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Research Application Summary

Household level determinants of adoption speed of soil fertility boosting technology: a duration analysis approach of compost in Toke Kutaye District of West Shawa Zone, Oromiya, Ethiopia

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Abstract

In the study of technology adoption and determination of smallholder farmer's adoption of an introduced technology at given point in time, the employment of 'Binary settings of logit and probit' is a commonly used methodology. This static approach of technology analysis, however, is found to be incapable of capturing the dynamic process of adoption. Adopters pass through stages of awareness, interest, evaluation and finally adoption. Thus, with a static point of view, one cannot study the speed of technology adoption, information that is highly demanded by researchers, policy makers and various stakeholders dealing with technology demand, development and uptake. Speed of adoption is much more valuable than a simplistic study of why one adopts. This study investigated determinants of adoption speed of compost technology adoption using the duration analysis approach and identified traditional and institutional barriers to accelerating the adoption of the technology. Based on the findings, recommendations for policy are highlighted.

Key words: Cox Proportional hazard Model, farmer groups, household head, speed of adoption

Résumé

Dans les études d'adoption de technologie introduite, par les petits exploitants, l'utilisation de «paramètres binaires du logit et du probit» est une méthodologie couramment utilisée. Cette approche statique d'analyse cependant ne prend pas en compte le processus de la dynamique d'adoption. Les adoptants traversent des étapes de sensibilisation, d'intérêt, d'évaluation et d'adoption. Ainsi, d'un point de vue statique, on ne peut pas étudier la vitesse d'adoption de la technologie, informations toutefois importante pour les chercheurs, décideurs et différents acteurs impliqués dans les demandes, le développement et l'adoption des technologies. La vitesse d'adoption est beaucoup plus importante qu'une étude simpliste sur les raisons d'adoption. Cette étude a examiné les déterminants de la vitesse d'adoption d'une technologie du compost en utilisant une approche d'analyse de durée et a identifié les obstacles traditionnels et institutionnels à l'accélération de l'adoption de la technologie. Sur la base des résultats, des recommandations en termes de politique ont été faites.

Mots clés: Modèle Cox de risque proportionnel, groupements d'agriculteurs, chef de ménage, vitesse d'adoption

Background and justification of the study

Ethiopia is one of the sub-Saharan African countries where depletion of soil resources is becoming a critical problem and is a major cause of declining agricultural yield, food insecurity and rural poverty (IFPRI, 2005). According to Bekele and Holden (1998), the poor performance of the agricultural sector in the country emanates from many factors of which the low use of agricultural technology is one. Bekele and Holden (1998) pointed out that resource degradation, particularly soil degradation, in the form of nutrient depletion is an important cause for decline in agricultural yields and production.

Faced with the danger that soil degradation would undermine efforts to increase agricultural productivity, the Ethiopian Government took preventive action and initiated investment in soil conservation and rehabilitation (Shimelis *et al.,* 2011). The 'Forty-Day-Campaign' of the national rural community mobilization campaign since 2012 is evidence of the government's commitment to reduce soil erosion and soil nutrient depletion in the country. Besides upgrading the traditional methods of soil conservation and rehabilitation, the government and other NGOs are combining efforts in restoring soil fertility through modern agricultural technologies including organic fertilizers.

One such organic recycling practice recommended by experts and found to be relatively cost-effective for farmers, environmentally amenable, and has relatively long term effect on soil fertility is compost technology (Hunegnaw, 2008). Despite efforts made towards enhancing adoption of this technology as a viable low cost alternative in restoring soil fertility, the speed of adoption by farmers remains slow and achievements made so far are below expectations. The limited success of these efforts highlights the need to better understand factors that constrain the adoption of the technology. To the best of the researcher's knowledge there have been no previous studies analyzing the timing of adoption or the effect of factors on farmers for this technology.

In the investigation of the adoption of new agricultural technology many previous researchers employed cross-sectional data in a static approach to analyze why some farmers adopt at a given point in time (Ayana, 1985; Mekuria, 1996; Yirga *et.al.,* 1996; Dadi *et.al.,* 2001; Marenya and Barrett, 2007; Tura, 2008). Adoption of agricultural technology should be considered as a continuous decision-making process (Sombatpanit, 1996). Individuals pass through stages of learning and experimenting from awareness of the problem to its potential solutions and finally deciding whether to adopt or reject a given technology. Adoption of new technologies normally passes through four different stages, which include awareness, interest, evaluation, and finally adoption (Rogers, 1995).

Each stage of the decision will have many constraints (social, economic, institutional or physical) for different groups of farmers. Therefore, the static modeling framework approach of examining why some farmers adopt at a given point in time has several important drawbacks (Butler and Moser, 2010). This may lead to inappropriate policy recommendations.

To begin with, the static approach ignores the timing of adoption, i.e., when is the right moment to adopt. The approach focuses at a single point in time and tries to identify who is using the technology and who is not. But, technology adoption is a dynamic process. This means early adopters differ from later adopters and current non-adopters may eventually adopt the technology under consideration. The static approach, therefore, fails to consider the speed of adoption and the effect of time-dependent elements in elucidating adoption (ibid). The other limitation of the approach is its inability to control for farmer heterogeneity even when panel data is available. Information from time-varying covariates is lost in this approach and therefore unobserved heterogeneity is not controlled in the model.

