Introduction

- Throughout the Sahel, food insecurity remains a persistent threat, and crop production is beset by challenges.
- Conservation agriculture (CA) practices such as mulching, green manure, mixed cropping, no tillage, intercropping with trees/shrubs have shown mixed results for yield improvement and frequently there are serious impediments to their adoption.
- Long-term experiments in the Sahel document that challenges to sustainable agriculture are urgent: 1) perennially sustain or increase yields; 2) are buffered for climate change; 3) can be adapted to fit local farmer needs and practices.

Objectives

- To determine the effect of a Guiera senegalensis intercropping system on millet and groundnut yields between 2011 and 2015 at the long-term intercropping station in Keur Matar, Senegal, West Africa.
- To determine the effect of the G. senegalensis intercropping system on soil carbon and nutrient cycling dynamics.

Experimental Design

Randomized Complete Block Split Plot

- Established in 2003
- Main plot—Shrub Presence (Density of 1600 ha-1) or Shrub Absence (0 ha-1). Plot size 46 x 6 m.
- Subplot—Fertilizer Rate (0, 0.5, 1, 1.5x recommended fertilizer rate for N, P, K). Plot size 10 x 6 m.
- Main plots 46 x 6 m. Subplots 6
- Recommended rate: 69 kg N, 15 kg P, 15 kg K ha-1 (millet years) and 9 kg N, 30 kg P, 15 kg K ha-1 (peanut years) m.
- Millet (Pennisetum glaucum Var. Souana 3) at 10,000 plants ha-1 in odd years and groundnut (Arachis hypogaea Var. 55-437) in even years 2004-2015.

Materials and Methods

Field Sampling and Data Collection

- Yield of millet and groundnut
- Shrub aboveground biomass at beginning of growing season, mid-season, and harvest.
- Soil samples (0-10 cm depth) at planting, mid-season, and harvest (2012-2015).

Laboratory Procedures and Data Collection

- Extractable (2M KCl) NH4-N and NO3-N measured colorimetrically (2012-2015).

Results: Yield

- In 4 of 5 years crops significantly > in +Shrub than –Shrub plots at 0 fert. level.
- Without shrubs or fertilizer, millet yields were nearly impossible to achieve.
- Shrub intercropping system has significant potential to increase carbon sequestration and buffer against climate change in the Sahel.
- G. senegalensis in a farmer’s field in Senegal. Average density of shrubs is 240 ha-1

Conclusions

- G. senegalensis improved crop yields, soil C and nutrients over 11 years.
- Without shrubs or fertilizer, millet yields were nearly impossible to achieve.
- For groundnut in the shrub plots there was little further yield advantage to adding fertilizer.
- Groundnut yields in shrub plots are associated with C content especially POM-C which increased over 8 years of cropping in the shrub plots but decreased by 63% in no shrub plots.
- A G. senegalensis intercropping system has significant potential to increase soil C.
- G. senegalensis intercropped with millet at Keur Matar. Average shrub density 1600 ha-1

References


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Table 1: Yield comparisons for groundnut and millet intercropping system conjoined with annual rainfall 2011-2015

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Fig a) Total C fractionated into POM-C and C <53 µm components in + and – shrub plots at harvest sampling 2012, 2013, 2015.

Fig b) Soil nutrients at harvest significantly increased by shrubs during 2014 and 2015 at 1.5 x fertilizer rate.

- 6 nutrients (N, K, Ca, Mg, S, Mn) significantly increased by shrubs during 2014 and 2015 (Fig a and b).
- Total extractable N very significantly increased by shrubs at midseason and harvest for 3 years and at planting for 2 years (Fig a).
- Addition of nutrients in 2015 shrub biomass was 50 kg N, 30 kg Ca, 17 kg K, 13 mg Mg, 4 kg P, 4 kg S, 2 kg Mn, 1 kg Fe.