Adoption of Integrated Soil Fertility Management Technology and Its Effects on Welfare of Smallholder Maize and Pigeon Pea Farmers in Babati District, Tanzania

By

Sanka Marco Bura

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Abstract

Tanzania is among the developing countries with impoverished soils. However, the country is increasingly promoting the use of integrated soil fertility management technology (ISFM) approaches as one of the most sustainable strategies to replenish its impoverished soils. In this case, this study aimed to analyse farmer adoption of ISFM and its impact on household welfare.

The study had the following objectives; -

- Analysed smallholder farmers' adoption of ISFM technologies and their impact on household welfare among smallholder maize and pigeon pea farmers
- Determined the adoption levels of ISFM and the factors that influences its adoption among small holder farmers
- To determine the effect of adoption of ISFM technology on welfare (farm productivity, per capita consumption expenditure and household food insecurity access scale) of smallholder

The study was conducted in Manyara region, Babati District. The study adopted a cross section design and used face to face interview to collect the data from a random sample of 500 maize and pigeon pea farmer households in Babati District. The adopted design was quasi-experimental design consisting of a cross-section survey of ISFM adopter and non-adopter populations of selected smallholder farmers of maize and pigeon. The survey data was collected from famer households growing maize and pigeon pea to estimate the rate of adoption of integrated soil fertility management technology, determine factors that drives and that constraints the adoption and to estimate impact of adoption.

The study used a multi-stage and random sampling procedure to ensure the representativeness of a sample subjects and for generalizability of the results. The total of 500 respondents were included in the study from Babati District and the villages that were involved were Mafuta, Sabilo, Hallu and Selloto as indicated in Table 9. Purposeful sampling was used to select agricultural officers and extension officers to be interviewed as the key informants from Wards that were selected.

Table 9: Sampling Frame for Study Villages

Villages	Sub-Villages covered by ISFM	Number of responded selected
Matufa	Chasau,Kichangani,Migungani,Burunge	100
Sabilo	Sabilo,Barjomot	100
Hallu	Kisutu,Gedamar,Nyamuhali	100
Seloto	Semak A, Daktara B, Daktara A, Qatabradice	200
Total		500

- Face to face interview was used to collect primary data from farmers. The village leaders guided the enumerators who were trained before data collection to the respective respondents. Farmers who could not be accessed at the time of interview were replaced by others based on the list provided by the village leaders.
- A semi-structured questionnaire was used to collect primary data from selected households on background information, household characteristics, farm size, asset value, livestock value, knowledge on maize and pigeon pea varieties, agricultural training. Others were on use of organic and inorganic fertilizer, cost of fertilizers and improved crop varieties, area under maize and pigeon pea, productivity of maize and pigeon pea, off-farm activities, food security, household expenditure and leadership in community organization. Information on access to credit, extension services, distance to agricultural office and distance to the trading centre among others were also collected.
- Documentary review was conducted on data pertaining to price, production and trade volumes from the district headquarters, Sokoine University of Agriculture, Ministry of agriculture, Food security and Cooperatives.

Data analysis was carried out using descriptive statistics and econometric models. A probit regression model was used to determine factors that drives and constraints adoption of ISFM. Propensity score matching model (PSM) was applied to measure the impact of adoption on farm productivity, household per capita consumption expenditure and household food insecurity access scale (HFIAS).

The study adopted the theory of diffusion of innovations in which the adoption decision undergoes a four-stage process of knowledge acquisition, persuasion, decision, and confirmation. All these are assumed to be influenced by the information receivers' socio-economic characteristics, social systems and the characteristics of the innovations. Farmers choose to adopt or not adopt a given technology, depending on their expectations. Within the general framework of utility function or profit maximization, economic agents - in this case smallholder maize and pigeon peas farmers decide to apply ISFM technology if the perceived utility or net benefit from this option is significantly greater than without it.

The study revealed the following innovative findings.

