DYNAMICS OF WEED SPECIES UNDER DIFFERENT LAND USE SYSTEMS IN PERUVIAN AMAZON

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Abstract

Widespread land use method to obtain farmland in tropics is traditional slash-and-burn farming. The cultivation is feasible only in condition of long fallow period, otherwise this leads to weed infestation and soil degradation. The objective of this stud implemented in the Peruvian Amazon around the city of Pucallpa was to determine possible use of Inga edulis for control of some weed species (e.g. Imperata brasiliensis) and how different agricultural practices influence weed occurrence. The study evaluate four treatments: (1) natural fallow; (2) cropping system with cassava; (3) planted fallow with Inga edulis; (4) planted fallow with I. edulis and kudzu (Pueraria phaseoloides). Weed biomass were measured at 3, 6, 9, 13, 17, 20, 24, 28 and 32 months after fallow initiation. Weed samples were enumerated by counting the number of weeds by species in each subplot. On the research plot, about 20 most frequent weed species were determined. Highest frequency had Imperata brasiliensis; 185.1 individuals m^{-2} at three months and 31.4 individuals m^{-2} at 32 months (Inga + Pueraria). Aboveground biomass reached 180.9 $g.m^{-2}$ at three months for Inga fallow. Results have shown that all four treatments led to successful control of grass weed species. But because of the poor development of Inga trees on severally degraded soil, the trees could not suppress the weeds by shading. The trees would probably need more time to prove this ability.

Key words: *Imperata brasiliensis,* improved fallow, *Inga edulis*, weed control, slash-and-burn

INTRODUCTION

Widespread land use method to obtain farmland in the tropics is traditional slash-and-burn (or shifting cultivation) farming. About 60% of the deforestation of tropical rain forest was caused by this method (World Bank, 1991). In the Peruvian Amazon, approximately 0.5% (350 000 ha) is converted to cropland or pasture each year (TCA, 1997). Greatest deforestation occurs mainly around population centres, e.g. Pucallpa, the capital of Ucayali region. Farmers traditionally use fallow after few years of cropping to renew soil fertility and control noxious weeds *as Imperata brasiliensis*. But the increased population pressure in the Peruvian Amazon has reduced the fallow periods from 10–15 to 3–5 years, leading to rapid soil degradation, and weed dissemination. Subsequently comes effect of yields losses and thus of economic returns generally, which put pressure on farmers to further forest destruction (Alegre et al., 2005). As a result of the poor sustainability of the agricultural production and weed invasion (like *Imperata*), extensive degraded areas have appeared.
One of the possible alternative, how to avoid of increase deforestation, land degradation, soil erosion and on the other hand obtain increase farm productivity, is using of appropriate agroforestry system. Several studies confirm that improved fallow systems based on leguminous trees could enhance soil fertility more rapidly than natural fallow and improve crop yields (Barios et al., 2005; Chirwa et al., 2004; Hartemink, 2005; Szott et al., 1999). They also have also the potential to control noxious weeds (Ekeleme et al., 2004).
One of the mostly valued trees by farmers, which could be used for improved fallow, is *Inga edulis*, locally known as guaba (Villachica, 1996). This fast growing, acid-soil tolerant tree is traditionally used to shade perennial crops such as coffee and cacao, provide firewood and charcoal, and produce a sweet pulp suitable for human consumption (Weber et al., 1997). More recent research has shown that *Inga edulis* is also useful as a green manure and helps control weeds and erosion in alley cropping and other agroforestery systems (Fernandes et al., 1991). The leaf litter protects the soil surface and roots of other plants, helps retain nutrients in the topsoil, and (most importantly for farmers in the humid tropics) controls weeds (Lawrence, 1993). The highest biomass production rates reported in the literature (Szott et al., 1995) are for *Inga. edulis* on acid soils at experimental station

near Yurimaguas, Peru, producing from 2 to 31 Mg/ha per yr. A review of the characteristic of *Inga edulis* which make it suitable for use in an improved fallow system is given by many authors (Weber et al., 1997; Villachica, 1996; Szott et al., 1995).
The objective of this study was to determine possible use of *Inga edulis* for control of grow of weed species (e.g. *Imperata brasiliensis*) and also analyzed the impact of different agricultural practices on weed occurrence around Pucallpa in the Peruvian.

