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Research Article

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Influence of Mechanized Soil Cultivation on Rice Growth and Yield in the Senegal River Valley

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Abstract: In northern Senegal, rice cultivation has been experiencing a decline in yields in recent years, mainly due to poor control of soil fertility and tillage practices. This decline in soil fertility is largely the result of an inadequately managed mechanization policy. This study therefore aims to analyze the influence of motorized soil tillage on rice growth and yield. To achieve this, a complete block experimental design with a single factor was set up (two treatments were assigned to this factor: minimal tillage with three depths and conventional tillage with three depths). Six treatments, each represented by 100 m² plots, were carried out in each parcel. The results showed that shallow tillage treatments (5 cm and 15 cm) offered advantages for growth variables. However, overall, deep tillage proved more effective at maturity, particularly in terms of grain yield. Thus, treatment T4 (20 cm) stood out with yields of 1000 kg/ha, followed by treatment T6 (40 cm). These findings highlight the importance of tillage depth in promoting the development of cereal crops, particularly rice.

Keywords: Motorized soil tillage, influence, rice cultivation, yield

1. Introduction

Senegal is currently experiencing significant changes in its agri-food systems. Food demand is increasing, putting food security at risk. Despite notable agricultural growth rates, the sector remains vulnerable to climatic shocks, which threaten yields and the economic stability of farmers. Agricultural yields remain below the global average, and rising input prices make achieving food security even more challenging. The COVID-19 pandemic and global food crises have exacerbated these issues, disrupting supply chains and heightening existing vulnerabilities. To shape a sustainable and prosperous agricultural landscape in Senegal, it is essential to identify an integrated strategy that balances economic, social, and environmental needs along with the associated challenges.

The use of mechanization and/or motorization in agricultural operations could represent an important factor in agricultural production and a catalyst for rural development. Agricultural mechanization has indeed become an indispensable tool for making farming operations efficient and productive, enabling farmers to increase their income. It can help expand cultivated areas, overcome time constraints related to performing two cropping seasons per year thanks to faster intervention, and promote the use of suitable equipment. In the Senegal River Valley, the use of agricultural motorization is relatively old. The first machines were introduced after the Second World War [Kanté, 1995]. Since then, mechanization has continued to grow. Motorized operations, to varying degrees, include pumping, soil tillage, harvesting, threshing, and processing. These operations are largely associated with rice cultivation, the main cereal grown in the area. Soil tillage is generally carried out on dry land and consists mainly of plowing (conventional tillage), cover-crop tillage ("offsetting" or minimum tillage), or ridging [Kanté, 1995].

Despite these major advances, rice yields—which had been steadily increasing over the years—are now declining. For the 2019 season, paddy rice production fell by 4.2% compared to 2018 [ANSD, 2019]. This decline may be explained by the negative effects of agricultural mechanization on soil conservation. With this mechanization shift, soil erosion has intensified on agricultural land, requiring the development of guidelines to reduce its impacts. The expansion of mechanization and the emergence of increasingly heavy machinery have worsened soil degradation on farmland. Changes in cropping practices, including mechanized soil tillage, lead to soil compaction, depletion of organic matter, and erosion [Dahou *et al*., 2018].

Efficient and sustainable use of motorized tools (soil tillage equipment) to increase rice yields while preserving soil quality has therefore become essential. This raises the key question: Which motorized soil tillage method would allow for better rice productivity? It is within this broader context that this study was conducted on “the influence of motorized soil tillage on rice growth and yield.” The objective of this study is to contribute to improving rice yields through the use of machinery.

2. Materials and Methods

Description of the study area

This study was conducted in the village of Ndiaye, located 35 km from Saint-Louis along National Road No. 2, in the arrondissement of Ndiaye Ngént, Dagana Department (16°14’ N, 16°14’ W, 9 m altitude). The region is characterized by flat terrain and an elevation generally below 100 meters, which favors the development of irrigated crops such as vegetables and rice due to the proximity of the Senegal River (SANE, 2018). The area was selected for its strategic importance in agricultural revival programs, which emphasize crop diversification and water management to improve the region’s agricultural trade balance.

