

Socio-environmental analysis and financial profitability of the efficiency of agricultural machinery on rice and maize areas in Benin

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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, ~~and~~ in-depth analyzes and surveys in Lalo. Data analysis indicates that agricultural mechanization improves soil permeability 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~~are 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 that~~ 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% (32,101 F). Repairs are complex. Recommendations, such as access to agricultural credits, ~~improving~~ access to equipment, and ~~the~~ training of producers, aim to promote sustainable ~~development of~~ mechanization.

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

1. INTRODUCTION

Agriculture in developing countries such as Benin, ~~is faced with~~ major ~~challenges~~ difficulties: ~~Very~~Great independence from natural rainfall, which is increasingly unpredictable; a deficit in energy power ~~that which~~ 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 (Mamai, 2001). These difficulties have led to problems including ~~that of~~ food insufficiency, because with ~~the~~population growth ~~in population size~~, demand exceeds supply. ~~For an intensification of production,~~ Each country has found some solutions ~~to intensifying production~~. With the aim of revitalizing agricultural growth, the Ministry of Agriculture has developed a strategic plan for the revival of the agricultural sector (PSRSA); ~~T~~this plan, adopted by the Council of Ministers in June 2008, aims to make Benin an agricultural power (Moussa G. 2013) and (MAEP, 2010). ~~Therefore,~~ ~~So~~ with the arduousness ~~nature~~ of farmers' work, the Beninese government opted for a first campaign between 2008-2009 ~~for the to~~ mechanization ~~of~~ its agriculture and acquired various agricultural equipment (MAEP, 2010). ~~Still for the To~~ modernization ~~of~~ the agricultural sector in Benin, structures were created and the National Society of Agricultural Mechanization (SoNaMA) was created on April 28, 2021. ~~This development~~ ~~It~~ 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), ~~which is~~ a company

manufacturing agricultural equipment and which intervenes with the structures ~~thus~~ created by the government ~~to for an intensification of~~ agriculture. So, we ask ourselves several questions: What ~~are the~~ socio-environmental impacts ~~are~~ linked to the use of machines and what ~~are these~~ efficiencies ~~impact on~~ financial profitability? This work offers potential for knowledge building regarding the link between theory and practice ~~on 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 ~~s~~ from them and to finally analyze and propose sustainability approaches for ~~the~~ better efficiency of agricultural machinery ~~yes~~.

2. METHODOLOGY

Study environment

The Municipality of Lalo is located ~~in the South-East of~~ the Couffo department and covers an area of 432 km². The commune has a total cultivable area of ~~approximately estimated at around~~ 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" ~~N~~orth latitude and 1°53'00" ~~E~~ast longitude. The Municipality of Lalo (fig 1) is limited ~~to~~ the ~~N~~orth, by the Municipalities of Klouékanmè (Couffo) and Agbangnizoun (Zou); ~~to~~ the ~~S~~outh, by the Municipality of Bopa (Mono); ~~to~~ the ~~W~~est, by the Municipalities ~~from of~~ Dogbo and Toviklin ~~and~~; ~~to~~ the ~~E~~ast, by the Municipalities of Zogbodomé (Zou) and Toffo (Atlantique).