MATERIALS AND METHODS

Field experiment was established at local farm "Vida Sana" near the city of Pucallpa. The farm is situated 19 km from Pucallpa on the main road to Lima (74º25´W, 08º25´S, 155 m above sea level) in the Peruvian Amazon basin. The soil is classified as fine loamy Ultisols (Acrisols according to FAO/UNESCO classification system), acid, infertile, low in organic C, N, P, Ca and Mg, but high in aluminum saturation (Table 1).
This research was aimed on influence of fallow and cropping systems on weed occurrence. The study was initiated in June 2006 and evaluates the following four treatments: (1) natural grass fallow; (2) continuous cropping with cassava (*Manihot esculenta*); (3) planted fallow with *Inga edulis*; and (4) planted fallow with *Inga* and kudzu (*Pueraria phaseloides*). The four treatments were replicated four times in a completely randomized block design in 12 m × 12 m plots. The plots were separated by paths (1–2 m wide) to minimize interactions between them. These buffer zones serve also like fire protection.
Kudzu (*Pueraria phaseoloides*) is a leguminous N_2-fixing herbaceous cover crop that withstands shade and is used as forage. It was planted 1 m × 2 m spacing using certificated seeds local branch of World Agroforestry Centre. It was sown directly. Any gaps in the tree stands were filled in within 2 months. Treatments with *Inga* and cassava were weeded with brush cutter and with machetes four times during the first year. The plots with kudzu and natural fallow systems were not weeded. No fertilizers were applied to the trees or cassava cropping. The natural vegetation that grows in the paths surrounding the plots was periodically mowed using a brush cutter. Before planting cassava, these subplots were burned as farmers usually do.
On each plot three samples of weeds were collected at 3, 6, 9, 13, 17, 20, 24, 28 and 32 months after establishment. The sampling 1.0 m × 1.0 m squares (sampling unit) were placed along a diagonal transect in each plot. Weeds in each square were classified into species and counted. Weed species in each of the three squares were clipped at ground level and number of weed individuals was enumerated by counting the number of weeds by species. Also amount of aboveground and belowground biomass were quantified. Weed samples were oven dried at 106ºC for 24 hr for dry matter (DM) determination. Belowground biomass of *Inga* with *Pueraria* was not collected at 6, 9 and 13. Data from monocropping treatment were not collected at 28 months for absence of weed species at this time.
Program SPSS was used for analysis of variance (ANOVA) to test the effect of fallow type on total weed density and weed DM. Assessment of weed species occurrence and their biomass production among different fallow and cropping systems was done. Total weed density and DM were analyzed as split-plot ANOVA.

RESULTS AND DISCUSSION

Both *Inga* and *Pueraria* established and grew well following frequent weeding. Although *Pueraria* was competitive with trees in the first year, it did not affect them later and final growth of trees in pure *Inga* and *Inga* + *Pueraria* fallows was quiet similar. Average tree diameter at 10 cm (D10) was 1.6 cm in pure tree fallows and 1.1 cm in *Inga* + *Pueraria* fallows after 25 months. Average tree height was 109 cm in pure tree fallows and 88 cm in *Inga* + *Pueraria* fallows. However, in plot number 4 (*Inga* + *Pueraria*) trees do not grow well, probably for flooding of this subplot and problems with drainage. Mortality of the trees on this plot reached almost 70%. The growth rate of Inga trees were very slow (mean D10 = 1.8 cm and height 120 cm at 24 months; mean D10 3.15 cm and height 191 cm at 32 months). Alegre et al. (2005) mentioned that in their trial by the end of 36 months *Inga* attained a height of 6.7 m with a D10 of 6.6 cm. The reason could be very poor soil conditions at the start of the trial as the land was deforested already 20 years ago and was severally degraded. This fact has influence the leaf biomass production and liter biomass

Tab. 1: Initial soil physical and chemical properties of the experimental area

Depth (cm)	pH (1:1)	E.C. (1:1) dS/m	$CaCO_3$ (%)	OM. (%)	P (ppm)	K (ppm)	Sand (%)	Silt (%)	Clay (%)	Texture	CEC (mmol/kg)	Exchangable Ca^{+2} (ppm)	Mg^{+2}	K^+	Na^+	$Al^{+3} + H^+$	Sum of Cationes	Sum of Bases
0-10	4.7	0.09	0.00	1.83	4.7	82	51	41	8	loam	77.20	120.5	28.8	23.5	21.5	155.0	3.49	1.94
10-50	4.6	0.06	0.00	1.00	2.6	39	46	38	16	loam	86.80	67.0	16.5	15.3	19.3	255.0	3.73	1.18

production, so the results of weed control were lower than we expected.

The natural fallow contained high diversity of weed species. We determined about 20 most frequent weed species on the whole trial block (Table 2). Individuals were counted and total biomass was weighed. Most dominant species include cashaucsha (*Imperata brasiliensis* family *Poaceae*) (Figure 1), cola de caballo (*Andropogon bicormis* family *Poaceae*) (Figure 2) and stylo (*Stylosanthes guianensis* family *Leguminoseae*), but there was observed more species respectively. All treatments were dominated by grass weeds at the beginning of the trial, but with the time the diversity of weed species increased. Results have shown that all four treatments led to successful control of grass weed species (Figures 1 and 2). Only in case of cassava treatment there is *Imperata* increase after six months. Most

