Amending Soils to Decrease Salinity and Acidity for Improved Rice Production in Casamance/Senegal

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Introduction and General Objective

The saline-sodic nature of the soils in Djibelor/Casamance, their acidity level, low nutrients and organic matter content restrict the growth potential of lowland rainfed rice (Mangrove) to about 3.4 mtons ha^{-1}. Average rainfall is 1200 mm yr^{-1}. The soil was a fine-loamy, kaolinitic, isohyperthermic family of Aeric Endoaquults. The pH of the study plot was 4.6. The average salinity was 24.2 dS/m, and the average SAR was 30.2.

Objective: determine the effect of planting methods (raised versus flat bedding), biochar, and shell (liming agent) on rice yield.

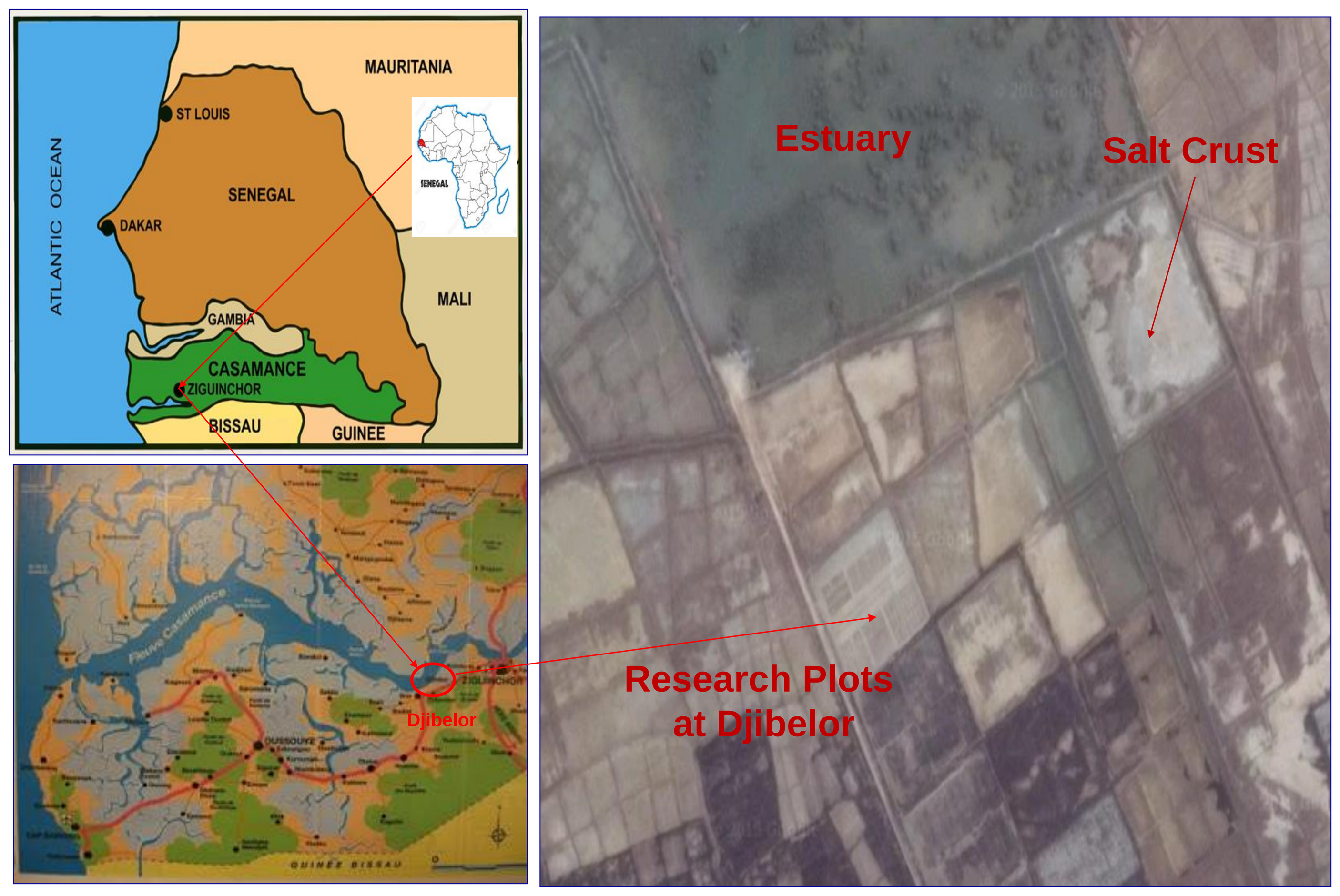

Figure 1. Map Senegal/Casamance region; and research plots

Methodology

We applied 373.33 kg ha^{-1} of NPK 15-15-15, 110 kg ha^{-1} of NPK 13-00-50, plus 134 kg ha^{-1} urea in a split plot design, with a target yield of 6 mtons ha^{-1}. Two-way ANOVA was used to separate treatment means.

