Improved Management of Iron-affected Soils for Casamance Rice Production

Ndeye H. Diallo-Diagne[1,2*], Greg Evanylo[1], W. Lee daniels[1], Wade Thomason[1], Simeon Bassene[2] and Brian D. Badgley[1]

[1]Virginia Tech, Crop and Soil Environmental Sciences, Blacksburg, Virginia 24061; [2]ISRA, BP 3120 Dakar, Senegal

*ndeyehd1@vt.edu

VirginiaTech Invent the Future

USAID FROM THE AMERICAN PEOPLE

Introduction

The Casamance region in southern Senegal traditionally produces rainfed rice, which is the primary cereal for human consumption (Fig. 1). However, Senegal produces only 1/3 of its rice consumption. In addition to record rainfall deficits in recent years, production is limited by iron toxicity resulting from the acid sulfate soil type that is prevalent in the lowland areas. Chemical and biological processes in these soils during seasonal flooding produce large amounts of soluble iron that reduces rice yields (1) at toxic levels. The effect is further amplified by deficiencies in other essential elements required for the growth of the plant. Soil amendments that raise soil pH (2) in these areas could influence the soil nutrient availability (3) to rice plants.

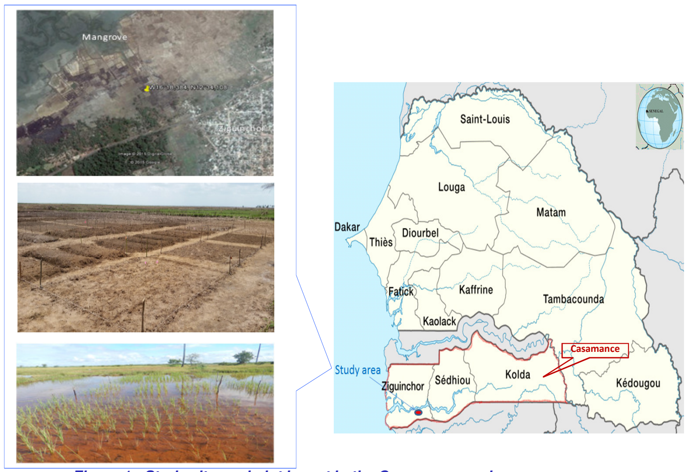

Figure 1: Study site and plot layout in the Casamance region near Ziguinchor, Senegal.

Objective

To examine the ability of beneficial soil amendments to improve soil properties and rice productivity in acid sulfate soils

Crop Science Society of America

Soil Science Society of America

American Society of Agronomy

Methods

- The field experiment was conducted over two growing seasons (2014 and 2015) the at Djibelor research agronomic center ar Ziguinchor, Senegal.
- The experimental design is a split plot with four replicates. The main plot treatment was the planting method using flat or raised bed. The subplot treatments were no amendment control **Co**, lime **Li** (13t/ha), biochar **Bio** (15t/ha), and pulverized oyster shell **She** (13t/ha). Amendments rates were applied one month before transplanting for a target pH of 6.2.
- Fertilizer is applied in all plots (NPK 100-30-120 kg/ha respectively)
- The BW248-1 variety was selected for high yield and blast resistance .
- Soil chemical and biological parameters and plant nutrient content is being monitored regularly for evidence of improved soil fertility and rice productivity.

Results and discussion

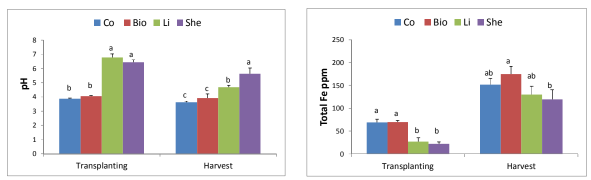

Figure 2: Soil pH and Fe content in soils Co, Bio, Li, and She at transplanting and harvest times. Bars with different letters are significantly different (P≤0.05).