Tab. 2. Weed species identified on experimental site

Number	Scientific name	Local name	Family	Bunch/Individual
1	*Aeschynomene americana* L.		*Fabaceae*	B
2	*Andropogon bicornis* L.	Cola de caballo	*Poaceae*	B
3	*Baccharis floribunda* L.	Sachahuaca	*Asteraceae*	B
4	*Brachiaria decumbens* Stapf.	Braquiaria	*Poaceae*	B
5	*Coix* sp.		*Poaceae*	B
6	*Cyperus rotundus*		*Cyperaceae*	B
7	*Digitaria sanguinalis*		*Poaceae*	B
8	*Hyptis* sp.		*Lamiaceae*	I
9	*Imperata brasiliensis* Trinius	Cashaucsha	*Poaceae*	I
10	*Lantana camara* L.	Sacha orégano	*Verbenaceae*	B
11	*Ludwigia erecta* (L.) H.Hara	Clavito	*Onagraceae*	I
12	*Panicum laxum*		*Poaceae*	B
13	*Paspalum conjugatum* Bergius	Torourco	*Poaceae*	B
14	*Paspalum* sp.	Colchon sacha	*Poaceae*	B
15	*Phyllanthus amarus*	Chanca piedra	*Euphorbiaceae*	I
16	*Pseudelephantopus* sp.	Lengua de perro	*Asteraceae*	I
17	*Pueraria phaseoloides*	Kudzo	*Leguminoseae*	B
18	*Rottboellia cochinchinensis* (Lou.)W.Clayton	Arrocillo	*Poaceae*	I
19	*Scleria melaleuca* Reich. Ex Schl.&Cham.	Cortadera	*Cyperaceae*	B
20	*Sida rhombifolia* L.	Pichana	*Malvaceae*	I
21	*Stylosanthes guianensis* (Aublet) SW	Alfalfa	*Fabaceae*	B

Tab. 3: Number of weed individuals per m^2, aboveground and root biomass ($g.m^{-2}$) of weeds under different agricultural practices at different time after fallow initiation (Pucallpa, Peru)

Treatment	Months in fallow								
	3	6	9	13	17	20	24	28	33
N° of individuals									
cassava	173.4	86.4	42.1^a	101.9	53.3	47.9	40.1	tr	21.5
natural fallow	136.8	119.8	65.4^a	60.8	45.8	50.8	39.9	37.4	34.4
Inga fallow	144.4	128.6	63.3^a	66.3	48.7	40.3	41.4	64.8	38.0
Inga+Pueraria	193.3	141.3	135.8^b	91.1	24.0	27.5	24.1	31.8	40.9
Aboveground biomass									
cassava	162.3	257.7	60.2^a	130.8^a	245.6^b	316.9^b	246.4	tr	165.1
natural fallow	246.0	326.1	296.1^b	524.6^b	382.5^c	385.4^c	285.8	380.8^c	164.2
Inga fallow	180.9	234.7	150.8^a	130.0^a	304.2^b	230.3^a	196.7	140.4^a	117.1
Inga+Pueraria	253.1	180.0	339.1^b	462.5^b	186.3^a	245.9^b	227.5	289.2^b	134.7
Root biomass									
cassava	139.8	138.7	120.8	77.1	271.9^b	103.5	120,4	tr	182.3
natural fallow	134.1	139.8	140.8	104.6	265.4^b	80.1	117.0	190.4	131.7
Inga fallow	128.0	154.6	165.8	90.0	315.0^c	100.7	111.2	130.8	129.0
Inga+Pueraria	126.5	no	no	no	142.1^a	111.5	128.9	147.1	156.6

For each date and weed dynamics indicator, treatments followed by the same superscript letter are not significantly different (P=0.05). tr – trace (zero values); no – no measured at this time promising results for control of *Imperata* are in cases improved fallow with *Inga* and *Inga* + *Pueraria*. Al number of weed individuals are generally decreasing, but in a case sachuahuaca (*Baccharis floribunda*, family *Asteraceae*) (Figure 3), which is local shrub species, rise up during the time, which is the sign of natural succession. In all treatments number of weed species increase during the time (Figure 4), which is also another sign of natural succession and improvement of weed composition.

Table 3 shows the number of individuals and aboveground and root biomass (g.m^{-2}) of weeds under all treatments at different times after fallow initiation. As far as

Figure 1: Occurrence of *Imperata brasiliensis* in different treatments at different time after experiment initiation (Pucallpa, Peru)

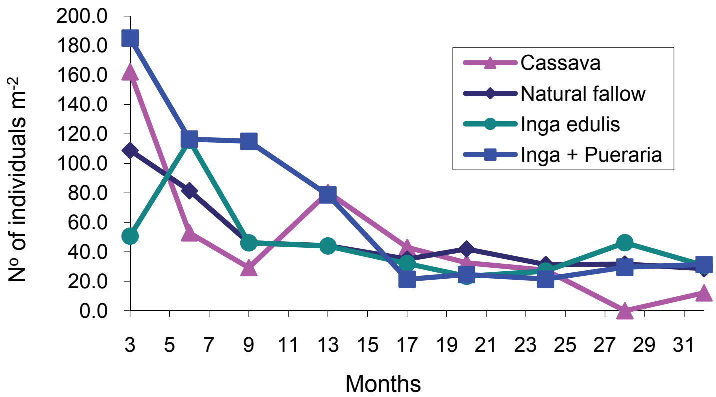


Figure 2: Occurrence of *Andropogon bicobnis* in different treatments at different time after experiment initiation (Pucallpa, Peru)