- ❑ Whole plot factor treatment:
  - ❖ Planting methods "Raised" versus "Flat" beds (raised beds were above water the whole growing season, flat beds were underwater
- ❑ Subplot factors treatments:
  - ❖ Biochar (*Eucalyptus camaldulensis*): 20 mtons ha^{-1}
  - ❖ Shell (crushed oyster shell) 7.2 mtons ha^{-1}
  - ❖ Biochar+Shell: 20 mtons ha^{-1} and 7.2 mtons ha^{-1}, respectively
  - ❖ Control

Soil properties were compared before treatments (Initial) and after treatments/harvest (Harvest).

Results

Soil EC (saturated paste): no treatment difference but decreased from Initial to Harvest by 76.5% in flat and 45.5% in raised beds

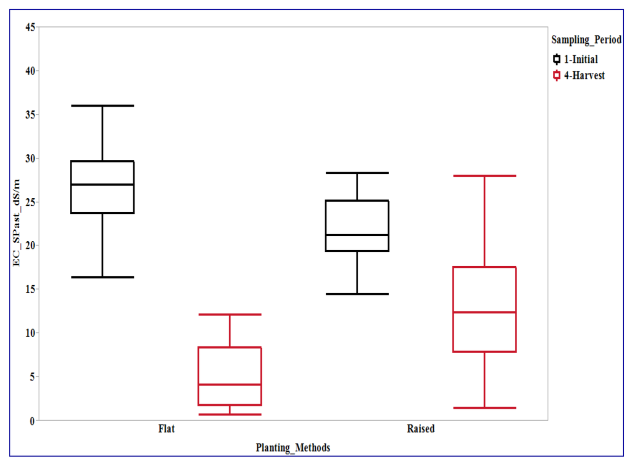

Fig. 1a: EC by planting methods

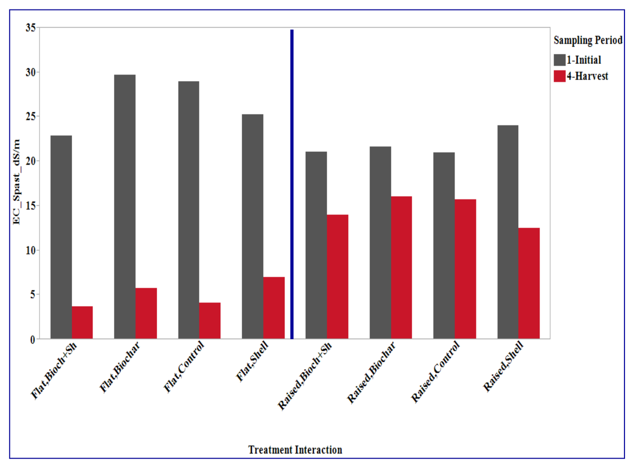

Fig.1b: EC trend by treatment interaction

Treatment Interaction	Percent Decreased (%)
Flat,Control	85.8
Flat,Bioch+Sh	83.7
Flat,Biochar	80.6
Flat,Shell	72.2
Raised,Shell	48.0
Raised,Bioch+Sh	33.4
Raised,Biochar	25.6
Raised,Control	25.0

