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Socio-economic factors influencing the intensity of use of bio mass transfer in food crop production in western Kenya

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Abstract Bio- mass transfer is defined as the incorporation into the soil of leafy shrubs, which release nutrients. The shrubs include *lantana camara* and *tithonia diversifolia*. This study analyzed the determinants of the intensity of use of *tithonia diversifolia* in kale production in western Kenya. A structured questionnaire was administered to 300 farmers selected through random sampling. Descriptive statistics results showed that the adopters were more educated and had more contact with the technology promoters more than non-adopters. Marginal rate of returns (MRR) were calculated through partial budgeting, whose results implied that the technology was profitable. Tobit regression results showed that education, contact with technology promoters, labour demand of the technology, hired labour, and technology profitability among other factors influenced the intensity of adoption. The study recommends that educational efforts and frequent contact with technology promoters be intensified. The already acquired knowledge of the technology by adopters can be exploited to benefit other farmers and also to improve on it by use of farmers' field schools. Information flow needs to be improved by researchers changing the approach and methods employed in on farm research to ensure information flow to all. Further, there is need to establish and strengthen networks of information exchange among relevant and interested organizations like church organizations, extension and community based organizations among others.

Key words: Adoption, intensity of adoption, bio mass transfer, *tithonia*.

Introduction

In sub-Saharan Africa, farmers face increasing difficulties in their attempt to maintain productivity on intensively cropped farms. This is a result of topographic, climatic and socio-economic factors. These difficulties have led to soil fertility depletion, consequently decreasing household food production. Further, Agricultural productivity has continued to decline given the rising costs of mineral fertilizers. This situation is found in Kenya especially western region where high population pressure has reduced the average land holdings. Small land sizes have led to continuous and intensive use of land through out the year thus increased decline in soil fertility.

Smaling (1993) reported that the major soil nutrients deficiencies in the Kenya highlands are nitrogen (N), phosphorous (P) and potassium (K). Farmers in western Kenya being resource poor are not able to invest in mineral fertilizers to replenish the heavy N, P, and K losses. Solution lies in the use of low cost agroforestry technologies like bio mass transfer (*tithonia diversifolia)*. These bios mass grows as fences for farm demarcation, protection and also grows on the roadside making it readily available to farmers. In order to scale up the adoption of the technology, there is need to have a deeper understanding of the prevailing socio–economic status of the farmer and their relationship to the decision to adopt the technology and its use. This will show how well the technology fits into the complex pattern of agricultural change in the farming system. Further, studies have shown low intensity of use of soil fertility management technologies in Western Kenya (Makokha *et al*, 1999) thus focus of the present study. Therefore the objective of this study was to identify the factors that determine the intensity of use of bio mass transfer in western Kenya. In addition the study looked at the returns of the technology when used to produce kales (sukuma wiki) at different intensities.

Materials and methods

Study location. The study was conducted in Western Kenya, specifically in Siaya, Vihiga, Kakamega, Busia, and Rachuonyo districts.

Conceptual Framework. Farmers were assumed to be consumers of agricultural technology inputs and therefore were categorized into adopters and non-adopters of bio mass transfer. If farmers are consumers of agricultural inputs, then according to the random utility theory, they will choose to adopt the alternative technology package that gives them highest utility. Adoption was further conceptualized as a function of farmer's characteristics, technology attributes, institutional factors and resource factors. This was based on the three major factors that affect adoption and intensity of adoption of new agricultural innovations, (Adesina and Zinnah, 1992). Further, the decision to adopt an innovation is a behavioral response arising from a set of alternatives and constraints facing the decision maker. These alternatives and constraints can be grouped into incentives and disincentives. Adoption proceeds only when the incentives outweigh the disincentives.

Empirical model. Descriptive statistics, partial budgets, marginal rates of return (MRR) and censored Tobit model were used. In the formulation of the censored Tobit model, farmers' adoption decisions on technologies were assumed to be based on the utility maximization with a number of important characteristics that influence adoption namely technology attributes, farm and farmer's characteristics, (Adesina and Zinnah, 1992).

According to Greene (1993), the general formulation of the censored regression (Tobit) is an index function shown below:

$$Y_i^* = \beta' X_i + \varepsilon_i,$$
$$Y_i = y_i^* \text{ If } \quad y_i^* > 0 \qquad (1)$$
$$Y_i = 0 \text{ if } y_i^* \le 0$$

Where the index variable, Y_i^*, defines an underlying unobservable tendency as adoption is a choice rather than a technical outcome. β, x_i is a vector of unknown parameters and ε_i is a random error term. From above the mean of Y_i^* is $\beta' x_i$. For convenience, the censoring point for the model is usually assumed to be zero (Greene, 1993) thus adoption is only observed when y_i^* is above a certain threshold level which is taken to be zero. Equation (1) in the present study means that adoption (y_i) of bio mass transfer will be observed only when the latent tendency is above the unobservable threshold ($y_i^*>0$). This was taken to be the quantity of *tithonia* used per hectare. On the other hand 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 intensity of adoption of bio mass transfer, Tobit model using the LIMDEP computer package was applied on equation (1).

