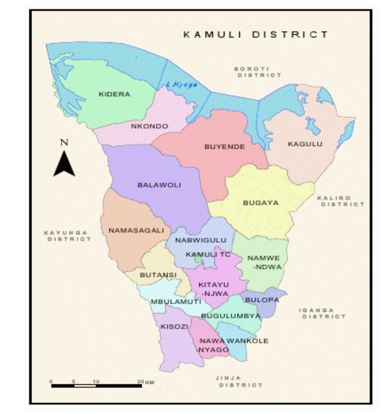
Green Manure Intercropping Systems to Boost Maize Yields: A Case study in Kamuli District, Uganda

Rebecca Alice Wokibula and Mark E. Westgate*

Iowa State University, Department of Agronomy, 2104 Agronomy Hall, Ames, IA 50011-1050



https://sites.google.com/site/ictcentreuganda/kamuli-district

Summary

Fertilizer use is not a common practice for small scale farmers in rural Uganda, except for a few who apply animal manure and other organic residues like compost manure. Lablab (*Doliochos lablab* Rongai) is a rapidly growing legume with potential as a green manure intercropped with maize. The **Goal** of this project was to develop green manure management practices involving Lablab what would improve maize yields and be within 'economic reach' of most small landholder farmers. **Specific Objectives** were to evaluate a range of maize/lablab/weed intercropping systems on farm, evaluate impact of these practices on soil fertility and maize yields, identify the most 'yield responsive' Lablab green manure intercropping system, and assess the potential for farmer adoption of this system. Lablab was a very effective green manure when grown as a relay crop. Farmers were very positive about the multiple uses for this crop, but concerned about the additional labor required.

Conclusions

- There was an overall improvement in maize yields on all four farms both seasons with Lablab incorporated as the green manure. Planting lablab as a relay crop with maize provided the greatest yield advantage.
- The stage of incorporation was not as important as the intercropping system (relay, synchronous, or delayed). Evaluating temporal and spatial aspects of Lablab intercropping systems is critical for adoption by small landholder farmers, particularly for labor management .
- Advantage of maize/lablab relay as an intercrop system over mixed or row intercropping may take several season to realize. Other advantages such as human or animal food source need to be evaluated for this system to be a realistic option for all small landholder farmers.

Green Manure Treatments

Maize/lablab relay -- Lablab planted in advance of maize, incorporated at closed canopy. Maize planted afterwards.

Maize/lablab synchronous planting -- Lablab and maize planted on the same day. Lablab incorporated at closed canopy.

Maize/lablab delayed planting -- -- Lablab planted two weeks after maize emerged. Lablab incorporated at closed canopy.

Maize/lablab delayed planting, delayed incorporation -- -- Lablab planted two weeks after maize emerged. Lablab incorporated at green pod stage.

Maize/lablab delayed planting, incorporation at harvest-- -- Lablab planted two weeks after maize emerged. Lablab incorporated after seeds harvested.

Weeds as green manure. Maize planted in monoculture. Indigenous weeds mixtures incorporated twice during normal weeding operations.

FIGURE 1: Lablab in monoculture (left), in mixed culture planted two weeks after maize emergence (center), and in mixed culture planted with maize and pictured prior to pod harvest (right).

Results

Maize Yield

Except for the Synchronous Planting treatment, incorporating Lablab as a green manure in the cropping system increased maize yields on all four farms; incorporating weed mixtures decreased maize yields (TABLE 1).

Planting maize in relay with Lablab gave the highest maize yields – a 70% increase over yields recorded on farm prior to the experiment.

The stage of Lablab incorporation was not as important as the timing of planting relative to maize (relay, synchronous, or delayed). Lablab grew aggressively when planted synchronously with maize (FIGURE 1 and 2)

TABLE 1: Maize yields form lablab and weed mixtures green manure treatments. Data are means for four farm trials conducted over two growing seasons expressed at 14.2% moisture. Average grain yield of the previous maize crops was **2,915 kg/ha** (~ 46 bu/ac)

Green Manure treatments	Season 1	Season 2	Average
	------------- (kg/ha) ---------------		
Lablab in Maize			
as Relay Crop	4,444	5,580	5,012
Synchronous Planting	1,530	1,383	1,457
Delayed Planting	3,457	4,099	3,778
Delayed Planting/Incorporation	3,950	4,593	4,272
Delayed Planting/Lablab for Yield	4,099	4,593	4,346
Weed mixtures in Maize	2,617	2,074	2,346

FIGURE 2: Farmers incorporating lablab, untwining lablab from maize before lablab incorporation, and incorporating weed mixtures.

Soil Fertility

Incorporating Lablab as green manure raised soil nitrogen, phosphorus, and pH levels (TABLE 2). Effects were evident soon after incorporating the plants into the soil and persisted to the end of the season (TABLE 3).

TABLE 2: Overall impact of green manure management on soil fertility parameters in maize intercropping systems. Initial values taken prior to experiment. Final values taken at the end of Season 2.

Soil Fertility Parameters	Initial Values	All Lablab Plots	Weed Mixture Plots
Nitrogen (ppm)	15-30	>30	15-30
Phosphorus (ppm)	0-25	0-50	0-25
Potassium (ppm)	>100	>100	>100
Organic Matter	> 4%	> 4%	> 4%
pH range	4.0-4.9	4.0-5.9	4.0-4.5

TABLE 3: Response of selected soil fertility parameters to Lablab incorporation as a green manure in maize/lablab intercropping systems. Data are pooled for all lablab treatments across two seasons.