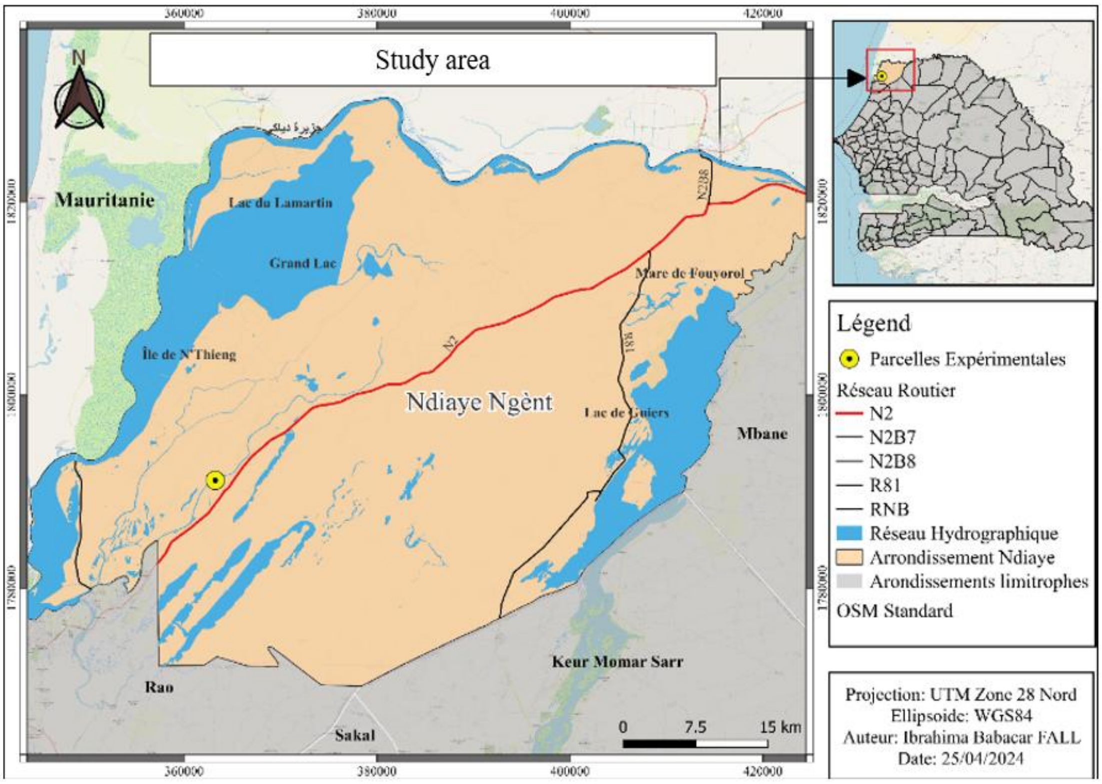

Figure 1: Map showing the location of the study area an experimental setup was established in two distinct plots: one located in the Ndiaye Mbéress rice-growing zone (16.197238; -16.275154) and the other in Lampsar (16.196967; -16.279298).

Materials

The plant material used is the rice variety Sahel 108 (IR 13240-108-2-2-3), officially released in 1994 by the West Africa Rice Development Association (WARDA) and the Senegalese Institute of Agricultural Research (ISRA). It is a short-cycle rice variety commonly grown during the off-season, with potential yields reaching up to 10 tons/ha. It has a sowing-to-heading cycle of 86 days and reaches maturity in 117 days during the hot off-

season. Sahel 108 remains the most widely cultivated variety because it provides high yields, enables two cropping cycles per year, and offers a good milling rate.
The tractor—self-propelled machinery capable of generating substantial traction power—is used to pull, push, carry, or operate various transport, treatment, or soil-working tools. Tractors are characterized, among other features, by engine power, type of traction, tire characteristics, hitching system, and the presence or absence of a power take-off (Wade, 2020).
The tractor model used is the New Holland T6 050, a robust and versatile machine with a power of 125 hp, making it suitable for a variety of agricultural tasks. Equipped with rear tires sized 520/70/38 and front tires sized 420/70/28, it offers optimal stability and traction on different types of terrain. Its radial carcass tire structure ensures enhanced durability and better pressure distribution. The recommended tire pressure is 0.9 bar, ensuring comfortable driving and adequate ground contact. With a forward speed of 6 to 8 km/h, this tractor efficiently completes farming operations while maintaining optimal productivity.
The moldboard plow (often mistakenly called a “share plow”) is a soil preparation tool used for plowing, a deep tillage technique that cuts and inverts a strip of soil.
In this study, the Nardi MEC20T0/Z3CN7 model was used. This agricultural implement, equipped with three bodies, provides efficient and versatile plowing capacity, allowing large areas to be worked effectively. Its mounted-reversible design facilitates maneuvering and ensures precise plowing.
Also called a “cover-crop” when the disc diameter exceeds 610 mm, the offset disc harrow is a shallow tillage tool used for soil loosening, weed destruction, or stubble breaking at working depths ranging from 5 to 15 cm. It consists of two disc gangs arranged in a laterally open V-shape, working the same strip of soil with opposing disc sets.
The tool used in this study is the Quivogne APL24D rotary harrow, a self-supporting cover crop implement. It provides excellent weight distribution across the discs, ensuring effective and uniform soil tillage.
A complete randomized block design with a single factor was established at each site (Ndiaye Mbéress and Lampsar). The factor studied was soil tillage, with two modalities, each applied at three working depths:
• Minimal tillage: 5 cm, 10 cm, and 15 cm
• Conventional tillage: 20 cm, 30 cm, and 40 cm
Minimal tillage corresponds to offset discing (soil working without inversion, with superficial mixing of organic matter).
Conventional tillage corresponds to plowing (operation performed using a moldboard plow, cutting and inverting the soil layer).
Figure 2: Experimental design
Six treatments with four replications were implemented in each of the two blocks. The four replications were represented by four sub-blocks, each containing the six treatments arranged randomly. The treatments were represented by square plots of 10 m × 10 m. The sub-blocks and treatments were separated by 1 m paths, helping limit external influences between plots.
The total area of the blocks is 0.48 ha, i.e., 0.24 ha per block. In total, 24 plots were installed at each site (48 plots in total).

