultural mechanization, by improving access to agricultural equipment and inputs, facilitating access to agricultural credit, and by strengthening support and advice systems for farmers in transition towards mechanized agriculture. It is also essential to restore soil fertility by integrating agriculture and livestock, promoting the use of organic smoke, and using agricultural inputs and soil and water conservation technologies. These actions can help increase agricultural productivity and reduce poverty.

5. CONCLUSION

This study carried out on agricultural mechanization allowed us to show the impact of agricultural mechanization in agriculture on different levels and to evaluate the agricultural income of farmers in the commune of Lalo in Benin. Analyzes of the data from the survey carried out showed that agricultural mechanization is not well developed. Due to the level of choice of equipment of farmers, which is essentially mechanical ploughing equipment and the most used is the motor cultivator with the strawberry (91.36 per cent); As for the tractor, few people use it. The method of access to this mechanized equipment is essentially rental and they pay service fees; shopping and other modes are very low. The use of mechanized agricultural equipment has had many positive impacts in the agricultural sector, but they are not without constraints and disadvantages. The positive impacts include, among other things, the reduction of arduous work ; poverty reduction ; reduction of labour costs ; soil permeability. As for the negative impacts we have : soil impoverishment ; soil compaction ; unemployment ; investments, very expensive maintenance repair equipment etc. Agricultural machines have a positive impact on the profitability of agricultural production, notably the evolution of the sown area sown and the increase in the quantity of production. Thus, we have, among other things, an improvement in agricultural yields and an evolution in the production area. Agricultural mechanization has made it possible to favour and intensify the production of certain crops, mainly rice and corn. Note that the impact of agricultural mechanization has been significant due to the joint use of inputs which allows agriculture to adapt to climate change. However, despite the positive points of mechanization, many constraints still need to be overcome for its development in the field of mechanization. The different lessons learned from this investigation led us, with the help of the farmers themselves and the people in the resource field, to formulate solutions to these problems and also to approaches the sustainability of agricultural mechanization in the commune of Lalo, more precisely Benin in general. The study of this theme allowed us to study mechanization on all levels, and taught us to put all our theoretical knowledge into practice.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1. Bibliographic review on the subject
2. Summarize the Socio-environmental analysis and financial profitability of the efficiency of agricultural machinery on rice and maize areas in Benin
3. Formulas and statistical analyzes to process my results.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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