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# Socio-economic factors influencing use of improved fallows in crop production by small-scale farmers in western Kenya

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**Abstract** This study analysed the factors influencing the intensity of adoption of improved fallows in Western Kenya. Three hundred farmers were interviewed. Descriptive results showed the adopters to be older, more educated and had more contact with technology promoters than the non-adopters. Partial budgets were constructed and marginal rates of returns (MRR) showed that the technology is profitable. Based on the censored Tobit, the results indicate that the intensity of adoption was significantly influenced by age, experience of the household head and spouse, total land area, contact with technology promoters, technology profitability and use of other soil fertility replenishment options. It is recommended that education efforts be intensified. There is need to strengthen contact with the technology promoters. In order to ensure information flow to all, there is need for improvement in the approach and methods employed in on-farm research. Further, there is need to establish and strengthen networks of information exchange among relevant and interested organisations

Key words: Adoption, marginal returns, soil fertility.

## Introduction

Declining soil fertility is a critical problem affecting agricultural productivity and human welfare in tropical Africa (Cooper *et al.*, 1996). Consequently, many countries are faced with problems of chronic food insecurity. Further, the decline in food production trend over the past 30 years contributed significantly to rural poverty (World Bank, 1999). Due to this, improving soil fertility management in African farming systems is increasingly a major issue of the development policy agenda.

Current soil fertility improvement efforts include use of agro-forestry based soil technologies, rock phosphates and chemical fertilisers (Okalebo and Woomer *et al.*, 1997). Agro-forestry is a land use system that involves socially and ecologically acceptable integration of trees with agricultural crops and or animals simultaneously, so as to get increased total productivity of plants and animals in a sustainable manner from a unit of farmland (Nair, 1984). These agro- forestry based techniques include use of improved fallows and biomass transfer, among others. Sanchez (1999) defines an improved fallow as the deliberate planting of leguminous tree/shrub species with the primary purpose of fixing nitrogen as part of a crop fallows. Use of improved tree fallow plays a major role in replenishing soil fertility (Sanchez and Palm, 1996).

In western Kenya, there is vigorous promotion of agroforestry soil replenishment technologies. Consequently, several studies have examined (Franzel, 1999; Pisanelli, 2000;

Place *et al.*, 2001) and reported relatively high rates of adoption. Makokha *et al* (1999) in western Kenya reported that farmers used soil fertility management technologies at intensities far below the recommended levels. They recommended further research to established the causative factors. The focus of this paper is, thus, to evaluate the factors that influence the intensity of use of improved fallow. Further, the paper will give insight in the returns to the technology at different intensities.

## Materials and methods

The study was conducted in five districts of Western Kenya, namely, Siaya, Vihiga, Kakamega, Busia and Rachuonyo districts.

The conceptual framework was on the primise that any adoption decision is a behavioral response arising from a set of alternatives and constraints facing the decision maker at the time of making the decision. This can be represented hypothetically as:

Decision= f (alternatives, constraint) Equation 1

Economically Equation (1) can be expressed in the following regression:

$y_i = ß\, x_i + e_i$ Equation 2

Where $y_i$ is the decision of the ith individual, ß is a column vector of unknown parameters, X is a matrix of known variables, while e is a stochastic disturbance term. The individual either adopts ($y_i$ = 'Yes') or rejects ($y_i$ = 'No') the technology. In econometrics the 'Yes' decision is equated with 1 and the 'No' decision is equated with 0. Further, Equation 2 becomes a discrete choice or qualitative response model whose dependent variable, $y_i$ is either zero or one denoting that the individual has rejected or accepted the technology. The individual accepts the technology if incentives are more than the disincentive.

In the present study, $y_i$ if 'Yes' is the proportion of the total farm size available for food crop production as a percentage under the fallow trees. $X_i$ is the known variables, namely, farmers characteristics, technology attributes, institutional and resource factors which are hypothesised to affect adoption and intensity of adoption of any new technology. Finally, the problem is to estimate ß and $e_i$ on the basis of N observations on $Y_i$ and $X_i$.

