Factors influencing adoption and intensity of adoption of orange flesh sweetpotato varieties: evidence from an extension intervention in Nyanza and Western province, Kenya

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Factors influencing adoption and intensity of adoption of orange flesh sweetpotato varieties: evidence from an extension intervention in Nyanza and Western province, Kenya

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Abstract

This study applied logit and logit transformed regression to examine factors affecting the adoption of orange flesh sweet-potatoes (OFSP), and intensity of such adoption, by a representative sample of 340 farmers in the Busia and Rachuonyo districts of Kenya in 2009. The study also investigated whether participation in a value chain extension intervention programme increased these farmers' likelihood of adopting OFSP. The results suggest that the district where the farmer comes from, knowledge on value addition and nutritional benefits, and availability of vines were the key factors for adoption. The results also suggest that participation in a value chain extension programme enhanced the probability of adoption. Factors affecting intensity of adoption were site, value addition, vines availability, level of commercialization and having a child of up to five years.

Keywords: Adoption, extension intervention programme, intensity of adoption, orange flesh sweetpotato.

1 Introduction

Sweetpotato (*Ipomea batata L.*) is an important traditional crop that is grown customarily by small-scale farmers mainly for household consumption. It is traditionally regarded as a 'poor man's' crop as it is typically grown and consumed by resource poor households, and mainly by women, and it gives satisfactory yields under adverse climatic and soil conditions, as well as

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under low or non-use of external inputs (Githunguri & Migwa, 2004; Carey et al., 1999; Ndolo et al., 2001; Kung'u, 1999).

As a food security crop, it can be harvested piecemeal as needed, thus offering a flexible source of food and income to rural households that are mostly vulnerable to crop failure and consequently fluctuating cash income. In addition to being drought tolerant and having a wide ecological adaptation, it has a short maturity period of three to five months. It is also an excellent source of vitamin A, especially the orange fleshed varieties (Ndolo et al., .2001). However, most varieties in sub-Saharan Africa are white-fleshed, low yielding and lacking beta-carotene, the precursor of vitamin A (Stathers et al., 2005).

Sweetpotato is produced in most parts of Kenya, beingconcentrated in districts of Nyanza and Western provinces. About 60% of the households in these two provinces live below the poverty line (Central Bureau of Statistics (CBS), 2003), an indication of potentially high proportion of population without adequate quantity and quality of food intake. The potential of sweetpotato's contribution to food security, increased incomes and reduction of nutritional deficit is, therefore, considerable and is yet to be fully exploited in developing countries (Woolfe, 1992).

The Traditional Food Project was a programme in Kenya and Tanzania jointly implemented between April 2007 and September 2009 by the International Potato Center (CIP), Farm Concern International (FCI), Urban Harvest (UH), and World Vegetable Center (AVDRC-Asian Vegetable Development Center). Its aim was to increase productivity, utilization and marketing of Traditional African Vegetables (TAVs) and sweet–potatoes, specifically orange flesh sweet potatoes (OFSP). The project aimed to achieve this through the delivery of improved extension services to the farmers participating in the programme. The three OFSP varieties promoted in Busia and Rachuonyo districts in Kenya were Ejumula, Vindolotamu and Vitamu-A.

To promote increased adoption, commercialization and marketing of improved varieties of the targeted crops by the programme farmers, FCI used a "Commercial Villages Approach" (CVA). The approach uses a collective approach in interventions aimed at increasing adoption, productivity and commercialization by the rural poor. In the scheme, farmer groups are clustered together to form one large group called a “commercial village” aims to benefit from economies of scale in extension work, input sourcing, production and marketing activities.

To evaluate the impact of interventions from this programme, the researchers plan to conduct impact analyses using baseline and adoption data between participants (members of the programme) and non-participants (non-members of the programme). However, before undertaking any impact assessment, it is imperative to establish whether the programme participation by farmers was instrumental in the adoption of technologies and innovations. The objective of this study is, therefore, to analyze the adoption of OFSP among sample farmers in two provinces of Kenya by identifying key determinant of adoption and intensity of adoption of OFSP, and establishing whether programme participation enhances adoption. The next section outlines a theoretical framework for adoption and intensity of adoption of OFSP. Section 3 then describes the research methodology and empirical models. The study results are presented and discussed in section 4, while some policy implications of the results are discussed in the conclusion.