Soil fertility parameters	Prior to planting lablab	One month after planting lablab	On day after incorporating lablab	One month after incorporating lablab	End of season
Nitrogen (ppm)	15-30	>30	>30	>30	>30
Phosphorus (ppm)	0-25	25-50	25-50	25-50	>50
Potassium (ppm)	>100	>100	>100	>100	>100
Organic Matter	> 4%	> 4%	> 4%	> 4%	> 4%
pH range	4.0-4.9	4.0-4.9	4.0-5.9	4.0-5.9	4.0-5.9

This project was supported by the

Center for Sustainable Rural Livelihoods

Discovering and applying sustainable solutions to world hunger

Iowa State University of Science and Technology

Farmer Survey

Designing the project to be farmer participatory and as an on-farm trail enabled close interaction with the farmers and a clearer understanding of some of their challenges and inputs in terms of time apportionment, labor, and practicability of adopting this alternate management technology for improving maize productivity. Farmers were very positive about the multiple uses for Lablab, but were concerned about the additional labor required because of Lablab's aggressive growth habit (TABLE 4).

TABLE 4: Survey tool used in the Post-Harvest Focus Group Discussions with three groups of 12 farmers from Namasagali and Butansi sub counties in Kamuli district, Uganda. All farmers involved in this Post-Harvest survey also participated in the Baseline Survey prior to the project.

Lead Question	Farmer Group			Responses/Explanations
	1	2	3	
	Percentage of positive responses			
Improvement in Knowledge of turning green plants into soil to generate manure	100	100	100	Timing of the green manure and the main crop so that the green manure will release maximum nutrients when the annual crop needs them most. For weeds it should be done before the seed matures to avoid weed infestation throughout the season.
Incorporate weeds during land clearing and weeding	100	100	100	To bury them and hasten the decomposition process.
Turning their food legume crop into green manures	8	0	0	If they anticipated crop failure and decided to incorporate the crops into the soil early in the season.
Will adopt Lablab in maize/ legume or any other cropping system	100	100	100	Farmers will grow Lablab in relay with maize and as an intercrop at wider spacings, and with other more robust perennial crops like bananas.
Preference of green manure to composting	100	100	100	Facilitates nutrient recycling even before it is incorporated.
Farmers willing to buy Lablab seed to apply it in their cropping systems	100	100	100	Lablab has additional benefits to soil, as forage, and farmers are interested in eating it.
Preference of Lablab as a cover crop rather than as a green manure	100	100	100	Lablab provided a good soil cover through the season and is a perennial crop. Labor requirements increase if Lablab is used as a green manure.
Preference of Lablab as a forage rather than as a green manure	100	83	58	The labor requirement in green manure systems. Lablab would solve the problem of scarcity of animal feed. Lablab can serve as cover crop and nutrient recycler even when used as a forage.

Methods

On-Farm Trials

The project was carried out in Kamuli District, in Eastern Uganda in two sub counties of Namasagali and Butansi. Kamuli District is part of the former Busoga District and lies at an average altitude of 1083 m above sea level and extends from 00 - 56' North / 330 - 05' East up to 01 - 20' North / 330 - 15' East. The experiment was conducted over two seasons on four farmer fields. Farmer fields measured 4.5 by 27 m2 and were divided into six equal sub-plots of 4.5 by 4.5 m2 where the treatments were applied. The treatments constituted two types of green manure, lablab and weed mixtures. Lablab green manure was incorporated at three growth stages under three intercropping patterns as detailed above. Farmer fields were the main blocks (replicates). The treatments within blocks were arranged in a completely randomized block design. Maize ears were collected at the end of each season from each treatment area. Yield per unit area was assessed by weighing shelled grain and correcting to an average moisture content of 14.2% on a fresh weight basis. Yield data of the previous maize crop for each site was provided by the cooperating farmers.

Planting Material and Soil Fertility

Maize (*Zea maize* L.) seed that was planted in each field was sourced from the cooperating farmer and was an open pollinated variety MM3. Seed was collected and saved from plants grown the previous seasons. Lablab (*Doliochos lablab* Rongai) used for this study was an erect bush type with white flowers and light brown seeds seed. It was sourced from a local Agro input market and given to the farmers free of charge. The Rongai variety is characterized as late-flowering with high dry matter production. It is mostly used for forage to feed animals and may flower over several months in the absence of frost. The impact of each green manure treatment on soil fertility was assessed using chemical soil tests for five soil fertility parameters (pH, OM, N, P and K) using a soil test kit that was developed by the Department of Agricultural Production, Makerere University, Kampala, Uganda. This kit provided estimates of soil pH and soil Nitrogen, Phosphorus, Potassium, and Organic matter content.

Farmer Survey

Prior to starting the experiment, a baseline study was conducted through focus group discussions (FGDs) to determine the current Knowledge, Attitude and Practices of small scale farmers regarding utilization of green manures on their farms. The FGDs involved three groups of 12 farmers each from Namasagali and Butansi sub counties in Kamuli district. These farmers were selected from the database of households working with the Volunteer Efforts for Development Concerns (VEDCO), an independent, non-governmental, non-partisan, and not-for-profit agricultural organization that has been a partner in rural development projects with Iowa State University since 2004. After the baseline survey, four farmers interested in the green manure management practices and willing to participate in the study were selected, and experiment sites were identified on their farms. After harvesting the maize for the second season of the project, there was a follow up survey for all the farmers who participated in the baseline survey to determinetheir current Knowledge, Attitudes, and Practices regarding utilization of green manures. The survey was conducted through a one on one interviews with each farmer.