Integrating Pigs and Maize production in a low input production system in the tropic of Mexico

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Abstract

In the tropic of Mexico the "Milpa-system" of slash and burn is a traditional farming system. However, the spatial separation of crops and animals results in a one way flux of nutrients from the crop fields to the home gardens. Additionally, there is a tendency towards a reduction of the fallow period of the forest. Both factors cause a considerable reduction in the maize yield. The objective of the experiment was to determine whether the use of pigs in a field rotation has a beneficial effect on maize yield.

The treatments were designed as follows: traditionally slash and burn (TT), keeping pigs before the cultivation of maize (PiK) and a control without pigs and without burn (WOPB). Creole pigs were used and fed with a diet of 75 % maize and 25 % heated mucuna bean containing 12 % crude protein. The parameters measured were pig performance, biomass of weeds, labour time in weed control, soil mineral nitrogen and maize yield. TT treatment was repeated twice, while PiK and WOPB treatments three repetitions were carried out.

Pig performance was similar in the three groups. In the last two years of evaluation a reduction of maize yield was found in TT and WOPB ($p < 0.01$) and no reduction was found in PiK compared to the first year ($p > 0.05$). A lower proportion of weeds was found in PiK compared to WOPB ($p < 0.01$). Labour time for weed control was reduced in PiK compared to WOPB. Higher mineral nitrogen in the soil was found in PiK.

The use of pigs in a field rotation system with maize is a low input strategy that provides advantages in relation to stabilize the maize production without the use of fire with benefits not only for the farmers but also to the global environment. Further research is needed to optimise the use of pigs for a sustainable production of maize.

Keywords: Field rotation, pigs, maize, low input system.

Introduction

In the tropics, the milpa system is one of the most important mixed farming systems which integrates animal, crop and tree production. However, the spatial separation of crops and animals results in a one way flux of nutrients from the crop fields to the home gardens. Additionally, the main disadvantages of the milpa system are: the shortened fallow periods, decreasing soil fertility and an increasing pressure of weeds. Farmers counteract these problems with the application of mineral fertilizers and herbicides (Gündel, 1998; Graephe, 2003). This practice has caused a reduction of companion crop diversity associated with maize such as squash and beans (Caamal et al., 1996). The present force over the milpa system requires the development of new technologies to provide adjustment.

Innovations with cover crops have shown effective results on weed control and maize yield improvement (Caamal-Maldonado et al., 2001). However, the low adoption of this technology suggest the need to explore other possibilities considering additional benefits on the animal component (Anderson et al., 1998).

There are reasons to assume that the pig rooting activity and the direct fertilization with faeces can sustain the maize yield. On the other hand, weeds after cultivation could play a role as forage feed source for pigs.

The milpa system is organized in an area for crop plantation, a backyard and a forest area. The crop plantation area consists mainly of maize (Zea mays L.) complemented by different squash and bean species. Animals such as pigs, chicken, goats, even cattle are located in the backyard sub-system (Anderson et al., 1998).

Crop and animal production in the milpa system have been focused by many research groups. However, low attention has been lagged on the integration of crop and animal production optimisation.

The implementation of pig rotation instead of burning as a method to prepare the land for cultivation is a method that implies a qualitative change in the milpa shifting cultivation.

The working hypothesis of this study was that the integration of pigs and maize production provides an alternative to the milpa system in order to enhance nutrient cycling efficiency and to stabilize crop and animal production.

The main objective of the experiment was to determine whether the use of pigs in a field rotation system has a beneficial effect on the following cultivation of maize.

Material and methods

The experiment was carried out at the Facultad de Medicina Veterinaria y Zootecnia (FMVZ) Yucatan, Mexico in the years 2000 to 2003. This site has a tropical climate with an annual average temperature of 27.7 ºC and an annual precipitation of 800 mm (raining season between June to November) (Gobierno del Estado de Yucatán, 1983).