Table 1: % Change in EC by treatment interaction

Soil pH (saturated paste): significant interaction between planting methods and amendments with a p-value of 0.0063 (Fig. 2a,2b), and also significant difference between amendments <0.0001 (Fig. 2c)

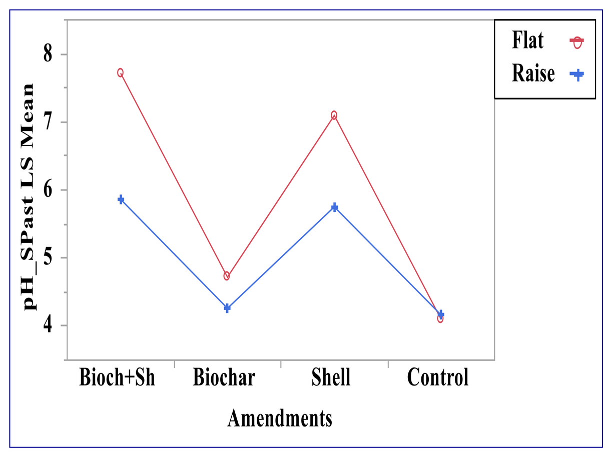

Fig. 2a: pH interaction plot

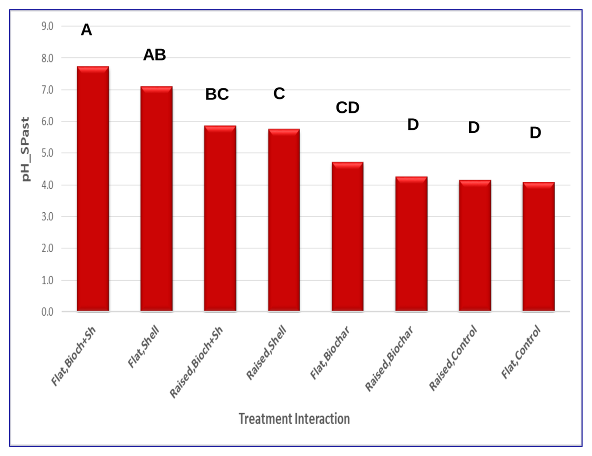

Fig. 2b: pH by treatment interaction

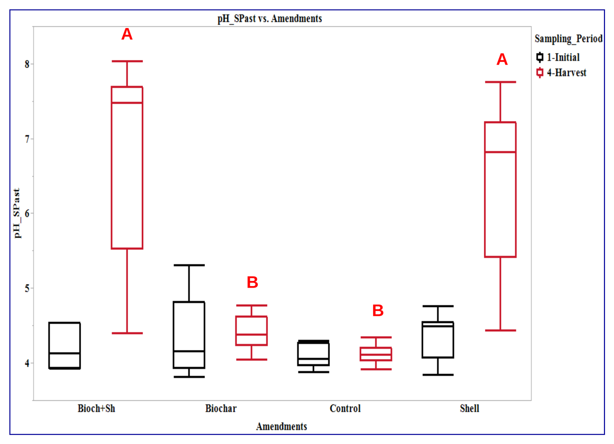

Fig. 2c: *pH by amendments*

Treatment Interaction	Unit Increased in pH_Spast
Flat,Shell	2.78
Flat,Bioch+Sh	2.58
Raised,Bioch+Sh	1.64
Raised,Shell	1.20
Flat,Biochar	0.24
Raised,Control	0.15
Raised,Biochar	0.07
Flat,Control	0.02

Table 1a: *pH unit change by interaction*

Amendments	Unit Increased in pH_Spast
Bioch+Sh	2.1
Shell	2.0
Biochar	0.2
Control	0.1

Table 1b: *pH unit change by amendments*

Rice Yield: no significant difference between treatments. Rice yield was affected by the percent of live plants, which was significantly different <0.0001 in planting methods and amendments interaction .