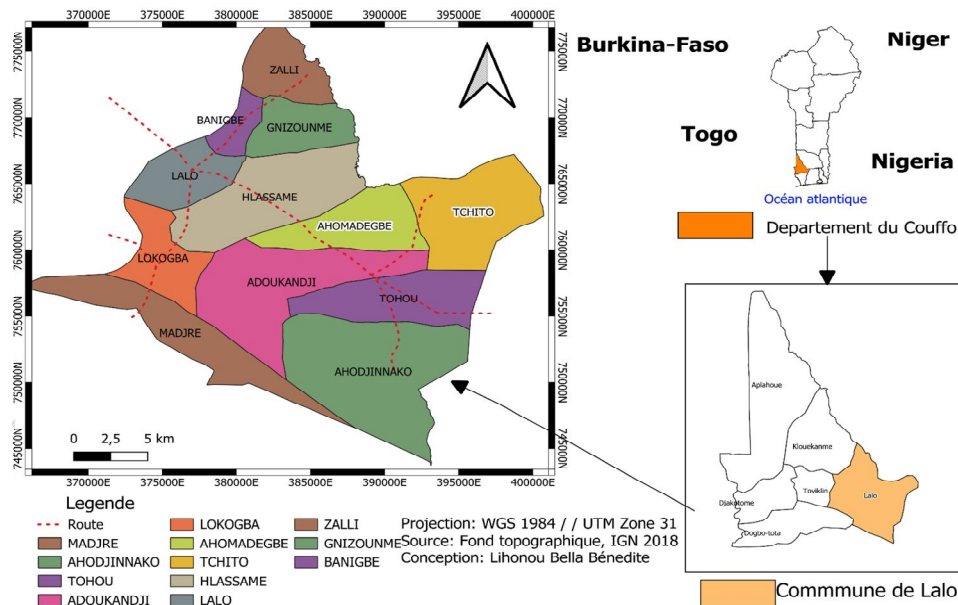


Fig. 1. Situation of the commune of Lalo and location of the study sites in Benin

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 in order to create the map of the site) and the 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.

➤ **Collecting data in the field**

❖ **Choice of sites**

The sites were chosen based on the donated status and use of these 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, and 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 also questioned some of them during their visits to the board of directors and the presidents of the cooperative unions of rice farmers in the area. In total, 106 people were attended, mostly men. It should be noted that there are a limited number of women using these machines.

Sampling

- **Sample characteristics**
- **Location of the surveyed sample**

Table.1. Location of households

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

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Thus, from the survey, 106 agricultural households were retained, i.e. approximately 5% per cent of the total household in the villages, which is comprising of 20,110 households for the

two districts. Including 61.3% per cent of people surveyed in ~~the village of~~ 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 at~~ 106 people surveyed, only 36.76% per cent were registered. 36.76% per cent of ~~the~~ machine users belong to a group, ~~that~~ mainly ~~on~~ produce rice production. In addition, 79.48% of these users have an education (higher level: 10.80%, 3rd to 1st: 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~~ that access to education influences agricultural mechanization, thus highlighting the importance of access to information and knowledge.

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† Primary study ~~done~~ in the field

After identifying the site, we ~~looked~~ searched for areas where ploughing ~~was~~ done ~~performed with using the~~ tractor, tiller and hoes to ~~be able to~~ carry out the first soil analyses.

Sampling method

The samples were taken using ~~the~~ manual auger, and ~~with~~ a tube to dig a 50 cm mini ditch ~~of 50 cm~~ and using a tube was used to observe ~~see~~ the rooting, ~~the~~ porosity, ~~the~~ 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, So~~ using a tape measure, we measured the levels s of large roots, fine roots and levels of absence of roots; and for the colour ur, 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 observation ~~of~~ (Guedioura-Djidjelli. I, 2017).

• Texture

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

> Data processing

At this stage, we ~~applied~~ used two approaches:

† The analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT) ~~which~~ that 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 in order to take inventory of ~~S~~ s strengths, ~~W~~ w weaknesses, ~~O~~ o opportunities and ~~T~~ t 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

1- Constraints, advantages and disadvantages of agricultural mechanization in Benin

Some authors ~~had to~~ 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 ~~s~~ 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, ~~the~~ scarcity of tractors available for rental and the lack of information on these machines (Article 6, Ahounsou et al., 2019). In addition, agricultural machinery is rarely used for sowing, weeding, fertilizing and harvesting. The unavailability of spare parts ~~is~~ also ~~constitutes~~ 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 ~~to 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 of tasks~~, ~~yield improvement of yields~~ and adaptation to large farms. To encourage the use of tractors, producers suggest granting credit at low interest rates and promoting stump removal (Ahounsou et al., 2019) and (Moussa G., 2013). ~~The a~~ 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 incomes ~~remains~~ low, and agriculture remains mainly subsistence. Costs related to equipment maintenance, labour ~~ur~~ and inputs impact farmers' net incomes (Koudougou M. 2015).