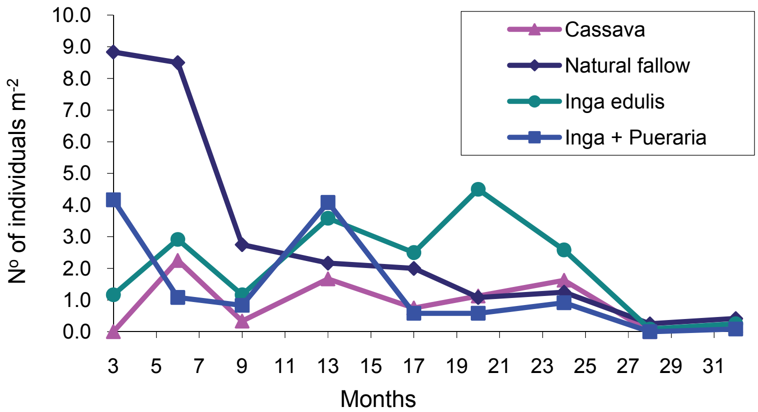
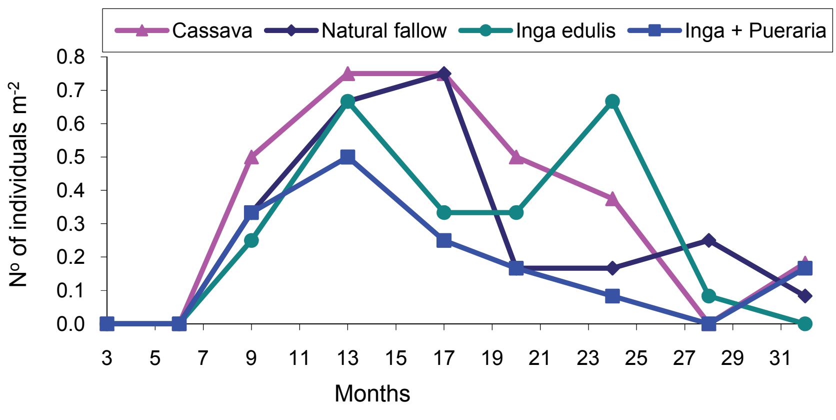


Figure 3: Occurrence of *Baccharis floribunda* in different treatments at different time after experiment initiation (Pucallpa, Peru)



the number of individuals is concerned, there are not any significant differences between treatments except at 9 months after fallow initiations, when the number of weed individuals was the highest in *Inga* + *Pueraria* fallow, reaching almost 136 individuals.m^{-2}, whereas in other treatments the numbers were significantly lower. The number of all weed individuals was decreasing with time (Figure 5), which is a good sign for the control of more numerous grass weeds as *Imperata* or *Andropogon*. Aboveground weed biomass oscillated and there were

Figure 4: Number of weed species in different treatments at different time after experiment initiation (Pucallpa, Peru)

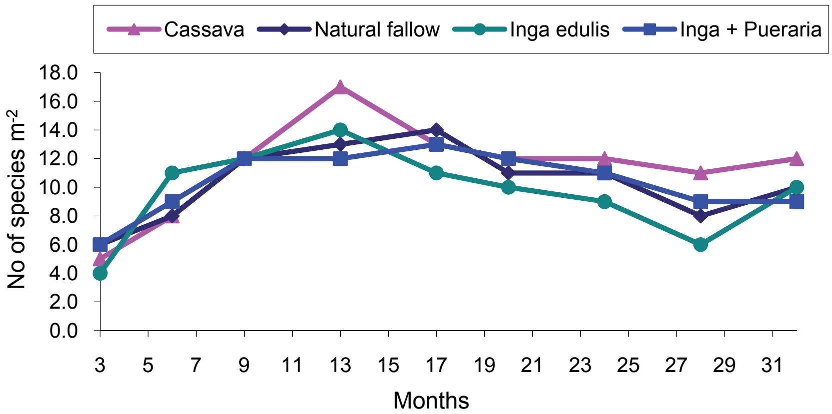


Figure 5: Number of weed individuals in different treatments at different time after experiment initiation (Pucallpa, Peru)