Crop Management

Broadcast sowing was carried out manually in a 5 cm sheet of water at a rate of 80 to 120 kg/ha, with an average of 100 kg/ha. For each experimental unit, 1 kg of certified Sahel 108 seed was used. It should be noted that the seeds were soaked in water for 24 hours beforehand to break dormancy. Water management in the plots followed the method adopted by SAED in the Senegal River Valley schemes:
- Low water level during the vegetative phase (5 cm water depth);
- Higher water level during the reproductive phase (10 cm water depth);
- No water between the dough stage and maturity (complete drainage of the plot).

The following irrigation program was applied:
- Sowing was performed in a 5 cm sheet of water maintained until the 7th day;
- Drainage from the 8th to the 10th day after sowing to allow good root establishment;
- Water depth raised again to 5 cm until the 19th day after sowing;
- Drainage on the 19th day for herbicide application (2 days), followed by urea application (4 days);

- Water depth raised again to 5 cm until panicle initiation;
- Lowering water depth to 5 cm for urea application (4 days);
- Increasing water depth to 10 cm until the dough stage (15 days after flowering);
- Complete drainage at the dough stage so that the soil is dry at maturity.
- Fertilization in irrigated rice is a critical step in production and significantly contributes to yield. It was carried out in two stages: basal fertilization and top-dressing.

Basal fertilization: 100 kg/ha of DAP (18-46-0) applied during soil preparation, i.e., 1 kg of DAP per experimental unit.

Top-dressing: Urea was used as top-dressing fertilizer in two applications at a rate of 250–300 kg/ha, with an average of 275 kg/ha. Each treatment unit therefore received 2.75 kg of urea:
- 40% at the beginning of tillering (1.1 kg per experimental unit);
- 40% at panicle initiation (1.1 kg per experimental unit);
- 20% at stem elongation (0.55 kg per experimental unit).

Phytosanitary treatment targeted weed control. Systemic herbicides—Propanil combined with Weedone—were used to control grasses, sedges, and broadleaf weeds. Herbicide application was performed on the 40th day after sowing (to account for weed infestation assessment) at a dose of 8–10 L/ha for Propanil and 1 L/ha for Weedone, corresponding to 0.09 L and 0.01 L per treatment unit respectively.

The following indicators were used to determine the harvest period:
- 80% of the plants (including the upper part of the panicles) had turned straw-yellow;
- Hulled rice grain cracked under the teeth and appeared clear and hard;
- Grain moisture content ranged between 20 and 25%.

At this stage, the rice had completed 117 days in the field (after sowing). Harvesting included the aerial part (panicles, stems, leaves, etc.) and the root part, providing information on grain yield and on root and shoot biomass.

Data Collection Methods

Field data collection made it possible to obtain all measurements required to calculate the optimal settings of the tractor–implement linkage system (working depth, working width, forward speed, and traction).

Data collection involved observing production parameters during the vegetative and reproductive phases, and yield parameters at maturity.

Production variables were measured at harvest from plants within the yield squares. Five (5) yield squares were installed in each treatment. Manual harvesting was carried out in each yield square of each experimental unit. Production variables included:
- Number of panicles per plant;
- Thousand-grain weight per yield square;
- Paddy weight per yield square;
- Shoot and root biomass per yield square;
- Agro-morphological parameters (plant height and rooting depth).

