Factors Affecting Adoption of Soil and Water Management Practices in Machakos County, Kenya

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***Abstract*—In Africa's dry land areas, inappropriate agricultural practices including adoption of ISFWM technologies account for 28 percent of the degraded soils resulting to low land productivity with consequent increased food and nutrition insecurity. The study was carried to establish the factors that affect smallholder farmer's adoption of ISFWM technologies. A multi-stage sampling was used. Two hundred and forty eight households were sampled in both sub-counties; Data collection was done by well-trained enumerators' and analyzed using SPSS software. Regression models (Tobit and logit), as well as descriptive statistics were used to analyze factors that affect smallholder famers' adoption of ISWFM technologies. The cost-effectiveness of the ISFWM structures was analyzed through Cost- Benefit Analysis. Tobit regression results revealed that The variables Age, gender, access to agricultural extension access and agricultural credit were found to influence adoption of ISFWM technologies significantly (P<0-05) whilst Education level, access to inputs, access to radio, Labor, appropriate equipment farm implements, output Market access and farmers' perception on reliability of October-November Short rain season were cited to affect adoption of ISFWM highly significantly (P≤0.01). The Cost-Benefit Analysis revealed that among the ISFWM structures practiced in LM AEZ 4 and 5 was Zai pit with CBR of 6.98 and 5.63 in LM AEZ 4 and 5, respectively followed by tied ridges with 5.29 in LM AEZ 4 and 5.14 in LM AEZ 5.**

***Index Terms*—soil, water, farmers, yatta, Mwala, Kenya**

I. Introduction

The world is facing multiple challenges in the 21st century which include poverty, food insecurity, scarcity of water, and most importantly, new and complex challenges emerging due to global warming and climate change [1]. In the dry land areas, inappropriate agricultural practices account for 28 percent of the degraded soils resulting to low land productivity [2]. Various authors [3], [4] defined ISFWM as the application of soil fertility practices and knowledge to adapt those to local conditions which maximize fertilizer and organic use efficiency and crop productivity.

Kenya's modern agricultural foundation was laid in the early twentieth Century with the arrival of the white settlers [5]. During the Swynnerton plan of 1954, there was a move to address the looming agricultural crisis in Kenya. The plan laid down the foundation for farmer education, the extension system, agricultural credit, the agricultural policy and Kenya's land tenure including also soil and water management practices. However, [6], cited that the colonial authorities in Kenya used coercive approaches to introduce new land-use and conservation methods such as terracing and forced destocking that may have contributed to negative attitude to soil fertility and water conservation measures among smallholder farmers.

Various authors [7], [8] defined such sustainable resource-conserving technologies as skills that enable a farmer to produce his or her desired output, while using the available resources such as land, water, labor, energy, inputs more efficiently and maintaining the productive capacity for the future.

Farmers tend to adopt and adapt new practices and technologies only if the switch offers additional gains in terms of either higher net returns or lower risks, or both [9]. This means that smallholder farmers are likely to adopt Natural Resource Management (NRM) interventions only when the additional benefits from such investments outweigh the added costs [9].

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The major components of integrated soil fertility and nutrient management system are inorganic fertilizers, farmyard manure, compost, green manure, crop residues, recyclable wastes, bio fertilizers and soil moisture conservation measures include; tied ridges, open ridges, Zai pits and contour terraces [10]. The components contribute nutrients, possess great diversity in terms of chemical and physical properties, nutrient release efficiencies, positional availability, and crop specificity and farmers' acceptability [10] and therefore important in enhancing soil fertility.