2- Acquisition of machines

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

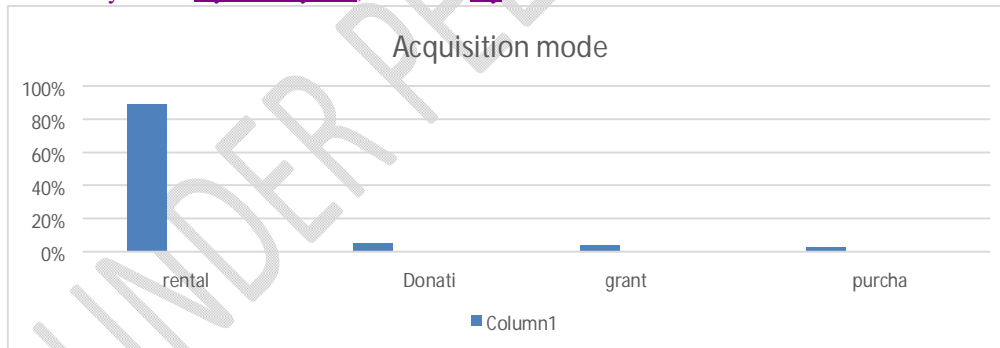


Fig.2.Machine acquisition method

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

3- Comparison of the impacts of agricultural machinery on the village's agro-pedological land in terms of mechanization and traditional ploughing wing.

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

> Land ploughed by tractor

Table. 2.Data collected from the tractor field

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

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Noticed :

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

> Land ploughed with the tiller

Table .3.Data collected from the tiller field

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

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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 35cm.

> Land ploughed with traditional tools

Table.4.Data collected using in the field of traditional tools

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

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Noticed :

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

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 their development/growth. This is not the case with traditional work tools that/which are shallow.

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 ~~with the using a machine makes the work is~~ faster. It compensates for labour shortages caused by immigration to the cities ~~with of~~ the most active workforce populations, ~~which constituted the workforce~~. It actually reduces labour costs because instead of paying several people for agricultural work, ~~this work is carried out by with~~ only a tractor driver or technician, ~~this work is carried out~~. It reduces the arduousness of ploughing for the producer who must constantly bend down for ploughing. It reduces poverty, because with the 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 carry out and reduces youth~~ unemployment ~~is reduced~~. As far as health is concerned, mechanization makes it possible to avoid certain illnesses, such as hip pain linked to ploughing work and others ~~traditionally illness~~; 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 field work.

‡ 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 ~~which just weed~~ the weeds at a small depth. It ~~slightly~~ reduces the greenhouse effect ~~because a little because~~ certain crops absorb the gases; thus, mechanization works for abundant production.

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

❖ ~~On the s~~ Social plans

As for the negative impacts on life and the environment, we have: unemployment because the active population ~~that which~~ 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 ~~money~~ aside ~~money~~ to pay ~~for~~ family expenses (food, health, travel, etc.) and ~~pay~~ the costs linked to mechanization. In terms of health, the impact is ~~greater~~ more 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 ~~which~~ will manifest itself in the long term and soil compaction due to machine tires. Damaged ~~the~~ terrestrial ecosystem because ~~with~~ machines ~~increase~~ the depth, ~~which has is~~

~~greater and this will have~~ effects on living beings in the environment ; the disappearance of certain species with the increase in surface areas ~~which~~ leads to deforestation.

5- Comparison of production yields with or without mechanization

Producers use tillers and tractors for work. Rice ~~production~~ is the main ~~crop production~~ because ~~farmers they~~ 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 amounts to~~ 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 over~~ recent years. Mechanization then had a positive impact on the ~~sown~~ area ~~sown~~.

➤ 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 ~~which are~~ for sale. For other crops, we have: soya, beans, sweet potatoes etc. ~~...~~ these crops are crops produced just for consumption.

Table .5.Data collected on ~~the~~ surface area

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

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 ~~respectively~~ of 31.29%; 27.43%; 61.12%.

❖ Comparison of crop yield before and after production

~~For e~~Every year, they produce twice, so we tried to give ~~the for a first season the yield for the first season~~.