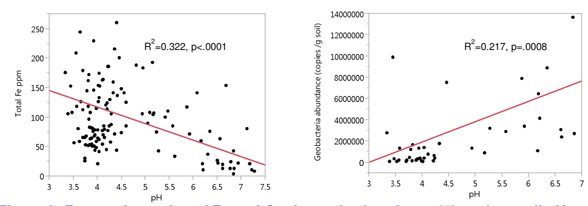

Figure 3: Regressions of total Fe and Geobacteria abundance (4) against soil pH.

Table 1: Effects of soil amendments on rice yield

	Tillers/hill	Panicle/m2	1000g weight	Height
Co	4.03 c	25.00 b	6.12 b	0.20 b
Bio	8.10 bc	90.00 ab	16.00 ab	0.57 ab
Li	11.13 ab	132.75 a	21.25 a	0.76 a
She	15.08 a	166.00 a	25.12 a	0.96 a

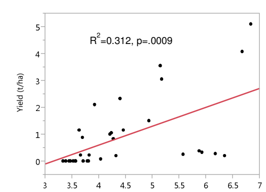

Figure 4: Regression of yield against soil pH

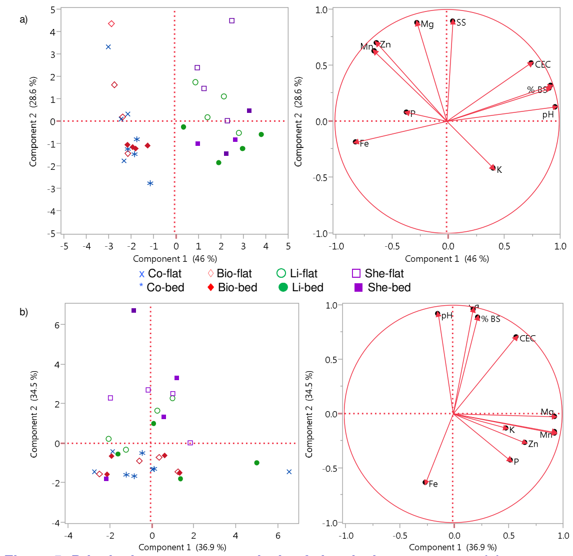

Figure 5: Principal components analysis of chemical parameters at (a) transplanting and (b) harvest

- Soil pH was significantly increased in the lime and shell amended plots (Fig. 2).
- Simple linear regression models showed significant relationships between total soil Fe content (Fig.3), *Geobacteria* abundance (Fig.3), grain yield (Fig.4), and pH (p<0.001 for each).
- Shell and lime amended plots produced significantly higher rice yield (Table 1).
- Principal component analysis of the soil chemical parameters shows distinct separation of lime and shell plots from biochar and control plots at transplanting time (Fig.5). The separation is still evident but less distinct at harvest.
- Biochar and planting method did not influence pH, total Fe content or yield values.

References:

(1)Sahrawat, K.L. 2004. Iron toxicity in wetland rice and the role of other nutrients. *Journal of Plant Nutrition,* 27, 1471-1504.

(2) Ai, C., Liang, G., Sun J., Tang P.H.S., Yang S., Zhou W., Wang X. 2015. The alleviation of acid soil stress in rice by inorganic or organic ameliorants is associated with changes in soil enzyme activity and microbial community composition. *Biology Fertility of Soils*, 51, 465–477.

(3)Shazana, M. A. R. S., Shamshuddin, J., Fauziah, C. I., Syed Omar, S. R. 2013. Alleviating the infertility of an acid sulphate soil by using ground basalt with or without lime and organic fertilizer under submerged conditions. *Land Degradation and Development*, 24, 129–140.

(4)Cummings, D.E., Snoeyenbos-West, O.L., Newby, D.T., Niggemyer, A.M., Lovley, D.R., Achenbach, L.A., Rosenzweig, R.F. 2003. Diversity of Geobacteraceae Species Inhabiting Metal-Polluted Freshwater Lake Sediments Ascertained by 16S rDNA Analyses. *Microbial Ecology*, 46, 257–269.

Acknowledgement:

We thank the USAID Education and Research in Agriculture for funding