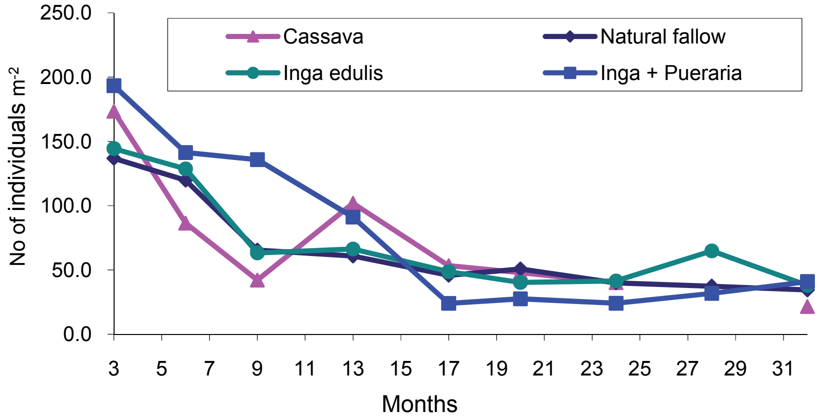
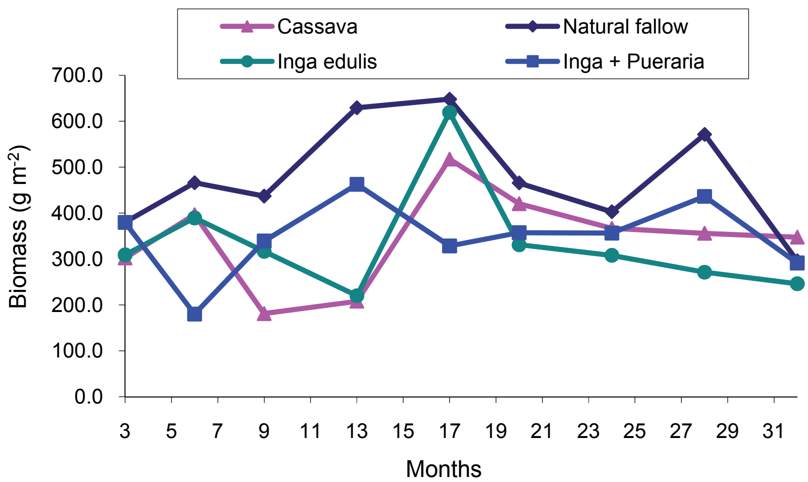


Figure 6: Total weed biomass production in different treatments at different time after experiment initiation (Pucallpa, Peru)



not any significant differences except at 9, 13, 17, 20, 28 months of growth. After 9 and 13 months aboveground weed biomass of natural fallow and *Inga* + *Pueraria* fallow had significantly greater mass than *Inga* fallow and cassava cropping . Aboveground biomass reached 524.6 g.m^{-2} in the natural fallow compared to 130 g.m^{-2} in the *Inga* fallow after 13 months. After 17 months, significantly lowest weed biomass was measured in mixed *Inga* + *Pueraria* fallow (186.3 g.m^{-2}) and significantly highest measured in natural fallow (382.5 g.m^{-2}). After 20 months, significantly lowest biomass was measured in pure *Inga* fallow (230.3 g.m^{-2}) and significantly highest again in natural fallow (385.4 g.m^{-2}). After 28 months, again significantly lowest weed biomass was found in pure *Inga* fallow (140.4 g.m^{-2}) and highest in natural fallow (380.8 g.m^{-2}). As for root biomass, significant differences among treatments were found only after 17 months, when weed root mass was significantly lowest for *Inga* + *Pueraria* fallow (142.1 g.m^{-2}) and highest for the *Inga* fallow (315.0 g.m^{-2}).

Based on our measurements we can see that in most cases pure *Inga* fallow were able significantly decrease weed aboveground biomass compared to natural fallow. In the study of Alegre *et al*. (2005), there was 130–190 g.m^{-2} of weed biomass under the natural and pure tree fallows after 36 month. The numbers in our study were much higher and oscillated between 190–650 g.m^{-2} during the trial (Figure 6), and there were no clear significant differences between the individual treatments. After 32 months the total weeds biomass range from 246 g.m^{-2} for *Inga* treatment to 347 g.m^{-2} for cassava treatment.

The results in this trial were affected by slow development and poor litter biomass production of *Inga edulis* which is essential condition for weed suppression for its function like mulch. Also insufficient canopy for weed shading was limiting factor. Shade is the major cause for efficient suppression of weeds under planted fallows, trees in natural fallows take 3–4 years or longer, depending on their growth rates and canopy structure, to establish a canopy cover to suppress weeds, although several other mechanisms also play important roles (Rao et al., 1998). In a previous study of Szott (1987) *Inga* and natural fallow required 3.5 years to achieve a level of weed control similar to that achieved by centrosema in 16 months (Alegre et al., 2005). This problem of slow development was probably caused of presence of higher underground water, which is unsuitable condition for well grow of *Inga*. So this results show that although some types of tropical soils are looks adequate for *Inga* establishment, there can exist other limiting factor. For this reason it is necessary look out for other tree species respectively *Inga* species for efficient weed control in different conditions.