II. Materials and Methods

A. The Study Area

1) Description of the study area

The study was carried out in the Arid and Semi-Arid Lands (ASALs) in Lower Midland Agro-Ecological Zone (LM AEZ LM4 and LM 5), of Yatta and Mwala sub-counties, Machakos County. The county has an altitude of 1000 - 1600 meters above sea level Kimanth. Yatta Sub-County lies in latitudes and longitude 1 °28' "/37 °' and 49' 60'' E, respectively and altitude between 700-800m a.s.l. Yatta sub-county covers 2,460Km^2 a population density of 273,519 (Males: 132,444, Females: 141,075) with 60,213 households. Mwala sub-county lies in geographical coordinates of 00 ° 38' N 33 ° 29' E/ 0.633 ° N 33.483 ° E and altitude between 1100-1550m a.m.s.l. (Mars group 2013, KNBS. 2009). These regions fall under AEZ LM4 and LM 5 Rainfall distribution is erratic, unreliable and occurs as short duration, high intensity storms coupled with partial or total crop failure in over 50% of the times [11].

2) Site description and selection of the Primary Participatory Agricultural Technology Evaluations (PPATEs) households

The project teams worked in areas known as Focal Research Development Areas (FRDAs) which formed the basic unit for research. In each FRDA, three Primary Participatory Agricultural Technology Evaluation (PPATE; i.e., Mother on-farm trials) areas were identified. One PPATE comprised of a registered farmer group of between 15-20 members and the PPATEs provided land for the trial. Each PPATE used to invite at least three Secondary Participatory Agricultural Technology Evaluation (SPATEs; i.e., baby on-farm trials) to come learn and pick technologies of their choice and go to practice in their own farms. In that way, dissemination of technologies was expected to diffuse within the rest of the farming communities as it was expected by the end of the three years. That way 60,000 farmers will have known the best farming packages including ISFWM for Arid and Semi-arid areas. FRDA formed a location; three PPATEs formed a sub-location whereas one PPATE formed a village.

A total of 124 PPATE households were randomly selected from both sub-counties comprising of 62 respondents from Yatta and 62 respondents from Mwala sub-counties. In each sub-county, 31 PPATE members were also randomly selected from LM AEZ 4 and 31 from LM AEZ 5.

III. Results

The various factors were regressed using Tobit model to determine their significance in influencing adoption of ISFWM technologies as shown Table I. Social characteristics such as age, gender, group membership were significant (P<0.05) in influencing the general adoption of ISFWM technologies with education being highly significant (*P*<0.01). The cost of ISFWM technologies was also found to significantly influence their adoption with cost and availability of farm machinery, cost of inputs accessibility of inputs and cost of labor being highly significant (P<0.01). Access to certain services such as extension and credit services were also significant (P<0.05), as well as access to radio information which was highly significant (P<0.01). Access to output markets was also another factor that significantly influenced the general adoption of ISFW technologies (P<0.01) in Mwala and Yatta sub-counties (P<0.05).

Table II shows how specific ISFWM technologies adoption varied among the respondents. Majority of the respondents (64.1%) had adopted use of open ridges compared to 31.5% and 4.4% who reported to have adopted the use of tied ridges and Zai pit respectively. Majority of the smallholder farmers, (50.8%) used organic fertilizer compared to 5.2% who used inorganic fertilizer. Those who reported to have been using both fertilizers were 44% of the respondents. Moreover, 87.5% of the respondents reported to have adopted the use of improved seeds compared to only about 12% who used local seeds.

IV. Discussion

The likely effect of age of farmer on adoption decisions is mixed claimed that age and or farmers' experience are very difficult factors to link with adoption of ISFWM. Likewise, in a study of technology adoption decision in dairy production, [5] cited that age was found to influence adoption decision positively. Further, in a study of soil conservation, it was found that age affected adoption decision of hedgerows both positively and negatively in Cebu and Claveria, respectively. This is consistent with earlier findings that have found a negative influence conflicting with other findings that have also found a positive influence of age with technology adoption [12]. Similarly [13] reported a negative and significant impact of age on the likelihood of adopting stubble tillage, as well as combining it with compost implying that the younger farmers are more likely to try innovation and that they might also have a lower risk aversion and longer planning horizon to justify investments in technologies whose benefits are realized over time.