➤ Yield ~~for over~~one season

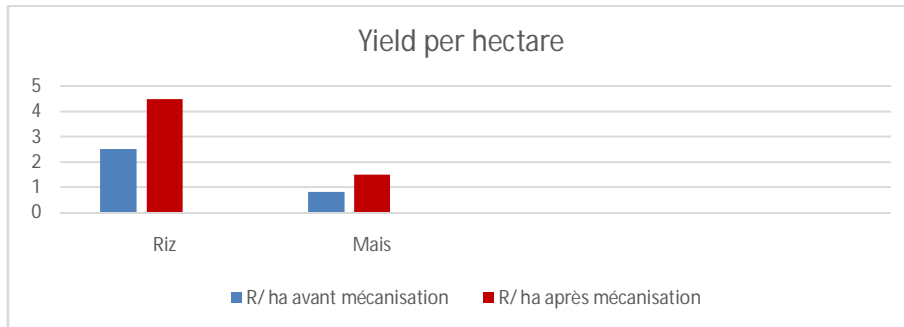
Table.6.Collected performance data

| Main crops | Yields per hectare before mechanization | Yields per hectare after mechanization |
|-------------------|--|---|
| Rice | 2 to 2.8 t/ha | 4 to 4.5 t/ha |
| But | 1.1 t/ha | 1.7 t/ha |

• Performance evaluation

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R/ ha: yield per ha

Fig.3. Yields per ha

From the analysis made, we see observe a considerable increase in the yield of both crops after mechanization. These facts demonstraeshow the importance of mechanization.

❖ Evaluation of the producer average income for a producer

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

➤ Rice production

Here wWe have calculated producer the income of a producer with the usinge of tillers and traditional tools after production.

• Small mechanized equipment (motor tillers)

Producers use mud tillers for to grow rice production. Thus, we calculated the average income of a producer for rice production.

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 | 30kg | 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 |

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| | | | | |
|--------------------------------|---------|---------|---------|---------------------|
| Mowing | 25,000 | 1ha | 25,000 | Formatted: Centered |
| Background fume | 3,200 | 1ha | 3,200 | Formatted: Centered |
| Transplanting | 24,000 | 1ha | 24,000 | Formatted: Centered |
| Spreading (1 and 2) | 6,400 | 1ha | 6,400 | Formatted: Centered |
| Maintenance of bunds | 12,800 | 1ha | 12,800 | Formatted: Centered |
| 2nd Interview | 6,400 | 1ha | 6,400 | Formatted: Centered |
| Avian hunting | 25,000 | 1ha | 25,000 | Formatted: Centered |
| Harvest | 60,000 | 1ha | 60,000 | Formatted: Centered |
| Pickup | 20,000 | 1ha | 20,000 | Formatted: Centered |
| Winnowing | 15,000 | 1ha | 15,000 | Formatted: Centered |
| Total 3 | 204 200 | | | |
| Other expenses | | | | |
| Communication costs | 15,000 | 1ha | 15,000 | Formatted: Centered |
| Unexpected | 30,000 | 1ha | 30,000 | Formatted: Centered |
| Total 4 | 45,000 | | | |
| Total A =total-1+ 2+3+4 | 520 200 | | | |
| B-Profitability | | | | |
| Turnover | 150 | 4,200kg | 630,000 | Formatted: Centered |
| Net revenue | 109,800 | | | |

- **Traditional tools**

The income obtained using with the use of the traditional tools by producers for rice production.