CONCLUSION

Planted tree fallows using fast growing trees such as *Inga* accumulate more biomass than the natural fallow over a 32 month period. However, there were no clear significant differences among our fallow and cropping systems. Under all treatments there could be seen quite successful succession from purely grass weed to more diversified weed composition during the time, but till the end of our trial the improved fallow was not able significantly control weeds compared to natural fallow or cassava cropping. The problem was poor development of Inga trees on severally degraded soil, so the trees could not suppress the weeds by shading. The trees would probably need more time to prove this ability. Surprisingly neither kudzu was able significantly control weeds, even though it grows very rapidly under our trial conditions.

We conclude that planted tree fallows with economically valuable trees such as *Inga* have probably the potential reduce grow of weed species after longer time, but they require more extensive testing under a range of biophysical conditions.

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A PROBIT ANALYSIS OF ACCESSIBILITY OF SMALL SCALE FARMERS TO FORMAL SOURCE OF CREDIT IN OGBOMOSO ZONE, OYO STATE, NIGERIA

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Abstract

The study analyzed the determinant of small scale farmers, access to formal credit in Ogbomoso zone, Oyo-State. Access to credit is very important since financial constraints were one of the most important problems of small-scale farmers limiting adoption of new farming technologies. Formal credit is the most reliable source of credit in terms of availability in optimal size and disbursement organization. 150 small scale farmers were purposively select for the study; Data used was collected from the farmers using interviewed schedule method. The data was analyzed with Probit model using SAMAZ software. The result of the study revealed that level of education, membership of cooperative, contact with extension agent and present of collateral security positively and significantly determine the likelihood of farmers access to formal credit, while farming experience negatively determine the probabilities of farmers having access of formal credit. The result was consistent with a prior expectation in terms of direction of relationship and economy theories. The study therefore recommended that, the direction of influence of these determinants should serve as a guide, in efficient disbursement of formal credit in the future.

Key word: Probit analysis, accessibly, formal credit

INTRODUCTION

Access to credit is very crucial to small scale farmers especially in less developed nation of the world. This is because it increases farmer's total production and improves their productivity per unit input. Credit is a necessary ingredient in the various aspect of farming operation. There is high demand for credit by farmers in Nigeria, mainly because capital is required for improvement on the land, for purchase of implements, machinery, and breeding stock, purchase of seeds, fertilizer as well as payment of wages of labour. Agricultural credit can be organized into two, informal and formal sources. The informal sources of credit include cooperative societies, commercial banks and development banks. According to Olomola (1999), credit from informal sources cannot contribute much to the process of agricultural development. Some of the problem associated with the informal source of credit as stated by Akande and Oni (2000) are:

(i) The tend to be small in size: hence they can only cater for limited number of trusted client.
(ii) Because the volume of lending is very small they may not meet the needs of the borrower.
(iii) Many of the loans are disbursed at exceedingly high rates of interest, as well as purchasing of farmers output at unreasonably low prices.
(iv) Adoption on third party guarantees as techniques at overcoming problem of collateral is defective in that enforceability is difficult and ineffective.

Despite the problem listed above, informal sources of credit are extremely popular among smallholder frames because of the relative ease of obtaining the loan and flexibility built into repayment most especially in areas where individuals are quite familiar with and share confidence in one another, formal sources of credit although believe to be the most effective sources from the point of view of overall agricultural development. It also has it associated problem in which inaccessibility to it by small scale farmers is the major one. Other problems which are also related to the major problem as stated by Olumola (1999) include the following:

– Scarcity of collateral in the rural area
– Poorly developed communication network and other rural infrastructures in rural areas make transaction cost of dealing with small loan, and geographically widely dispersed large number of borrowers too high for institutional lenders.
– High risk associated with agriculture as a business. These include weather fluctuation as well as change in commodity price.
– Enforcing loan repayment constitutes a serious constraint to channeling credit to the agricultural sector.

– Problem of imperfect information due to adverse selection and moral hazards.
– Bureaucratization of lending slows down loan processing and exposes credit to political or religious pressures.
– Loan diversion to non-agricultural or non-productive uses.
– Counter productive government policies
– Misconception about loans is often regarded as part of the national cake instead of depositor's money. Given the importance of credit in agriculture and the fact that only formal sources of credit is the source that can disburse credit efficiently to small scale farmers, couple with the enumerated problem associated with these source, this study therefore aim at analyzing some of the major determinants of accessibility of small scale farmers to formal sources of credit using Probit model.