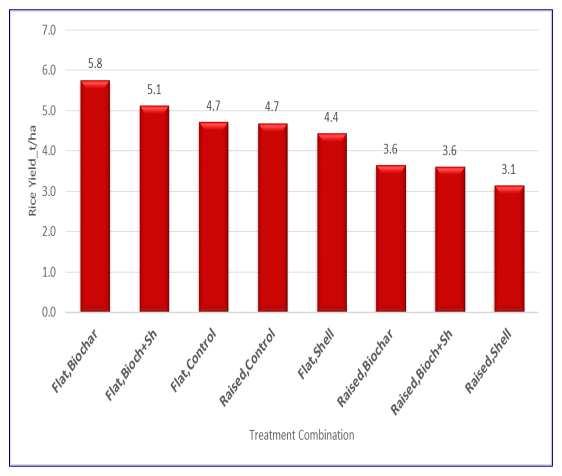

Fig. 3a: Rice yield by treatment interaction

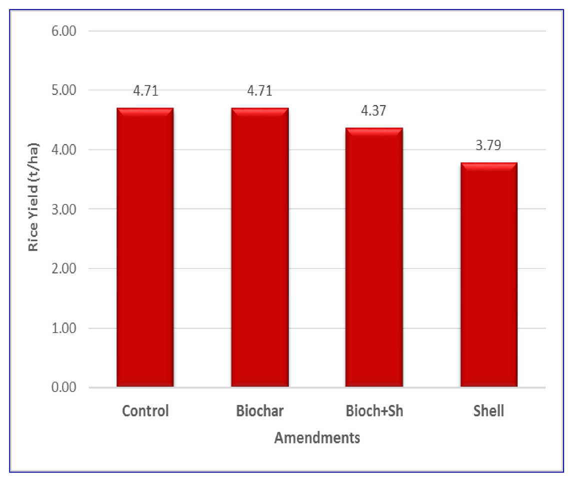

Fig. 3b: Rice yield by amendments

Discussion/Conclusions

Soil salinity after harvest:

- ❑ Lower EC in the flat beds because they had more leaching of soluble salts due to longer submerged soil than raised beds where salt tend to accumulate at the top-center
- ❑ The physical properties of the biochar and shell fragments probably helped retain salts

Soil pH after harvest:

- ❑ Flat and raised beds receiving shell and biochar+shell (Fig. 2b), as well as the amendments biochar+shell and shell (Fig. 2c) have the highest soil pH and percent increase (Table 1a and 1b)
- ❑ The biochar source used has a pH of 7.6 and the oyster is composed of of calcium carbonate (liming agent)

Rice Yield:

- ❑ High plant mortality was observed a week after rice transplanting. The lack of rainfall that year (2014) was one of the main causes;
- ❑ The number of harvested plants was determining the rice yield values.

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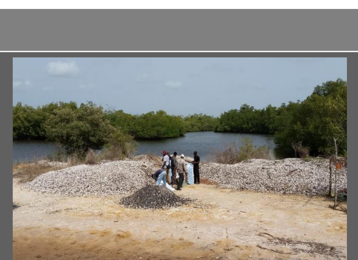


Oyster shell pile

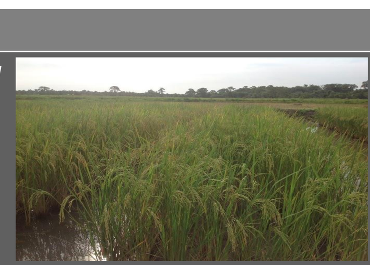
Biochar pile

Preparing rice beds

Applying amendments

Rice nursery

Dead rice plants raised bed



Rice growing

Harvested rice

"Caldou" Casamance meal