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Describing Adoption of Integrated Soil Fertility Management Practices in Northern Ghana

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1. Introduction

As population grows the need to increase agricultural production becomes more challenging given the finite land resource. In Sub-Saharan Africa, replacing soil nutrients can contribute to the fight against food insecurity and poverty (Place et. al., 2003). In order to achieve this, sustainably integrated soil fertility management (ISFM) practices have been promoted. Effective promotion of ISFM requires information on the factors that can stimulate or constrain uptake.

Factors such as gender, experience, land and labor resources, credit, extension, training, management skills, location, livestock ownership, and expenditure influenced ISFM adoption (Geta et. al., 2013; Mugwe et. al., 2008; Odendo et. al., 2009). The results though useful for the development of strategies to promote ISFM examined only the discrete decision to adoption.

Effective strategies will also require information on the determinants of the extent of adoption of ISFM (Dankyi et. al., 2005; Oladele, 2005). This study therefore extended earlier studies by examining the factors that affect the probability and intensity of ISFM adoption.

2. Material and Methods

2.1. Identification of ISFM components adopted

Integrated soil fertility management (ISFM) includes use of improved crop varieties, inorganic fertilizers, organic fertilizers, and specific adaptations (Vanlauwe, 2010). With the exception of the latter, a farm household that used all the other components was for this study considered as an ISFM adopter and was assigned a value of 1, and 0 otherwise. Each component was considered separately. For a particular component, a farm household that used it was also considered was an adopter of that component and was assigned the value of 1, and 0 otherwise.

The intensities of adoption of the components were measures as the quantity used per unit area of land. However due to the challenges of summing up the components, the proportion of land was used as a measure of intensity of ISFM adoption.

2.2. Identification of determinants of ISFM adoption

The determinants of the probability that a farmer adopts a technology have been analyzed with Probit or Logit regression models (Donkoh et. al., 2011; Odendo et. al., 2009). Tobit regression models have also been used to examine the factors that affect both probability and intensity of technology adoption (Oladele, 2005). The Tobit model however assumes that the probability and intensity of adoption are joint decisions and are influenced by the same factors. It is however argued in this study that for ISFM the two decisions are separate. For this reason the Cragg's two-step model was used to examine the factors that affect both decisions separately.

The first step involved the estimation of a Probit model for the discrete decision as follows,

$$I = Prob(I|I^* > 0) = x\alpha + \varepsilon \quad (1)$$

Where I represent the adoption state, I^* the latent adoption state, x and α vectors of independent variables and coefficients respectively, and ε the error. The second step involved the estimation of a Truncated model of the proportion of land under ISFM as follows,

$$Z = E(Z|Z^* > 0) = x\beta + \mu \quad (2)$$

A log likelihood test was conducted to justify the use of the two-step model. It involved the comparison of likelihood ratios from the Probit, Truncated, and Tobit models (Mal et al., 2012).

2.3. Sample and Data

The study was based on data from 225 maize producing households randomly selected from 45 communities in northern Ghana. The data described the characteristics of the households, their livelihood activities, and the institutional arrangements in the communities.

3. Results and Discussion

3.1. Adoption of ISFM and components

Among the components in the integrated soil fertility management (ISFM), the use of inorganic fertilizers was most adopted by about 96% of the sampled households. This was followed by adoption of improved maize varieties and the adoption of organic fertilizers (Table 1). The promotion of ISFM should therefore emphasize the adoption of organic fertilizer which lags behind the other components.

Table 1: Components of ISFM

	Non-adopters	Adopters	Pooled
Sample (N)	110	115	225
Land area (ha)	5.90	6.12	6.01
Maize area (ha)	2.45	2.36	2.40
Maize yield (kg/ha)	1157.25	1571.01	1367.85
Use improved varieties	78.18	100.00	89.33
Proportion of land under improved varieties	0.84	0.62	0.72
Seed rate (kg/ha)	28.11	25.89	26.97
Use of inorganic fertilizers (%)	92.70	100.00	96.44
Inorganic Fertilizer application rate (kg/ha)	283.75	338.35	312.68
Use of organic fertilizers (%)	18.18	100.00	60.00
Organic Fertilizer application rate (kg/ha)	175.00	199.62	196.68
Proportion of land under ISFM	0.00	0.57	0.29

For the pooled sample, about 51% of the farm households had adopted the ISFM technology package on 57% of their maize fields. There is still an adoption gap in term of incidence and rate of application. Obviously promotional activities should seek to fill this gap.

3.2. Adoption of ISFM and components

The results from a Cragg's two step model show that the probability and intensity of ISFM adoption are influenced by separate sets of factors. It is therefore important for future studies to examine these differences. All the factors that affected the probability of adoption also influenced the intensity of adoption. The reverse was however not true (Table 2).

Education for instance influenced both decisions. Just like earlier adoption studies, education builds the capacity of technology recipients to appreciate the importance of the ISFM technologies and also understand the rubrics of its application (Lin, 1994). It is therefore important to encourage education among farm households to facilitate adoption of technologies in general. Extension as a source of information has also been shown to influence adoption of agricultural technologies (Marsh et. al., 2000). In the case of ISFM, the effect of extension could be through demonstrations on good agricultural practices. This should be maintain and if possible out-scaled to include a wider coverage.

Table 2: Factors affecting adoption of ISFM technology

	Tier1		Tier2	
	Coef.	Std. Err.	Coef.	Std. Err.
Educated household head	0.535	0.234**	22.934	13.237*
Off farm livelihood activities	-0.634	0.293**	-36.126	16.888**
Extension	1.065	0.321***	28.162	14.817*
Project member from association	-0.155	0.193	10.999	13.777
Experience of household head	0.002	0.006	-0.105	0.445
Labour land ratio	-0.016	0.017	2.221	1.025**
Proportion of males in the household	0.979	0.665	81.352	47.186*
Credit	0.242	0.222	-0.237	0.118**
Ownership of livestock	0.253	0.624	-29.434	49.387
Per capita income	0.571	0.285**	-118.145	31.203***
Asset index	-0.057	0.052	11.679	3.735***
_cons	-0.386	0.815	33.841	58.598
N	225	Wald chi2(13)		33.050
Prob > chi2	0.001	Log likelihood		-649.089
/sigma	45.725	Likelihood ratio test stat		57.13***

*10% significant, **5% significant, ***1% significant

The use of ISFM technology implies expenditure on improved varieties, fertilizers, and organic fertilizers. The application of these also comes with labor cost. Households with high financial status as measured by their per capita income, assets, credit, and labour resources were therefore in a better position to make such investments (Grazhdani, 2013). It is also important to encourage those with off-farm incomes into ISFM.

4. Conclusions and Outlook

This study shows that the probability and intensity of adoption of integrated soil fertility management (ISFM) are affected by different sets of factors. It has also shown that there exist an adoption gap to be filled through appropriate targeting and extension activities.

The study measured the intensity of ISFM adoption by the proportion of land that was assigned to it. This may not necessarily be the best measure of intensity because a small proportion of land may have high rate of application of the technology. It is therefore recommended that future studies explore more realistic measure of the intensity of ISFM adoption.

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