- The influence of the level of education, age and occupation of the head of the household as well as the size of household on ISFM is likely to increase by 17.00% if the said determinants increase by one unit. Household size is a proxy for labour endowment. A higher ratio of household members who contribute to farm work is generally associated with a greater labour force available to the household for timely operation of farm activities including preparation of the farm and application of manure, compost and mineral nutrient.

- Farmers who received agriculture extensions and financial services had the better agriculture yield compared with non-adopters. About 89.80% of adopters received some form of training in the past twelve months compared to only 32.80% of the non-adopters. This is because agricultural training imparts farmers with necessary knowledge and skills on application of ISFM packages in the study area. Further, extension service is the sources of information, knowledge and advice to smallholder farmers.

- There were significant changes for the farmers who adopted the new maize varieties compared with farmers who continued using the same maize. About 86.64% of adopters bought improved maize varieties from local traders, that is 2.39% higher than non-adopters. Further, the results revealed that 0.39% of non-adopters bought local seeds from seed producer and there were no adopters who bought from local seed produce.

- Adopters have obtained higher farm income on average in both maize and pigeon pea compared to their counterpart's non-adopters. Average farm income of both maize and pigeon pea for adopters was reported at TZS. 1,872,541.00 compared to TZS. 667,748.00 reported by non-adopters ($p< 1\%$). A possible explanation is that ISFM technology has bigger role in improving farm productivity.

- Adoption of agricultural technologies improves food security status of the farming households and the probability of being poor, chronic and transitory food insecurity declines with the intensity of adoption. However, there are some extra foods in the households that adopted the new farming technology.

- There was higher average per capita expenditure for the adopters of ISFM of about TZS. 274,134.04 compared to TZS. 184,512.98 per year for their non-adopting counterparts. The observed higher expenditure among adopters indicates a gain in purchasing power due to adoption as adopters are likely to produce more output translating into more marketable surplus, hence more expenditure on non-staple food, non-fresh food items, non-food items, contribution and expenditure on agricultural inputs

- Marginal effects for livestock value is 0.02; indicating that adoption of ISFM is likely to increase by 2.00% if the livestock value increase by one unit. This is because livestock are important source of organic manure and cash in the study area. Hence, having them offer a better propensity to purchase farm inputs such as improved seed and fertilizers that are needed for adoption of ISFM. Livestock ownership was also noted as the indicator of wealth in the study area.
- The welfare effects of adoption show that ISFM can generate sizeable gains in maize and pigeon peas yields. For instance, the yield gain of maize and pigeon pea were 32.68% and 45.60% respectively. Moreover, ISFM increases households' per capita consumption expenditure; for instance, the findings have shown that gain in purchasing power was about 32.69%. With regard to food insecurity access scale, adopters of ISFM recorded lower index of food insecurity access scale (2.92) compared to (3.31) reported by non-adopters.

Conclusion

The adoption level of ISFM in Babati district is higher compared to the levels of agricultural technology reported in the previous studies in Tanzania except to the adoption rate of improved maize varieties. The adoption of ISFM is enhanced by education of the household head, family size, livestock value, asset value, extension services, agricultural training and access to credit. However, it appears to be constrained by factors such as off-farm income participation and high cost of ISFM components. The use of ISFM increases household per capita consumption expenditure, crop yield in kg/acres and reduces the household food insecurity access scale among ISFM adopters. The difference between per capita expenditure and yield of both maize and pigeon pea as the measure of household welfare are different.

Recommendations:

- Further, studies should be carried out to estimate the intensity of adoption and factors affecting the intensity for adoption of ISFM

- A study also recommends on the contribution of integrated soil fertility management (ISFM) practices to both technical and allocative efficiencies in the maize and pigeon pea farming system can also be carried out.
- Sophisticated model is needed to account for the potential endogeneity between adoption of ISFM and the explanatory variables. Given the complexity and multitude of the technology packages under study there is a need to explore the application of other factors