Experimental design and treatments

There were three treatments and four years of evaluation, every year of one cultivation period. The experimental field (100 by 100 m) was subdivided into eight plots of 20 by 60 m. The treatments were designed as follows: traditionally slash and burn (TT), keeping pigs before the cultivation of maize (PiK) and a control without pigs and without burn (WOPB). The experimental field was selected in a forest area of the FMVZ with 10 years of fallow. The experimental design is described in table 1. During the dry season different methods of land management were carried out. In the TT the slash and burn was used every year according to the local farming practices. In the PiK treatment the pigs were kept on the plots before the maize cultivation and in the treatment WOPB there was manually slash without burn. TT treatment was repeated twice, while PiK and WOPB treatments three repetitions were carried out.

Table 1. Experimental design.

Treatments	Year 1		Years 2-4	
	Season		Season	
	Dry	Raining	Dry	Raining
TT	Slash and burn	First Maize cultivation	Burn	Maize cultivation
PiK	Slash without burn		Pig keeping	
WOPB	Slash without burn		Slash without burn	

Management

Animals: For PiK treatment a group of 4 or 5 male Creole pigs (Cp) per repetition were used with 10 kg initial live weight (ILW) for the first period and 30 kg ILW for the second and third period. Except for the first season, pigs were kept on the plots before the cultivation period. The pigs stayed in the plots during the dry season for around 4 months. The pigs were fed on a diet of boiled mucuna (*Stizolobium deeringianum*) beans and maize in a ratio of 25-75. Mucuna beans was boiled for 30 minutes using 2 litres of water per 1 kg of mucuna, then was sun-dried and ground in a hammer miller using a 3 mm sieve. In the plots of pig rotation there were natural shadows (trees) of 15 m^2 and huts with of 6 m^2 size.

Maize cultivation: The maize was planted at the beginning of the raining season (June) After germination, two plants were left per position. 30 days after sowing the maize manual weed control was carried out in all the treatments.

Measurements

Parameters measured were: Feed intake of the pigs, live weight gain and feed conversion rate, biomass of weeds, labour time for weed control, soil mineral nitrogen and maize yield. The biomass of weeds was recorded using 15 replicates of square meter per treatment. Time spent for weeding was determined 30 days after sowing the maize. Maize yield per treatment was assessed by sampling every third plant of every second furrow. Soil mineral nitrogen was determined at the beginning and during the cultivation period of the first pig stay.

Results

Results of performance criteria are presented in table 2. Pig performance was similar in the three groups within each year. The maize yield is described in figure 1. In the second and fourth year a reduction of maize yield was found in TT and WOPB and no reduction was found in PiK compared to the first year (p<0.01). In the fourth year of evaluation a higher maize yield was observed in the PiK compared to the TT and WOPB treatments. However, the two last years of evaluation were on average yield similar in the TT and PiK treatments. Maize yield in the third year was destroyed by Hurricane Isidor. The presence of weeds and labour time spent on weed control are shown in tables 3 and 4 respectively. Lower weeds were found in PiK compared to TT and WOPB (p<0.01). Labour time for weed control was reduced in PiK compared to WOPB. The mineral nitrogen in the soil at the beginning and end of the cultivation period of 2001 is described in table 5. Higher mineral nitrogen in the soil was found in PiK.

Table 2. Feed intake, live weight gain and feed conversion in Creole pigs fed with maize and Mucuna beans (*Stizolobium deeringianum*) during three periods.

	Year			Average of all the groups
	2001	2002	2003	
Initial live weight kg	10.1	30.2	30.3	
Feed Intake kg/day	0.73	1.27	1.39	1.13
Live weight gain kg/day	0.16	0.32	0.29	0.26
Feed conversion	4.82	3.93	4.81	4.52