Height and rooting depth values represent the mean of measurements taken from plants in each yield square. Height was measured from the collar to the tip of the longest panicle or leaf, while rooting depth was measured from the collar to the tip of the longest root. The number of panicles per plant was obtained by dividing the number of panicles per yield square by the number of plants within that square.

Thousand-grain weight, an important yield component, was determined in the laboratory by weighing a sample of 1000 grains. These grains were collected from full grains counted using a Numigral seed counter, and weighed with a precision balance (1/1000 g). A mean value was then calculated to obtain the average thousand-grain weight per treatment (expressed in grams). Grain yield was obtained from harvested yield squares. Grains from each square were weighed to determine yield per square. Yield per hectare (ha) was estimated by extrapolating the average yield per square. This extrapolation was done by multiplying the average yield per square meter (m^2) by 10,000 m^2. Grain yield is expressed in kilograms per hectare (kg/ha): Yield (kg/ha) = (Weight of product from yield squares (kg) / Number of squares (m^2)) × 10,000 m^2. Shoot and root biomass were determined after air-drying, followed by weighing the dry matter using a precision balance. Raw data were processed using Excel (2019). For data analysis (growth and yield data), univariate statistical analyses were performed using R software (version 4.3.0).

3.Results & Discussion

Analysis of the Effect of Motorized Tillage on Rice Grain and Straw Yield

Effect of Motorized Tillage on Plant Height at Maturity

The analysis of variance revealed a significant to highly significant average variation between treatments, based on the mean of the two years, for both Ndiaye Mbéress and Lampsar sites. The highest values were observed under shallow tillage T1 (91.56 cm) for Ndiaye Mbéress and deep tillage T6 (86.31 cm) for Lampsar. For both sites, the lowest values were recorded under deep tillage T4 (84.58 cm) and T5 (79.96 cm), respectively for Ndiaye Mbéress and Lampsar.

The analysis of variance also indicated a moderately significant variation ($p<0.05$) between years for the Lampsar site. In contrast, no significant difference was observed between years for Ndiaye Mbéress. The best performances for plant height at both sites were obtained in the second year under deep tillage T4 (124.70 cm and 109.89 cm) for Ndiaye Mbéress and Lampsar, respectively.

Overall, the analysis of variance showed no significant difference ($p>0.05$) between plowing and offset tillage at the Lampsar site. However, offset tillage produced the best result, with an average height of 83.25 cm compared to 82.08 cm for plowing. Conversely, for the Ndiaye Mbéress site, the analysis revealed a significant difference ($p<0.05$) between offset and plowing, with average heights of 88.49 cm and 86.25 cm, respectively, indicating the dominance of offset tillage.

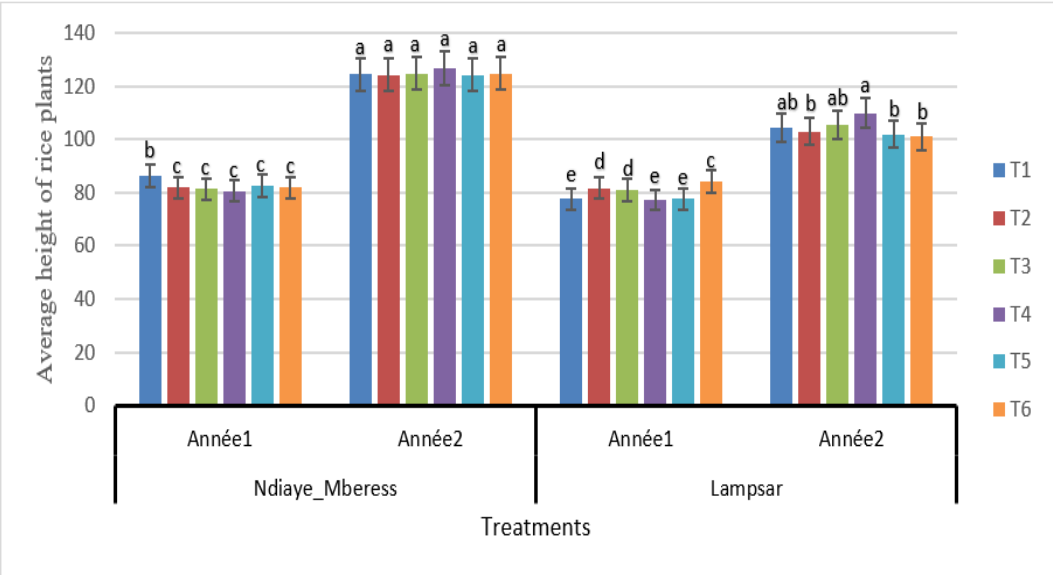

Figure 2: Variation of Plant Height According to Treatments

Effect of Motorized Tillage on Rooting Depth at Maturity

The results highlighted a significant difference between treatments based on the two-year average for the Ndiaye Mbéress site, whereas this difference was not significant for the Lampsar site. Maximum rooting depths were observed under deep tillage (T6, 26.5 cm) and shallow tillage (T1, 26.35 cm) for the Ndiaye Mbéress and Lampsar sites, respectively.