MATERIALS AND METHODS

Probit model

The use of qualitative response model in explaining discrete decision making is well documented. The simplest of these models, the linear probability (LPM) is amenable to the ordinary least squares method (Agada and Philip, 2002). However, it suffers the limitation that is disturbance term is potentially heteroscedastic and the model probability predictions are not necessarily bounded within (0, 1) (Pindyck and Rubin-fied, 1981). The transformation of the LPM with bounded probability values within (0, 1) are the Probit and logti model. Probit model means cumulative Normal probability functions, while Logit model is cumulative logistic probability model. The Probit model assumes the existence of some index Z such that

(a) Z_i is unobserved or unmeasured
(b) Z_i is continuous
(c) Z_i is determine by X_i
(d) Z_i is normally and independently distributed i.e $Z_i' \sim nid$

Model specification

in specifying a Probit model, a random variable Y (dependent variables) takes the value of 1 if the event occurs i.e if small scale farmers have access to formal credit and zero if otherwise.

Yi*= Xib + ÎI

$$Yi = \begin{cases} 1 \text{ if } yi^* > 0 \\ 0 \text{ otherwise} \end{cases}$$

Where: i = 1,2, …, n

Furthermore, the probability of an event occurring depends on a vector of independent variable X and a vector of unknown b. The Probit probability functional form where a standard normal distribution function is used to transform the original data of the binary

Model is expressed as: $F(Z) = f(Z) = \int_{\omega}^{z} \frac{1}{2\pi} e \frac{u^2 \boldsymbol{d}}{2}$

Where: (Z) = Xib

The Probit model specified in the study to analyze farmer's accessibility or inaccessibility to formal credit can be expressed as:

Tab. 1: Factors affecting farmer's accessibility to formal credit

Variable symbol	Definition	Measurement
Y_i	farmer access to formal	the value of one if farmer have access to credit, 0 otherwise
X_1	farmers age	in years
X_2	sex	one for male, 0 otherwise
X_3	literacy level	years of schooling
X_4	farm size	in hectare
X_5	land tenure state	one for land owner, 0 otherwise
X_6	type of credit	1 if short term, 0 if long term
X_7	collateral security	1 if available, 0 otherwise
X_8	cooperative membership	1 if member, 0 otherwise
X_9	farm record	1 if available, 0 otherwise
X_{10}	project type	1 for crop husbandry 0, otherwise
X_{12}	farming experience	in years
X_{13}	contact with extension agent	no of visitation

yi = 1 = XiP + Ei if Xib + Ei > T
yi = 0 if Xib + Ei £ T
i = 1, 2, …, n

Where yi is farmers accessibility to credit which takes on the value of 1 and value 0 for non-accessibility. T is the threshold point and Ei is an independently distributed error assumed to be normally distributed with zero mean and constant variance.

$V' \sim N (06^2)$

Explanatory variables (Independent variables) expected to influence farmer access to formal credit are age, education, level, farm, size/type of credit, collateral security farm record and accounts, project type etc. The main advantage of the Probit functional form is that it is bounded between 0 and 1, hence the problem of predicting values being outside the probability range is overcome, furthermore, it compels the disturbance term to be homoscedastic because the form of the probability function depends only on the distortion of the difference between the error terms associated with one particular choice and another (Amemiya, 1973).

Hypothesis Testing

H_0: $b_j = 0$, (j = 0, 1, 2, …, 12)

H_i: b_j ¹ 0

Literature on probability model

Many authors have used various types of probabilities models in their studies. Ayinde (2004) used Logit regression model to study the probability of health hazard resulting from the use of insecticide in cowpea production in Kano and Ogun State, his findings revealed that insecticide usage imposes health hazard on the respondent (cowpea farmers) in the study area. This study also confirms the findings of Dung and Dung (1999). Adesina et al. (1999) also used Logit model in their study 'Policy shift and Adoption of Alley farming in West and Central Africa'. In this study, logit analysis showed that farmers socio-economic characteristic, village characteristic and farmers perception of technology attribute were all-important in explaining farmers adoption behaviour. Adejobi (2004) in his study, "Rural livelihood, poverty and household food Demand structure in Kebbi State. Nigeria", used Tobit regression model to analyze household characteristics and livelihood variables that determined food poverty level in the study area, his findings reveled that only 14 out of 23 household characteristic and livelihood variables included in the model had their coefficient significant at 5% (p = 0.05). Akinbode (2005) used logit regression modle to estimate factors affecting the willingness to pay for safety food among the respondent study in Ogun State. The study shows that age (X_1), education (X_2), income (X_3) and consciousness (X_6) significantly affected the likelihood or otherwise of willingness to pay for safety food among street food consumers. Rahji (1996) used probit model to determine the characteristics that influenced the probability that a farm household member will participate on off farm work. The outcome of the study revealed that some of included variables like Age (X_1), level of education (X_3), and five others, significantly determine the participation in an off-farm work. Chikwendu (2002) make use of logit model to analyze the determinants of Adoption of improve technologies among farmers participating in public and alternative extension system in Nigeria. The result showed that the probability of a farmer adopting a new technology was much higher under the NGOs/PAE system than under the government financed and controlled Training and visit (T&V) extension system. Agada and Philip (2002) in their study 'A Logit Analysis of the participation in the Nigeria Agricultural Insurance Scheme by maize growing farmers in Kaduna State'. The study revealed that about 94% of the farmers studied were correctly classified by the model. The statistical significant adoption factors are the amount of loan (X_4), year of education (X_1) and contact with extension agent (X_7) and this were significant at 1% level (0 < 0.01), while job statue (X_2) was significant at the 5% level and the size of loss suffered (X_9) was significant 10% level (> 0.10).