Duration models, on the other hand, have several advantages over these static models. They take advantage of more information, meaning the timing of adoption, which cannot be exploited in logit or probit models. Thus, they allow continuous-time analysis regardless of the periods used in the data themselves. This means that probabilities can be predicted over a period of one year regardless of the number of periods observed. They also take into account the evolution of the adoption of the technology and its determinants over time. Moreover, duration analysis techniques are appropriate to account for right censoring[1], and can easily handle time-varying covariates (Poolsawas and Napasintuwong, 2012). These "right-censored observations contribute to the hazard rate with their survival information" (Coetzee, 2006). Finally, duration models can be used to control for unmeasured heterogeneity (Deaton, 1997; Butler and Moser, 2010). Thus, a further advantage of hazard models is the ability to control for unmeasured heterogeneity without the need for a full panel data set. While this is not the same as controlling for farmer fixed effects (since, as described above, duration models can control for unmeasured differences in the pool of adopters and non-adopters over time) this is still an important improvement over standard cross-sectional approaches.

Objectives of the study.This study explored why this soil fertility improving technology recommended by experts is not widely adopted by the farmers in West Shawa Zone of Ethiopia. The study sought to answer the following research questions: (i) What are the socio-economic and institutional factors that inhibit and constrain their adoption at the household level? (ii) Among the group of adopters themselves why some farmers adopt the technology sooner and others later.

Methodology and approaches

This study employed the Cox Proportional Hazard Model which is quite important especially in the analysis of agricultural technology adoption such as compost adoption from a dynamic point of view. This model is one of the most frequently used classes of duration models.

Recently, this model has been getting growing interest in a number of agricultural economics studies to capture the dynamic aspects of technology adoption. In general, there is an

[1]A right censored subject's time terminates before the outcome of interest is observed. We see the entry date into a particular state, but we do not know its end date. Thus, if we observe entry at a particular time, say t_0 , the only thing we are sure about the exit date' t' is that it is t > t0 " (Trokie, 2009). Right censoring techniques allow subjects to contribute to the model until they are no longer able to contribute (end of the study, or withdrawal), or they have an event (Coetzee, 2006).Generally, the objective of survival analysis is to use all the information provided by the censored individual up until the time of censoring.

understanding about the limitations of static approach in the analysis of adoption studies on one hand and the credibility of duration models on the other hand by recent researchers.

The model combines the proportional hazards model with the partial likelihood method of estimation.

The model set up:

$$h(t,X) = h_0(t) exp\left(\sum_{i=1}^{p} X_i \beta_i\right)$$, Or equivalently, $$ln\, h(t,X) = lnh_0(t) + \left(\sum_{i=1}^{p} X_i \beta_i\right)$$

1. $h_0(t)$ -is considered as a starting or 'baseline' version of the model, prior to considering any of the 'X's. It only involves time, t.

2. $exp \sum_{i}^{p} \beta_i x_i$ -Contains the linear predictor and multiplies the baseline hazard. Notice that this term does not involve t. The assumption being made is that the individual predictors, xi, are time-invariant.

3. x_i is a vector of covariates or set of explanatory variables which accelerate or decelerate the adoption decision of the technology.

4. β represents a vector of regression coefficients.

It was by using this popular model that primary data from a sample of 200 farm households (both adopters and non-adopters drawn using simple random sampling) were analyzed.

Findings and lessons

The study came up with the following findings. First, farm size was found to have a positive effect on adoption speed of compost. This implies that farmers with larger farm size can adopt earlier compared to those with relatively smaller farm size. Second, speed of adoption of the technology is highly correlated with awareness. This corroborates innovation-diffusion theory of Rogers (1995) and empirical works of others. Third, education of the head of the household positively and significantly influenced the adoption speed of compost. Households with secondary level of education were found to accelerate the adoption of the technology as compared to households with less than this level of education attainment. Hence, farmer's educational level needs to be raised before substantial rate of adoption is expected. This can be achieved through the provision of basic adult education to all farmers in the district. This supports the human capital theory and empirical works of other researchers. Fourth, land tenure is positively correlated with adoption and land tenure security result (especially the descriptive result of the study) shows that early adopters of the technology are those with secured perception of their land in the future. Therefore, creating more awareness towards their land security may really increase the adoption speed of the technology. Provision of features that enhance land security such as land certification, may be needed as well to enhance adoption speed. Early adopters of the technology are those who perceive themselves with secured land holding including in the future. Fifth, traditions made people fear compost preparation as it is believed to increase a worm they call 'anthrax' which, however, is not supported by science. This cultural belief inhibited some potential adopters and highly retarded adoption speed of the technology. Compounding the slow adoption rate of the technology in the district is that compost is not 'perceived' as a 'new technology'. Distance of a farm plot from residential area negatively affected the adoption rate of the technology since transporting this compost requires huge number of laborers. Efforts are required to encourage group facilitation in preparation and transportation of compost.

Conclusions

This study evaluated adoption speed of soil fertility boosting technology of compost using duration analysis (Cox Proportional Hazard Model). The study revealed that the key socio-economic factors that influenced the adoption speed of the technology in the District are the size of farm land, distance of farm plots from residential area, index of awareness (a composite measure of number of contact with agricultural development agents, number of trainings provided and field demonstration on compost and compost related issues), education attainment of the head of households, perception of land tenure security and traditional perception of health side effects of compost preparation. Of these factors two of them (distance of farm plots from residential area and traditional perception of health side effects of compost preparation) are important in retarding adoption speed. The rest of the variables fuel rate of adoption of the technology.

On the other hand, years of age of household head, number of livestock owned, accessibility to water and ratio of economically active to inactive family members are found be insignificant in influencing adoption speed of the technology.

Study recommendations

Based on the findings of the study the following recommendations are made. Priority should be given to farmers having larger farm size and then to small farm size owners in designing this technological intervention for the sake of fast adoption of the technology. For smooth functioning of this cooperation it is proposed to form a 'Village based' committee to inform households at the time of compost preparation and transportation to farm plots. Frequent compost related trainings should be provided and related agricultural advisory services to improve awareness of technology.

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