The analysis of variance also showed a moderately to highly significant decrease in rooting depth in the second year for both Ndiaye Mbéress and Lampsar. However, shallow tillage treatments predominated over deep tillage for both sites during both years, except for the first year at Ndiaye Mbéress, where deep tillage treatments were dominant.

The analysis of variance revealed a clear predominance of offset tillage over plowing for both sites, although this difference was not statistically significant.

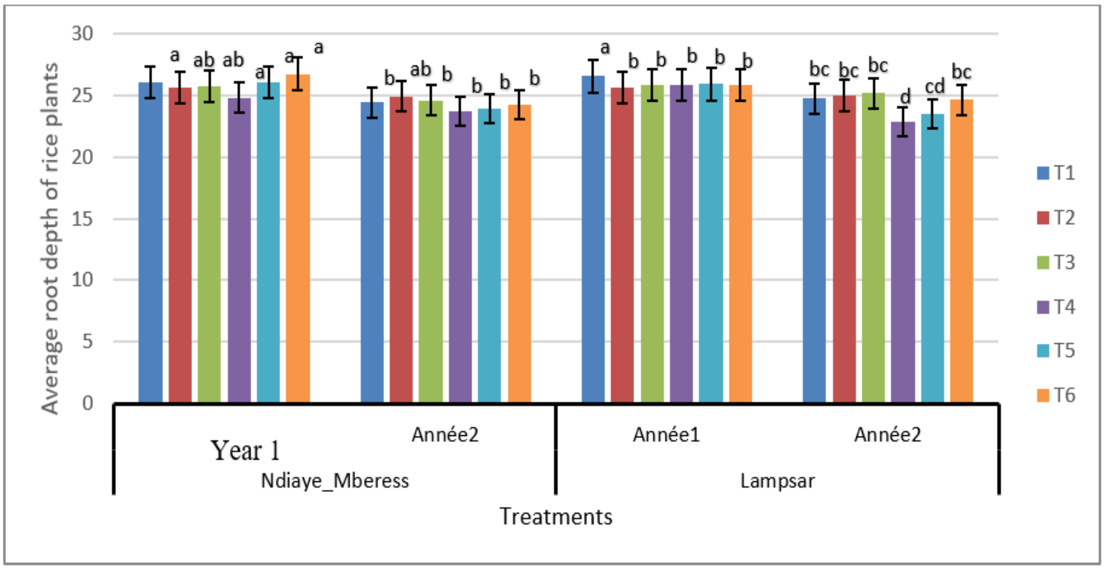

Figure 3: Variation of Plant Rooting Depth According to Treatments

Effect of Motorized Tillage on Straw and Grain Yield Parameters at Maturity

Effects of Motorized Tillage on Straw Yield Parameters

The analysis of variance revealed significant differences between treatments in terms of the two-year average at the Ndiaye Mbéress site for the following variables: number of tillers, above-ground biomass, and root biomass per square meter. Maximum values were observed under shallow tillage treatments for the number of tillers, with T1 reaching 14 tillers. Regarding root and above-ground biomass per square meter, deep tillage treatments gave the best results, with T4 achieving 107.87 g and 223.60 g, respectively, for these two variables.

For the Lampsar site, the analysis of variance showed a significant difference between treatments for the two-year average for the number of tillers and root biomass per square meter. Maximum values were observed for shallow tillage treatments: T1 (14.27 tillers) and T3 (106.13 g), T4 (98.78 g). However, the difference between treatments for above-ground biomass per square meter was not significant. Nevertheless, the best result for above-ground biomass was obtained under shallow tillage treatment T3 (203.28 g).

It was also observed that results increased from Year 1 to Year 2 for variables such as root biomass per square meter at both sites. Conversely, for other variables such as the number of tillers and above-ground biomass, Year 1 produced higher values.