Area of study

The study was carried out in Ogbomoso zone of the Agricultural development project (ADP) of Oyo State. The zone comprises of five local government areas namely, Ogbomoso North and South, Orire, Ogo-Oluwa and Surulere respectively. The Geographical location is one latitude 8.1°N longitude 3.29°E. The zone is regarded as derived savannah vegetation zone and a lowland rainforest area. The climate of the region is characterized by a fairly high uniform temperature, moderate to heavy seasonal rainfall and relative humidity. The mean annual temperature is 26.2°. Agricultural activities in the area include production of corps like Vegetable, Cowpea, Yam, Cassava Maize Pepper, Rice and Okra. Permanent fruit crops grown in the area include Cashew, Mango, Citrus, Banana, Pawpaw and Pineapple.

Method of data collection

The study make used of primary data. The primary data was collected through a survey and administering set of interview schedule to small scale farmers in Ogbomoso. Primary data provide information on the socio-economic characteristic of the farmers, their source or accessibility to credit of credit procurement, uses of credit and son on.

Sampling technique

Purposive sampling techniques was used to select 75 small scale farmers who have access to formal credit and 75 small scale farmers who did not have access to formal credit in the zone.

Method of analysis

A Probit model was estimated using SHAZAM computer software.

RESULTS AND DISCUSSION

Table 2: reveal the maximum likelihood estimates of the model investigated. About 81% of the farmers studied were correctly classified by the model. The model chi-square, statistically significant at 1% level was 172.82. The parameters for the model were evaluated at the 1%, 5% and 10% levels. Five of the twelve independent variables included in the model were found to be statistically significant at different levels.

The variables that are significant are literacy level (X_3) and cooperative membership (X_8) both were significant at the 1% level, collateral security (X_7) was significant at 5% while farming experience (X_{11}) and contract with extension agent (X_{12}) were significant at 10% level.

The signs of all the significant parameter estimates except for farming experience were positive and are consistence with a prior expectation.

The result of analysis implies that literate farmers who belong to cooperative society and have collateral security with reasonable contact with extension agent are more likely to have access to formal credit. That is a unit change in the above listed variables increased the probability of having access to formal credit by 10.48, 5.12, 7.13 and 2.11% respectively.

For farming experience (X_{11}), the higher the farming experience (in years) the less likely the farmers will have access to formal credit since it coefficient is negatively sign.

Most of the variables analyzed show an outcome that is consistent with a priori expectation. For example, literacy level is expected to increase their awareness about extent of formal credit. An educated farmer will also find it easer to process credit; all this will increase his accessibility to formal source of credit. The same argument is true for presence of collateral security, member of cooperative society and contact with extension officers which will al increases the odds of having access to formal credit. In the case of farming experience, which has negative reactive relation with access to credit, it shows that with increasing farming experience, farmers became very conservative about sourcing credits from formal source and they prefer sourcing there funds from informal institution like friends, relative, money leaders and produce buyers. Older farmers may not even believe in funding his business with borrowed capital, he may rely on his insufficient equity.

Tab. 2: Maximum likelihood estimates of the Probit Model

	Variables	Expected sign	Coefficient	T-statistic	Elasticity
1	Farms Age (X_1)	+	–0.112	0.242	0.051
2	Sex (X_2)	±	–0.004	0.013	0.022
3	Farm size (X_3)	+	2.123***	0.321	1.048
4	Farm size (X_4)	+	0.034	0.139	0.10
5	Land tenure statue (X_5)	+	0.056	0.183	0.032
6	Type of credit (X_6)	neutral	–0.086	0.184	–0.127
7	Collateral security (X_7)	+	1.077**	0.528	0.713
8	Cooperative membership (X_8)	+	1.413***	0.263	0.512
9	Farm record (X_9)	+	0.132	0.166	0.201
10	Project types (X_{10})	neutral	–0.017	0.181	–0.062
11	Farming experience (X_{11})	±	–0.416*	0.421	–0.137
12	Contact with extension agent (X_{12})	+	0.372*	0.186	0.211
	Constant	+	–4.124***	1.14	

Log likelihood = –330; Number of observation = 150; Chi-Square = 172.82; Percentage of right prediction = 81

***Significant at 1%; **Significant at 5%; *Significant at 10%

CONCLUSION

The study showed that certain variables usually determine the accessibility of farmers to formal sources of credit. Among this variables, are level of education, membership of cooperative, availability of collateral security, farming experience and contact with extension agent, were the most important, it is therefore important for policy maker to take full advantages of indicated direction of influence of this factors in designing effective credit program.

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