Agroforestry: A Sustainable Cropping Option for Uplands in Western Thailand

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Abstract

In Western Thailand, maize production is mainly carried out on uplands and freshly cleared forests.

It is not only reducing the forest area but also soil fertility.

The fertility of land is reducing over time due to many factors such as losses of fertile top soil due to lack of proper soil cover, low fertilizer inputs, intensive and inappropriate land use.

We tested various maize based soil conservation options including Agroforestry system/alley cropping.

Agroforestry systems conserve the soil resources for stainable crop production.
Such studies are important to convince farmers to adopt such conservation systems.

Introduction

World's two billion hectares of agricultural land is affected by soil degradation (Hillel et al., 2005).

Ten million hectares of cropped land is being lost due to soil erosion worldwide which reduced world food production (Pimentel and Burgess, 2013).

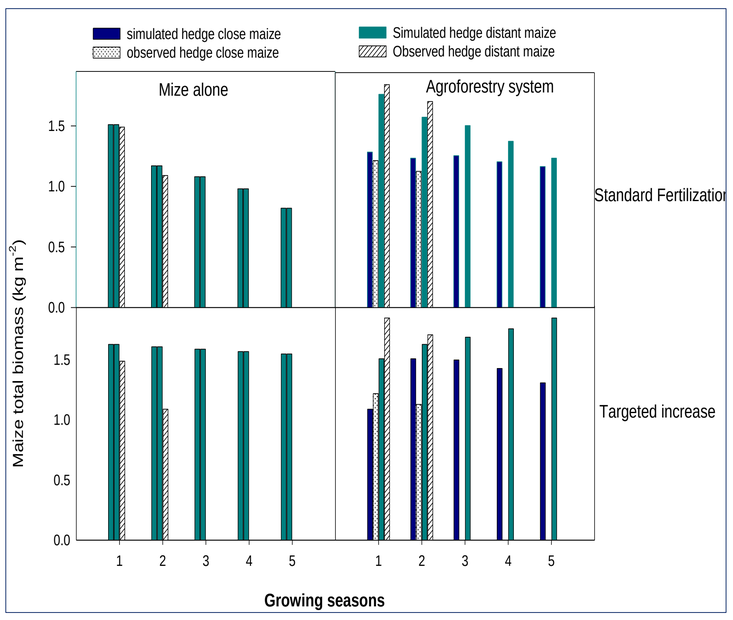
Thailand's population is around 64 million of which 39% are depend on agriculture.

Rice, cassava, maize, sugarcane, oil crops and fruit trees are considered as major field crops not only for food security but also for income generation and exports.

Maize occupies about 33% of its upland area (Ekasingh et al., 2004).

In Thailand almost 34% of cultivated land is already degraded by soil erosion (Pansak et al., 2010).

Agroforestry systems would be sustainable options of cropping on such uplands.



Simulated maize-agroforestry options

Methods and Materials

Field experiment was carried out in 2011, two years after establishment of an erosion trial in Western Thai Uplands (Slope gradient was 20-25%, rainfall: 1200 mm during May to October).

Treatments investigated were:
T1: Maize alone (farmers' practice, control)
T2: Maize-chili intercropping
T3: As T2, minimum tillage, Jack bean relay cropped
T4: As T3 but with hedgerows (Agroforestry system)
T5: As T3 but without fertilization
T6: As T4 but without fertilization

Maize total biomass, Land equivalent Raito, Grain nitrogen concentration measured

Water, Nutrient and Light Capture in Agroforestry (WaNuLCAS v 4.1) model was used for simulations

Model validation: EF= 0.82, RMSE= 6.3,, ME=0.2, CRM =-0.02 (Hussain et al., 2016)

Maize biomass yield (g m^{-2}) , Grain nitrogen con. (%N) and land equivalent ratio (LER)

Treatments	Biomass yield	Grain N	LER
T1	1161 bc	1.45 AB	1.17
T2	1365 a	1.56 A	1.03
T3	1242 ab	1.51 AB	1.21
T4	1250 ab	1.51 AB	0.88
T5	1033 d	1.31 C	0.94
T6	1076 dc	1.39 BC	1.17

Results

Highest maize total biomass (1365 g m^{-2}) was observed in T2.

T2, T3 and T4 biomass yield was statistically at par but higher than farmer's practice (T1, control).

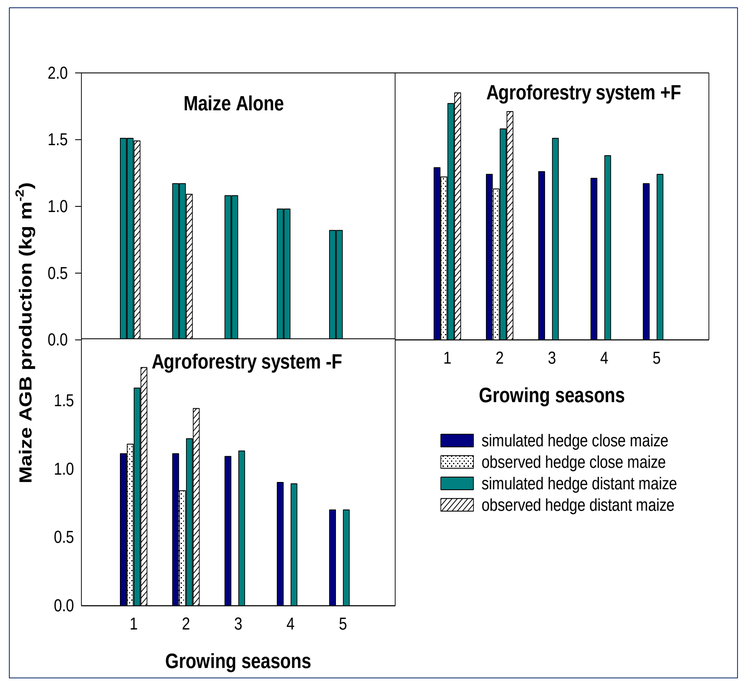
Grain nitrogen con. did not differ significantly in T1, T2, T3 and T4 but was higher than nonfertilized treatments.

Land Equivalent ratio (LER) was highest (1.23) in T4 (Agroforestry system), 23% higher than T1.

T2, T3, T5 were used for model calibration.

Maize total biomass simulations over a period of five years showed that agroforestry systems are very sustainable production systems on uplands.

Model suggested a small additional amount of fertilizer application just at crop rows planted close to hedgerows which sustain maize total biomass yield up to 1.8 kg m^{-2}.



Performance of Maize alone vs Agroforestry systems over a period of 5 years

Discussion

High mass biomass yield in intercropping and agroforestry was due more space for light capture and below ground resources.

Highest LER in Agoforestry system indicated 23% better utilization of resources than maize alone.

Simulations showed continuous decrease of biomass yield along with the seasons due loss of soil fertility over time.

Simulations also indicated that Agroforestry systems are more sustainable than maize alone because it conserve the soil and reduce the loss of fertile soil.

Small targeted increase in fertilizer application can make the agroforestry system more sustainable with passage of time due to increase in soil fertility.

Conclusions

Agroforestry systems are very sustainable systems on uplands with only 19% decrease as compared to farmer practice with 50.

Model evaluated options to overcome the major limiting nutrient at the crop-soil-hedge interface.

Small additional amount of fertilizer application at rows close to hedgerows will improve sustainability.

This modification will sustain total maize biomass yield up to 1.8 kg m^{-2}.

Such strategic management can be adopted by the local farmers' fostering soil conservation systems for sustainable agroforestry production in future.

It will also reduce deforestation on uplands.

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