**Empirical model.** Descriptive statistics, partial budgets, marginal rate of return (MRR) and Tobit Model were used. To analyse the factors affecting the intensity of adoption, the Tobit Model was used. Other empirical models commonly used to study factors affecting adoption include Probit and Logit. These models, however, fail to capture the degree of adoption. This inadequacy is overcome with the use of the Tobit Model (Greene, 1993). This is because the latter can efficiently analyse both censored and uncensored observations. Data sets with censored and uncensored observations cannot be properly analysed by ordinary least squares (OLS) procedure because OLS lumps together the censored and uncensored observations. According to Greene (1993), the general formulation of the censored regression (Tobit) is an index function shown below:

$$Y_i^* = \beta' X_i + \varepsilon_{i,}$$
$$Y_i = y_i^* \text{ If } \quad y_i^* > 0 \qquad \text{Equation 3}$$
$$Y_i = 0 \text{ if } y_i^* \leq 0$$

Where the index variable, $Y_i^*$ defines an underlying unobservable tendency as adoption is a choice rather than a technical outcome. $\beta x_i$ is a vector of unknown parameters and $\varepsilon_i$ is a random error term. Equation (3) in the present study means that adoption ($y_i$) of improved fallow will be observed only when the latent tendency is above the unobservable threshold ($y_i^*>0$). If $y_i^*$ is less than or equal to zero, then $y_i$ becomes zero, meaning that there is no adoption. To estimate the probability and level of adoption of improved fallow, Tobit Model using the LIMDEP computer package was applied on equation (3).

**Data sources and sampling technique.** The study used both primary and secondary data. Primary data were collected using questionnaire interviews with 300 farmers chosen by use of random sampling. Secondary data were obtained from publications and available records.

## Results and discussion

The study revealed that adopters were older, more educated and had more contact with the promoters of the technology than the non-adopters. This contact could have assisted in accessing inputs such as seed. In partial budgeting below, utilisation level of improved fallow at 5% implies that five percent of the total farm available for food crop production was devoted to improved fallow per year. This was the average of areas from 1999 to the year 2001. Costs and benefits were obtained by comparison of adopters and non-adopters. The results showed that extra benefits are higher than the extra cost incurred at different intensities (Table 1, 2, 3), where. 1US$ = 75 Kenya shillings (Kshs).

Maize and beans prices used were the average prices at harvest time and two months after the harvest. The price of improved fallow seeds (US$/kg 1.43) was based on what the International Centres for Research in Agroforestry (ICRAF) paid farmers for collecting the seeds in 1999; the commodity was not available in the market, thus, no market price. Extra benefits were higher than the extra cost incurred at different intensities. Majority of the farmers used the lowest intensity, which was devoted less than 5% of their total farm to the improved fallow. At this level, it was profitable to invest in the technology though the full expected impact could not be realized as the returns were still increasing with higher intensities. This meant that farmers could be advised to increase their intensities of use to more than 10% as they would get benefits of increasing returns.

Marginal rate of returns were calculated for different intensities of use. They indicated what farmers could gain on average, in return for their investment if they changed from one practice to another. The net benefits from investment increased as the amount invested increased. In this study, moving from one practice to another involved moving from a lower intensity of use to a higher intensity. The following formula for calculation of MRR was adopted CIMMYT, (1988).

$$\text{MRR} = \frac{Additional\,benefits}{Additional\cos ts} x100$$

Utilisation of improved fallow at 5 % level had an MRR of 111 %. This implied that for US$1 invested in the use of the improved fallow per ha, farmers recovered the one dollar plus an extra 1.11 dollar per ha in net benefit. A move to a higher intensity of between 5 - 10 % and over 10% led to an increase in MRR of 122 and 125 %, respectively. The range of acceptable minimum MRR to farmers is between 50 and 100% (CIMMYT, 1988). Thus, the calculated MRRs were higher than the minimum acceptable range. These results imply that it is worthwhile investing in the technology at the given intensities. Marginal rate of return was increased as intensity increased thus, the need to find out the intensity of use at which returns start to decline.

Tobit regressions revealed that the intensity of adoption of improved fallows was significantly affected by age of the household head, farm size, farming experience of the household head and spouse, contact with technology promoters, technology profitability and use of other soil fertility replenishment technologies, among other factors (Table 4).

The positive and significant coefficient of experience of the household head and spouse implied that farming experience is positively related to intensity of adoption of improved fallows.

The coefficient of contact with technology promoters was positive and significant. This provided technical backstopping in terms of information, seeds and other inputs, implying that there is need for frequent contact of farmers and the promoters of the technology. Technology profitability was positive and significant. This implies the need for farmers to fully understand the technology attributes in order to increase its adoption. Use of other soil fertility replenishment technologies was negatively significant. This suggests that adopters of improved fallow used the technology in combination with other available technologies mainly farm yard manure.

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