Data sources and sampling technique. Both primary and secondary data were used. Primary data was collected from a random sample of 300 farmers from five districts in western Kenya by use of questionnaire interviews. Secondary data was obtained from research institutions and publications.

Results and discussion

An adopter of bio mass transfer was considered to be any farmer who had used *tithonia diversifolia* at least twice since 1999. The non-adopters in the area sited the lack of technical information and intensive work required in the use of the technology as their main constraint hindering adoption. The technology was commonly grown with high value crops like vegetables due to its labour intensiveness, but a few of the farmers used the *tithonia* for maize-bean intercrop. Descriptive statistics results showed that the adopters were older, more educated and had more contact with the technology promoters more than the non-adopters.

Partial budgets were constructed in order to analyze marginal changes that occur in benefits and costs due to the introduction of the technology. They take into account only those changes in costs and benefits that result directly from the proposed modifications i.e. use of the technology. Based on this, the study compared adopters and non-adopters in order to give the costs and benefits associated with the use of bio mass transfer. The results revealed that the technology benefits are more than the costs at different intensities of use giving a return on investment (see Table 1,2, and 3).

The partial budgets were constructed for kale production under bio mass transfer. Since the technology is labour intensive, it was applied in production of a high value crop, (Rommelse, 2001). Over half of the farmers interviewed applied *tithonia* at the lowest intensity of 1-1000 kg per hectare. Only 9% of tithonia adopters used the technology at the recommended rate of 5 tons per hectare. The partial budgets for *tithonia* showed that most farmers used the technology at intensities below recommended levels. As quantity increased the net gain also increased. This showed that there is need for farmers to be advised to increase the quantity used to 5 tons per hectare.

Marginal rate of return (MRR) were calculated to show returns to investment. For category one i.e. 1-1000kg of *tithonia* per ha, MRR attained was 164%, while for 1000-3000kg of *tithonia* per ha was 178%. A higher intensity of use of over 3000 kg per ha yielded an MRR of 205%. Adopting the range of minimum acceptable rate of return to be between 50 and 100% (CIMMYT, 1998), we find that the three intensities are above the minimum thus giving a return on investment. This implied that it was profitable to invest in these levels of the technology but the farmers can get more net returns by increasing their current intensities of use which are low to higher ones. Though the intensities used currently by the farmers give a return on investment, they constrain the optimum benefits and impact as the returns gained are still increasing with increased intensities.

Table4 above shows that as farmers increase their intensity of use, returns to investment also increases. This

shows that there is need for farmers to be advised to move from their low application rate to higher rates.

A Tobit analysis (Table 5) revealed that education, labour demand of the technology, hired labour, contact with the technology promoters and technology profitability were positively significant in affecting the probability and intensity of adoption of bio mass transfer. Other factors that were significant but negative were total farm size and use of other soil fertility replenishment options. Age, gender, off farm income, farming experience of the household head and the spouse did not significantly affect the intensity of use of the technology.

Conlusions

The results of this study showed that the adopters of the technology were mainly older, more educated and had been contacted within the last four years by the technology promoters more than the non-adopters. This shows that technical backstopping is very important in terms of information and inputs such as seeds, which enhance adoption. Technology profitability significance implies the need for the farmers to be well enlightened about the technology attributes. Total farm size negative significance implies that the technology is very much suited even in area where land is very scarce probably due to the increased land productivity. Education had a significant effect on the intensity of use of biomass. Education enhanced a farmer's synthesis of information about bio mass transfer influencing his/her decision-making.

The study therefore recommends frequent contact of farmers with promoters of the technology. Due to the limited number of the research personnel and other resources there is need to strengthen the grass root (farmer) total participation in the dissemination and adoption of the soil fertility technologies for example by working with farmers' groups and community-based organizations. There is need to incorporate several regions in the dissemination process. Educating farmers would increase the use of the technology. The study thus recommends the need for the government and other development agencies to invest more in village schools and other educational efforts. The already acquired knowledge of the technology by adopters can be exploited to benefit other farmers and also to improve on it by use of farmers' field schools. Information flow needs to be improved by researchers changing the approach and methods employed in on farm research to ensure information flow to all. Further, there is need to establish and strengthen networks of information exchange among relevant and interested organizations like church organizations, extension and community based organizations among others. Further areas for research is to find out at what intensity of use the returns reach optimum level.

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