THE USE OF LEGUMES FOR IMPROVEMENT OF FALLOW LAND IN SMALLHOLDER FARMING SYSTEMS

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ABSTRACT
Two legumes, centro (*Centrosema macrocarpum)* and pigeon pea (*Cajanus cajan)*, were evaluated for their ability to improve the productivity of fallow land as assessed by a following maize crop. Maize yields were increased after 12 or 18 months of managed legume fallow. Adoption of legumes for improvement of fallow land will depend on ease of establishment and alternative uses for the legume or whether they regenerate naturally.

KEYWORDS
Fallow land, legumes, N fixation, smallholder

INTRODUCTION
Many smallholder farmers in upland farming systems follow a rotational system in which a period of cropping is followed by a period where the land is left idle or in 'fallow'. In short fallows, the natural vegetation is generally unproductive even for grazing though the fallow does serve to reduce disease incidence and increase soil organic matter. Introduction of legumes into the fallow could have a large impact on overall productivity through soil improvement and provision of quality feed to livestock. The purpose of the following study was to determine if a managed legume fallow would have a positive effect on following crop yield in the Cauca region of Colombia.

METHODS
Site. North Cauca, Colombia is 2^0 47' N, 76^0 32' W, 1500 masl. The terrain is highly dissected with steep slopes. The area is used for cropping cassava, beans and maize, vegetables and grazing by dual purpose cattle, but with 60% of the land in fallow. Rainfall is bi-modal and occurs during April-July and October-December with an average total of 1800 mm per annum. The soil was a sandy clay loam of pH 5.5, extractable P (Bray 1 ppm) 1.3, exchangeable bases (me/100g) Ca 1.09 , Mg 0.25 and K 0.23. The on-farm site had not been cropped for five years.

Experiment. **Treatments:**

Covers -	(i) *Centrosema macrocarpum* CIAT 5713, (ii) cowpea followed by pigeon pea after 6 months, (iii) natural cover.
Fertilizer (kg/ha)-	(i) 20 P, (ii) 100 P, (iii) 100 P + 1000 lime, 50 K, 20 S, 20 Mg,CuBZn, (iv) Poultry manure 8 t/ha, equiv. to 240 N, 110 P, 150 Ca, 30 Mg, 150 K (fertilizers applied to legume covers only)
Fallow length -	(i) 12 months (ii) 18 months

A split-split design was used with 'fallow length' as the main plots and 'covers' as the subplots with fertilizer treatments randomized in the legume subplots and 3 replications.

Additional Ca was added to the 20 P treatment equivalent to that added in the 100 P treatment. The existing natural fallow system was left untouched as a control for comparison with the two legume fallow systems.

The legumes were fertilized at establishment as growth was known to be slow without P addition. Poultry manure was included as it is commonly used with cash crops in the area.

The covers were planted in rows in October, 1993, followed by maize crops in October, 1994 and April, 1995. The covers were incorporated into the soil 2 weeks before planting the maize which was fertilized with a basal application of (kg/ha):50 P, 50 K, 20 Mg, 30 ZnBCu mixture and either 0, 25, 50 or 100 N.

RESULTS
Cover yield. While there was rapid establishment of cowpea, the other legumes took about 6 months to form a full cover. The cowpea, which was a grain type, matured and died within 4 months regardless of fertilizer treatment. The other legumes formed dense foliage and dominated the natural vegetation with time. There was a large effect of fertilizer on rapidity of establishment and yield of the legumes. The total amount of herbage at the time of incorporation (Table 1) does not fully reflect the legume yields as there was considerable leaf fall each dry season.

Available N. Fertilized legume covers increased the amount of available soil nitrogen for the following crop. NO_3+NH_4 -N (ppm N at 0-10 cm) measured at the time of planting maize was 16.8, 13.4, and 7.4 ppm at 12 mth and 25.1, 19.6 and 7.9 ppm at 18 mth for the centro, pigeon pea (100 P treatment) and control, respectively. Soil samples taken to 40 cm depth suggested no leaching of N below 20 cm at 30 days after planting.

Maize yield. Fertilized legume covers increased the yield of the following maize crops over that of the natural fallow (Table 1). The effect was greater where the legume was fertilized with 100 compared with 20 kg/ha of P. Maize yields were even higher where additional nutrients had been added by fertilizer or poultry manure.

The maximum effect of *Centrosema* was evident in the first maize crop due to high yield and coverage of the legume at 6 months. The later development of pigeon pea, which was planted at 6 months, i.e. after the cowpea had matured and died, meant that the maximum effect of the legume was not seen until the second planting of maize at 18 months.

DISCUSSION
There are two reasons for the increase in maize yields in the legume treatments over that in the natural fallow treatments. The first is an effect of N contributed by the legume which would be expected to be proportional to the legume growth. The second is due to the additional nutrients in the '100 P + additional nutrients' and 'manure' treatments. The response to N was higher in these treatments (Figure 1). It is not possible to separate the two effects with the design that was used.

There was an interaction between fertilizer N applied to the corn and the legume covers which might be explained by the temporal difference in development of the two cover crops. There was also an interaction between rates of fertilizer N applied to the corn and the fertilizer treatments applied to the covers which can be assumed to be due to some deficiency in the amount or type of basal nutrients applied to the corn.

The results demonstrate that a fallow oversown with legume has the potential to increase overall productivity of these hillside soils. The improvement occurs within six months of onset of vigorous legume

growth. Incorporation of legumes is a viable practice in the Cauca hillsides where land is prepared by cultivation with oxen. A limitation to the introduction of the use of legumes in the fallow is to devise a feasible method of establishment. We believe that this might be done at the time of the second weeding or at harvest of cassava, which is usually the last crop grown prior to spelling of the land under fallow. Rapid establishment of legumes is desirable to avoid undue competition from weeds.

Natural regeneration of introduced legumes in fallows is one way to enhance adoption as in leucaena-based fallow systems (Piggin and Parera, 1984) or *Mucuna*-based systems (Buckles *et al*., 1992). Other legumes that have been observed to regenerate naturally in crop systems are *Arachis pintoi* in South America (M. Ayarza, pers. comm.) and *Centrosema pubescens* in Togo, West Africa (P. Kerridge, pers. comm.). In such cases, there is a need to develop crop management practices to ensure that the legume does not compete with the following crop. In Cauca, where a self regenerating legume has not yet been identified, there will need to be an alternative use of the legume to soil improvement, e.g. for livestock feed, to ensure adoption.

The results of this preliminary study support further investigation into the use of legumes to improve natural fallows in smallholder farming systems.

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Table 1

Ground cover at time of incorporation and grain and total dry matter yields of maize (averaged over N rates).

Cover	Fert. Applic.	Cover 12 mth	Cover 18 mth	Crop 1 (12mth) Grain (kg/ha)	Crop 1 (12mth) Total	Crop 2 (18mth) Grain	Crop 2 (18mth) Total
Natural		6000	9950	350	1500	350	1500
Centro	P20	2750	4300	750	2300	700	2850
	P100	5100	8200	1550	4250	1850	5700
	P100+	4300	5950	2550	6800	1600	5100
	Manure	4000	6600	3100	7450	2900	7850
Pigeon	P20	400	9750	450	1750	350	1700
pea	P100	550	13400	450	2150	1100	3950
	P100+	600	8000	1550	4200	1450	4500
	Manure	1950	18200	1700	4550	2900	9250
$LSD_{P=0.05}$		540	1800	110	260	200	580

Figure 1

Grain yield of maize after natural fallow or following 12 months of fertilized *Centrosema macrocarpum*. See text for treatment details.