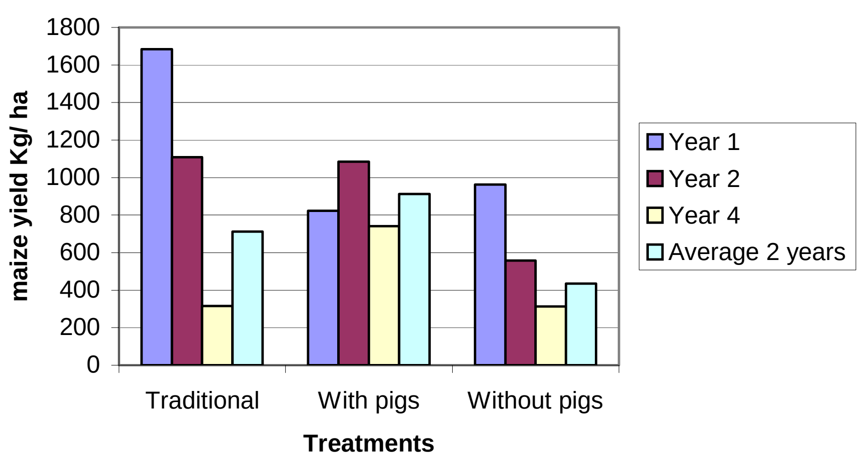

Figure 1: Maize yield of treatments with or without pig rotation and the traditional milpa system slash and burn.

Table 3. Weeds measured 35 days after the maize was sowed with or without pig rotation and the traditional milpa system.

Treatment	Weeds kg/ha		
	Year		
	2000	2001	2002
Without pigs	1256[a]	2068[b]	1935[b]
With pigs	1303[a]	809[b]	1263[a]
Traditional (with burn)	345[a]	873[b]	1900[c]

Values between columns with different literals are statistically different ($p<0.05$).

Table 4. Labour time for weed control 35 days after sowing maize.

Treatment	Labour time*
	2001
Without pigs	15.0
With pigs	10.3
Traditional (with burn)	10.2

*Average hours pro plot (each plot of 1200 m^2)

Table 5. Mineral nitrogen in the soil at the beginning and the end of cultivation during the second period of cultivation.

Date of sample (year 2001)	Mineral nitrogen (mg/kg soil)		
	Without pigs	With pigs	Traditional
Beginning (June)*	36.0[a]	52.0[b]	33.2[a]
End (October)**	13.6[a]	30.0[b]	19.8[a]

*Values between columns with different literals are statistically different ($p<0.10$).
** Values between columns with different literals are statistically different ($p<0.01$).

Discussion

The similar pig performance in terms of feed intake, live weigh gain and feed conversion of the three repetitions of each year can be interpreted as a similar input of nutrients in the experimental areas. The lower pig performance in the first pig stay can be explained by the lower initial pig weight used in comparison to the two following years. The increase of the initial weight was made in order to increase the density of pigs per area.

In the literature there are no data available of Creole pigs kept in outdoor conditions. However, a recent experiment carried out in cages by Trejo et al. (2003) using Creole pigs of 40 kg initial live weigh with the same diet (Mucuna-maize) the feed intake and weight gain was 42% higher in comparison to the present experiment. Possibly concentrate diet intake is modified when forage is available in outdoor conditions.
In the TT treatment there was a reduction of the maize yield as expected. A similar reduction was seen in the treatment WOPB whereas in the treatment PiK there was a stable maize yield. This can possibly be explained by the combination of lower weed and input of nutrients in this treatment.
Experiments in India (Tamil Nadu) reported the use of pigs to control the very noxious weed the nut sedge (*Cyperus nilotica*). Every year before planting rice pigs are used to eat the plants and tubercles of this weed (Chinnamuthu, 1996).
Although an input of nutrients was measured in PiK treatment during the second year of cultivation, the maize yield was similar in treatments TT and WOPB. This possibly suggests a great importance of weeds but not nutrient inputs during the second year of cultivation. After four years of cultivation the higher maize yield in the PiK treatment compared to the other treatments can possibly be explained not only by lower weeds but also by higher nutrient inputs.

Conclusions

The use of pigs in a field rotation system is a low input strategy that can provide advantages in stabilize maize yield without the use of fire which has benefits not only for the farmers but also for the global environment. Further research is needed to optimise the use of pigs for a sustainable production of maize.

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