TABLE I. TOBIT REGRESSION ANALYSIS OF FACTORS AFFECTING SMALLHOLDER FARMERS' ADOPTION OF ISFWM TECHNOLOGIES IN MWALA AND YATTA SUB-COUNTIES

ISFWM adoption variables	Coef.	Std. Err.	T	P>|t|
Age	-0.6752945	0.3026915	2.23	0.027*
Gender	0.6844905	0.3028938	2.26	0.025*
Education	-0.032818	0.0126182	2.6	0.010**
Group membership	0.2072526	0.0850131	2.44	0.016*
Land size	-0.0011474	0.0015236	0.75	0.452
Land tenure systems	-0.2065312	0.1124082	-1.84	0.068
Costs of inputs	-1.307192	0.1800221	7.26	0.000**
Access to radio	-0.0661206	0.0121874	5.43	0.000**
Cost of labor	0.6451344	0.2208105	2.92	0.004**
Availability of farm machinery	0.0249648	0.1579676	0.16	0.001**
Access to extension services	0.6752945	0.3026915	2.23	0.027*
Access to credit services	-0.0280713	0.0116234	2.42	0.017*
Access to output markets	-2.550073	0.091092	-2.8	0.006**
Perception on season reliability	-0.2581763	0.0890947	2.9	0.004**
Perception on improved seeds	0.1600545	0.0940362	1.7	0.090
Constant	3.844093	0.2627518	14.63	0.000

Tobit regression Number of obs 248 F (18, 229) = 28.54
Prob> F = 0.0000 Log pseudo likelihood = -178.67432
Pseudo R^2 = 0.8335
Key- Significant at 5% and ** Significant at 1%*

TABLE II. ADOPTION OF DIFFERENT ISFWM TECHNOLOGIES AS REPORTED BY HOUSEHOLD HEADS IN MWALA AND YATTA SUB-COUNTIES

Type of technology	Specific Technology	Frequency	Percentage
Structures	**Open Ridges**	159	64.1(.489)
	Zai pits	11	4.4 (.522)
	Tied Ridges	78	31.5 (.499)
Fertilizers	**Inorganic fertilizer**	13	5.2 (.000)
	Organic fertilizer	126	50.8(.000)
	Both fertilizer	109	44 (.262)
Seeds	**Local seed**	31	12.5 (.000)
	Improved seed	217	87.5 (.500)
	Sample size	248	100

Gender difference was found to be one of the factors influencing adoption of a new technology thus due to many social-cultural values and norms because males have freedom to mobility and consequently have greater access to information [14], [15] on his study on the dynamics of soil degradation and incentives for optimal management in the Central Highlands of Ethiopia noted that the chances of using inorganic fertilizers on an average plot would be higher by 22.2% for households having access to extension.

Adoption is a decision to make continued use of an innovation as the best course of action available and excludes occasional use of the idea, object or practice [6]. The explanation why the farmers were reluctant to access credit probably due to lack of land ownership for security purposes [2]. However the results were in line with the work of [2] who showed that there was a systematic association between participation in credit and adoption of conservation structures. The coefficient of Agricultural credit access for the household interviewed was found to be negative (-0.0281) regarding ISFWM technology adoption. This indicated that households who had previously accessed agricultural credit facility were more likely to adopt ISFWM agricultural credit access compared to those who had not [16]. Other studies on factors influencing the adoption of soil conservation practices in Northwestern Ethiopia by [6] indicated that poor rural households in developing countries lack access to credit which in turn impacts a significant negative influence to technology adoption. Similar trends were reported in Tanzania [17] who reported 96.3% of the farmers used radios to access information and knowledge in farming systems.

V. Conclusion

The study established that adoption of ISFWM technologies among smallholder farmers in the region varied within the project and non-project sites where results from the adoption were slightly of higher percentage within farmers in the project areas of Mwala and Yatta compared to non-project sites.

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