Table 1: Effect of mechanized soil tillage on paddy weight and 1000-grain weight of rice at maturity in the first and second year for the two sites

Treatments	Weight Paddy /m2			PMG/m2		
	Année1	Année2	Moyenne	Année1	Année2	Moyenne
			Ndiaye Mbéress			
T1	$89,87^{abABC}\pm43,04$	$97,97^{abAB}\pm31,65$	$93,92^{a}\pm37,51$	$22,36^{bcCDE}\pm3,49$	$20,36^{cF}\pm2,28$	$21,33^{c}\pm3,06$
T2	$80,97^{abBCD}\pm34,85$	$86,53^{bBCD}\pm38,67$	$83,26^{a}\pm36,00$	$22,30^{bcCDE}\pm3,10$	$20,91^{cDEF}\pm3,53$	$21,73^{bc}\pm3,30$
T3	$66,36^{bD}\pm23,1$	$112,04^{aA}\pm35,67$	$89,20^{a}\pm37,61$	$21,75^{cCDEF}\pm3,42$	$23,01^{aBC}\pm1,53$	$22,38^{bc}\pm2,69$
T4	$100,01^{aAB}\pm47,22$	$97,55^{abABC}\pm18,10$	$98,78^{a}\pm42,18$	$25,25^{aA}\pm1,84$	$22,93^{abBCD}\pm2,13$	$24,09^{a}\pm2,28$
T5	$71,76^{bCD}\pm37,16$	$103,34^{abAB}\pm36,49$	$89,80^{a}\pm39,55$	$22,34^{bcCDE}\pm4,44$	$20,74^{cEF}\pm2,36$	$21,42^{c}\pm3,45$
T6	$88,41^{abBCD}\pm45,$	$96,88^{abABC}\pm26,$	$92,64^{a}\pm36,91$	$24,30^{abAB}\pm2,5$	$21,57^{bcCDEF}\pm1,$	$22,94^{ab}\pm2,5$

	38	43		5	80	8
Moyenne générale		82.62	99.81	22.96	21.56	
Pr>F		0.0007343 ***	0,6894	0.0004653 ***	0,0008338 ***	**Pr>F**
			Lampsar			
T1	$73,00^{abBC}$±47,05	$101,06^{aAB}$±43,45	$89,04^{bc}$±46,53	$20,93^{aD}$±3,67	$21,89^{bcBCD}$±1,64	$21,47^{bc}$±2,70
T2	$102,30^{aAB}$±43,15	$103,63^{aAB}$±53,90	$102,96^{ab}$±49,08	$21,02^{aCD}$±3,55	$21,08^{cCD}$±2,01	$21,05^{c}$±2,84
T3	$95,06^{aAB}$±53,06	$109,87^{aA}$±59,69	$102,46^{ab}$±56,25	$22,21^{aBCD}$±3,38	$23,55^{abAB}$±1,99	$22,88^{ab}$±2,82
T4	$78,22^{abBC}$±37,34	$98,88^{aAB}$±32,59	$88,55^{bc}$±36,14	$23,11^{aABC}$±3,82	$22,84^{bcBCD}$±1,85	$22,97^{ab}$±2,97
T5	$64,21^{bC}$±35,03	$95,21^{aAB}$±24,05	$79,71^{c}$±33,56	$21,01^{aD}$±3,42	$23,41^{abAB}$±2,73	$22,21^{bc}$±3,29
T6	$101,57^{aAB}$±45,17	$114,79^{aA}$±39,02	$108,18^{ab}$±42,20	$22,59^{aBCD}$±2,91	$25,10^{aA}$±6,53	$23,85^{a}$±5,14
Moyenne générale	86.28	103.91		21.85	22.98	
Pr>F	0.001613 **	0,008582 **	0.01333 *	0,003746 **		

Effects of mechanized soil tillage on grain yield parameters

Analysis of variance revealed significant differences between treatments in terms of the two-year average at the Ndiaye Mbéress site for the 1000-grain weight per square meter. The highest values were observed under deep tillage treatments, with T4 reaching 24.09 g. However, results show no significant differences between treatments in terms of the paddy weight, although deep tillage treatments, particularly T4 (98.78 g), tended to be superior.

At the Lampsar site, the analysis of variance showed moderately significant differences between treatments for the two-year average of both paddy weight and 1000-grain weight per square meter. Maximum values were obtained under deep tillage treatment T6, with 108.18 g for paddy weight and 23.85 g for 1000-grain weight.

It was observed that paddy weight per square meter increased from year 1 to year 2 at both sites. The analysis also indicated that the 1000-grain weight significantly increased in year 2 at Ndiaye Mbéress, while a non-significant decrease was observed at Lampsar.