Table 8. Evaluations 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 | Formatted: Centered | |
| Small tools depreciation | 1,167 | 4 months | 4,668 | Formatted: Centered | |
| Total 1 | | | 36,668 | | |
| Inputs | | | | | |
| Seeds/Rice | 500 | 25kg | 12,500 | Formatted: Centered | |
| NPK | 22,000 | 2bags | 44,000 | Formatted: Centered | |
| Urea | 22,000 | 1.5bags | 33,000 | Formatted: Centered | |
| Pesticides | Selective herbicide | 4,000 | 1.5L | 6,000 | Formatted: Centered |
| | Total herbicide | 5,000 | 2L | 10,000 | Formatted: Centered |
| Total 2 | | | 105,500 | | |
| Labour | | | | | |
| Ploughing | 35,000 | 1ha | 35,000 | Formatted: Centered | |
| Herbicide | 6,400 | 1ha | 6,400 | Formatted: Centered | |
| Mowing | 25,000 | 1ha | 25,000 | Formatted: Centered | |
| Background fume | 3,200 | 1ha | 3,200 | Formatted: Centered | |
| Transplanting | 24,000 | 1ha | 24,000 | Formatted: Centered | |
| Spreading (1 and 2) | 6,400 | 1ha | 6,400 | Formatted: Centered | |
| Maintenance of bunds | 12,800 | 1ha | 12,800 | Formatted: Centered | |
| 2nd Interview | 6,400 | 1ha | 6,400 | Formatted: Centered | |
| Avian hunting | 25,000 | 1ha | 25,000 | Formatted: Centered | |
| Harvest | 50,000 | 1ha | 50,000 | Formatted: Centered | |
| Pickup | 15,000 | 1ha | 15,000 | Formatted: Centered | |
| Winnowing | 10,000 | 1ha | 10,000 | Formatted: Centered | |
| Total 3 | | | 219,200 | | |
| Other expenses | | | | | |
| Communication costs | 5,000 | 1ha | 5,000 | Formatted: Centered | |
| Unexpected | 10,000 | 1ha | 10,000 | Formatted: Centered | |
| Total 4 | | | 15,000 | | |
| Total A =total-1+ 2+3+4 | | | 383 368 | | |
| B-Profitability | | | | | |
| Turnover | 150 | 2,800 kg | 420,000 | Formatted: Centered | |
| Net revenue | | | 43,632 | | |

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 the one~~ 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 ~~the majority most of~~ producers ~~for to produce~~ corn ~~production~~. Thus, we calculated the average income of a producer for corn production.

Table-10. Evaluation of income with the tractor

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| Activities | Unit price (FCFA) | Quantities | Amount (F CFA) |
|--------------------------------|-------------------|---------------|----------------|
| A-CHARGES | | | |
| Land-equipment | | | |
| Land rental | 20,000 | 1 ha | 20,000 |
| Tractor rental | 50,000 | 1 ha | 50,000 |
| Total 1 | | | 70,000 |
| Inputs | | | |
| Seeds/Maize | 200 | 15kg | 3,000 |
| NPK | 22,000 | 2.5 bags | 55,000 |
| Urea | 22,000 | 1.5 bags | 33,000 |
| Pesticides | 4,000 | 4L | 16,000 |
| Total 2 | | | 107,000 |
| Labour | | | |
| Sowing | 14,000 | 1 ha | 14,000 |
| Herbicide | 12,800 | 1 ha | 12,800 |
| Harvest + Collection | 15,000 | 1 ha | 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 | 1 ha | 5,000 |
| Unexpected | 10,000 | 1 ha | 10,000 |
| Total 4 | | 15,000 | |
| Total A =total 1+ 2+3+4 | | | 259,300 |
| B-Profitability | | | |
| Turnover | 200 | 1,700kg | 340,000 |
| Net revenue | | | 80,700 |

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- **Traditional tools**

Income calculations for corn production using traditional tools.

Table-11. Income assessment with using traditional tools

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| Activities | Unit price (F CFA) | Quantities | Amount (F CFA) |
|-----------------------|--------------------|------------|----------------|
| A-CHARGES | | | |
| Land-equipment | | | |
| Land rental | 20,000 | 1 ha | 20,000 |

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

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% (32,101 FCFA).

❖ Impact of mechanization on income

From all the analyzes carried out, we can say that regardless whatever of the machines used to produce, the income earned 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.

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; subsidize producer groups so that they can acquire agricultural machinery.

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 based on social, economic and environmental factors. Agricultural mechanization must be the seen as 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, by facilitating access to agricultural credit, and by strengthening the 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 application 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 also 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%); 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 etc. As for the negative impacts we have: soil impoverishment; soil compaction; unemployment ; a lot of investments, very expensive maintenance repair equipment etc. Agricultural machines have a positive impacts on the profitability of agricultural productioners' agricultural production, notably the evolution of the sown areas sown and the increase in the quantity of production. Thus, we have, among other things, thean improvement inof agricultural yields and; an evolution ofin the production area. Agricultural mechanization has made it possible to favour and intensify the production of certain crops, mainly the production of rice and corn. Note that the impact of agricultural mechanization has been significant due thanks to the joint use of inputs which increasingly allows agriculture to adapt to climate change. However, But 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 fieldpeople, to formulate ~~some~~ solutions to these problems and also to approaches~~to~~ 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.

UNDER PEER REVIEW

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