4. Discussion

During the growth phase, the variables used to assess the effects of plowing versus offset on rice growth were quite discriminating. Based on the results, the minimum tillage treatments showed better performance than deep tillage treatments, particularly for variables such as plant height, number of roots, and total root length. Treatments T1 and T3 stood out compared to the others. This increase in performance under shallow tillage could be explained by the direct effects of minimum soil tillage (offset) on rice root growth and development, which improves the soil's physicochemical and biological properties for young plants. The upper layers of soil contain more organic matter under shallow tillage systems than in plowing systems. This is due to the lack of incorporation of crop residues in shallow tillage systems. The soil structure, influenced by organic matter content, is more stable in non-plowed soils (Dahou *et al*., 2018).

In soils, organic matter ensures the proper functioning and sustainability of agroecosystems by storing and providing nutrients needed by plants. It stimulates biological activity, plays a central role in soil structure, and contributes to stability against external stresses (rain, compaction, etc.). Organic matter also improves soil permeability, aeration, water retention capacity, and overall stability. Cultural practices influence the maintenance or depletion of organic matter in the soil. Shallow tillage practices (direct seeding, minimum tillage) are better suited than conventional plowing for maintaining soil organic matter (Bellemou, 2012).

However, for root depth, the best performance was observed under deep tillage treatments, particularly T4 and T6. This difference could be related to improvements in certain soil parameters, such as porosity, which favored good root development. Root growth is closely linked to soil porosity. This effect of porosity on rooting is mainly due to two properties: mechanical resistance to penetration and soil aeration (Chopart, 1980). According to Chopart, plowing improves soil porosity and reduces mechanical resistance to root penetration. Studies by Dahou *et al*. (2018) showed that different tillage practices affect soil physical parameters, influencing rooting depth. Higher penetration resistance corresponds to shallower rooting depth.

Results at maturity favored deep tillage for aboveground and root biomass. The best performance across both sites was observed with treatment T4, reaching 223.6 g/m² for aboveground biomass and 107.87 g/m² for root biomass. These results align with the root depth data, where the best result was observed under T6 (26.5 cm). This can be explained by the fact that deep tillage improves soil structure, particularly porosity, which facilitates root development. Conventional plowing therefore promotes better root growth compared to minimum tillage or direct seeding (shallow tillage), resulting in greater plant rooting depth (Dahou *et al*., 2018).

However, only the variables "number of tillers" and "plant height" favored shallow tillage treatments (T1), with 14.31 and 14.27 tillers for Ndiaye Mbéress and Lampsar, respectively.

For grain yield variables, the best performance was obtained under deep tillage, with highly significant differences between treatments. The highest paddy weight per square meter and 1000-grain weight were observed under T4 (100.01 g/m², equivalent to 1000.1 kg/ha, and 24.09 g/m²) for Ndiaye Mbéress and T6 (101.57 g/m², equivalent to 1015.7 kg/ha, and 23.85 g/m²) for Lampsar. This could be explained by the structure of plowed soils, which promotes better root development, ultimately enhancing yield. According to Bellemou (2012), plowing significantly improves soil physical properties, particularly in soils with fragile structures.

Additionally, these results may be explained by the effect of plowing on reducing weed pressure compared to shallow tillage techniques. These findings are consistent with those of Bellemou (2012), who reported higher plot yields in plowed plots compared to minimum or shallow tillage plots. Similar results were observed by Pale *et al*. (2021), where plowing led to substantial increases in grain yield (266–635 kg/ha) compared to other tillage practices. They demonstrated that plowing, by improving soil structure and root system development, had the most beneficial effect on productivity.

These results highlight the importance of plowing compared to shallow tillage. Beyond the tillage method, plowing depth plays a critical role in crop development. In this study, based on yield parameters, deep tillage at 20 cm (T4) clearly outperformed other plowing depths. According to Dahou *et al*. (2018), plowing to a depth of approximately 20 cm is necessary for optimal cereal crop development.

5. Conclusion

This study highlighted the significant impact of plowing and shallow tillage on rice growth and yield during both the vegetative and maturity phases. A series of adjustments on the tractor alone and on the tractor-tool combination were necessary to optimize the use of these machines. These adjustments indicated that additional weight on the front axle was required for the tractor-offset combination at a 15 cm working depth and for the tractor-plow combination at a 40 cm working depth. However, the load distribution on the axles was optimal for other plowing and offset depths. These adjustments improved machine efficiency in the field and optimized fuel consumption while preserving the soil.

Following these adjustments, field experiments on rice cultivation clearly showed that during the vegetative phase, shallow tillage treatments promoted superior performance in terms of plant height, number of roots, and total root length, particularly treatments T1 (5 cm) and T3 (15 cm). Conversely, deep tillage treatments showed more remarkable results at maturity, concerning root depth, aboveground and root biomass, as well as grain yield (treatments T4 (20 cm) and T6 (40 cm)). These results underscore the importance of plowing depth, with depths around 20 cm proving optimal for the development of cereal crops, especially rice. Therefore, hypotheses H1 and H2 were confirmed.

Following this work, we recommend:

• Ensuring compliance with the adjustment schemes for the tractor-tool combination to allow their optimal use;

• Continuing research by extending trials to other rice varieties;
Extending this study over multiple years, incorporating fertilization to achieve higher yields;
• Conducting trials combining plowing and offset tillage to compare these results with those obtained in this study;
Determining the optimal types and depths of soil tillage for other crops, which will likely improve crop productivity and maintain soil fertility.

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References

[1]. ANSD. Regional economic and social situation: Saint-Louis [online]. 2019, 135p.PDF. Available at: https://www.ansd.sn/sites/default/files/2022-12/SES-Saint-Louis-2019.pdf (Accessed 16 February 2024).

[2]. BELLEMOU, A. Study of the results of trials of different durum wheat sowing techniques (Chen's) [online]. 2012, 152p.PDF. Available at: http://dspace.ensa.dz:8080/xmlui/bitstream/handle/123456789/109/bellemou_a.pdf?sequence=1&isAllowed=y (Accessed 16 February 2024).

[3]. BONNEFOND, P. Introduction of mechanization in traditional agriculture [online]. 1970, 13p.PDF. Available at: https://horizon.documentation.ird.fr/exl-doc/pleins_textes/pleins_textes_4/sci_hum/01258.pdf (Accessed 03 February 2023).

[4]. CHOPART, J. L. (1980). Field study of root systems of major rainfed crops in Senegal [online]. PhD Thesis in Plant Production and Product Quality: National Polytechnic Institute of Toulouse, 1980, 219p.PDF (Accessed 06 February 2024).

[5]. CHOPART, J. L., & NICOUS, R. Influence of plowing on root development of various crops in Senegal. Consequences for their water uptake. 1976, 7 28p.PDF (Accessed 22 March 2024).

[6]. CIRAD, Gret, & Ministry of Foreign Affairs. Agronomist's Handbook [online], 2003, 1698p.PDF. Available at: https://www.doc-developpement-durable.org/file/Culture/Agriculture/Memento-de-l-Agronome_CIRAD.pdf (Accessed 04 February 2024) (ISBN: 2-87614-522-7).

[7]. DAHOU, N. M., & ZOKPODO, B. K. L. Impacts of mechanized plowing on soil and crop yields: A critical review. 2018, 12p.PDF (Accessed 15 April 2024).

[8]. DAO, M. Evaluation of yield potential of 250 rice lines in minor beds and lower slope areas in the Banfora lowland ecosystem (Burkina Faso) [online], 2012, 91p.PDF. Available at: https://beep.ird.fr/collect/upb/index/assoc/IDR-2012-DAO-EVA/IDR-2012-DAO-EVA.pdf (Accessed 02 February 2024).

[9]. MANE, C.A., DIEDHIOU, S., GOUDIABY, O.K., SALL, M., GILLET, G. Perception of the mechanization of rice cultivation and its effects on soil in the Senegal River Valley. 2024, 15p.PDF (Accessed 20 August 2024).

[10]. OUEDRAOGO, I. Determining factors for the level of agricultural mechanization and the impact of mechanization on cotton yield and certain soil chemical parameters. Master's Thesis, Polytechnic University of Bobo-Dioulasso, Burkina Faso, 2012, 102p. (Accessed 31 May 2024).

[11]. PALE, S., BARRO, A., KOUMBEM, M., SERE, A., & TRAORE, H. Effects of soil tillage and organo-mineral fertilization on millet yields in the Sudan-Sahelian zone of Burkina Faso. International Journal of Biological and Chemical Sciences, 2021, 15(2). PDF. Available at: https://doi.org/10.4314/ijbcs.v15i2.10 (Accessed 25 March 2024).

[12]. PERNÈS, J. Management of plant genetic resources: Volume 1 – Monographs [online]. Paris: Technique & Documentation- LAVOISIER, 1984, 247p.PDF. Available at: https://horizon.documentation.ird.fr/exl-doc/pleins_textes/2023-11/17443.pdf (Accessed 27 January 2024).

[13]. ZINGORE, S., LYDIA WAIREGI, & MAMADOU KABIROU NDIAYE. Guide for the management of rice cropping systems, 2014, 60p.PDF. Available at: https://africasoilhealth.cabi.org/wpcms/wp-content/uploads/2016/06/French-Rice-Guide-A5-colour-lowres.pdf (Accessed 01 February 2024).