2 Theoretical framework

2.1 Past adoption studies

The review of adoption studies by Feder and Zilberman (1985) indicated *inter alia*, that adoption decisions are influenced by a number of socioeconomic, demographic, ecological and institutional factors and are dependent on the technology. Studies of the key determinants of technology adoption by farmers growing upland rice and soybeans in Central-West Brazil (Strauss *et al.*, 1991) and to evaluate the role of human capital and other factors in adoption of reduced tillage technology in corn production (Rahm & Huffman, 1984) found that farmers' education and experience play a crucial role in facilitating technology adoption. Doss (2003) reported that the major reasons for not adopting farm-level technology in East Africa were: (1) farmers' lack of awareness of the improved technologies or a lack of information regarding potential benefits accruing from them; (2) the unavailability of improved technologies; and (3) unprofitable technologies, given the farmer's agro-ecological conditions and the complex set of constraints faced by farmers in allocating land and labour resources across farm and off-farm activities. The mismatch between technology characteristics and farmers' technology preferences was also responsible for low level of technology adoption in Ethiopia (Wale & Yallew, 2007).

Other studies have revealed that off-farm incomes and availability of information influence technology adoption decisions through affecting risk aversion levels of smallholder farmers. Risk aversion level is likely to be negatively associated with adoption as farmers are less certain about the profitability (productivity) of new technologies when they use them for the first time. Farmer's level of risk aversion which is the function of their poverty level, lack of information on the productivity of the technology, and stability of the impact of the technology are all important factors (Kaguongo et al. 1997; Feder & Slade, 1984; Feder *et al.*1985; Kristjanson, 1987).

To improve availability of relevant information for increasing adoption, many development agents have devised several approaches and innovations. When the innovation system (such as extension service) is linked to farmers to promote effective communication, problem identification, problem solving and personal interactions of a formal or informal nature, higher adoption of technology is likely (Steffey, 1995).

Putler and Zilberman (1988) revealed the importance of physical capital endowment in the adoption process. Physical capital commonly associated with adoption of technologies has been identified as farm size or cultivated land, livestock and farm implements owned (Feder & O'Mara, 1981; Rahm & Huffman, 1984; Shapiro, 1990; Nkonya et al., 1997).

A Kenyan study, which evaluated the effect of women farmers' adoption of OFSP in raising Vitamin A intake, found that women farmers were likely to adopt the OFSP if the clones were sufficiently high in starch, low in fiber, and if they were introduced through community-level education programmes that focused on the health of young children (Hagenimana & Oyunga, 1999). A recent study in Mozambique revealed that some of the key factors affecting adoption of OFSP included availability of vines, intensity of extension service and number of times the respondent received vines (Mazuze, 2005).

A number of studies have also revealed that most of the factors affecting adoption do also affect the intensity of adoption (Alene et al., 2000; Kaliba et al, 2000).

2.2 Modelling adoption and intensity of adoption

Modeling farmers' decision making about whether to adopt or not to adopt a technology constitutes a discrete (whether or not to take up the technology) and continuous (the intensity of use of the technology) decision (Wale & Yallew, 2007). Most adoption models are based on the assumption that farmers are faced with a choice between two alternatives and the choices they make depend on identifiable characteristics of the technologies (Pindyck & Rubinfeld, 1997). When modeling adoption following the random utility theory, the model assumes that the decision made by the farmers on whether to adopt the technology or not is guided by a utility maximization objective which states that technology 2 (t_2) is preferred to technology 1 (t_1) as long as the utility derived from technology 2 (the new technology) is greater than the utility derived from technology 1 (the old and already existing technology). The utility function ranking the i^{th} farmers' preference for technology is represented as follows (Rahm & Huffman, 1984):

$$U(M_{ti};A_{ti}) \qquad (1)$$

where:

M= vector of farm and farmer specific attributes of the adopter

A=vector of the attributes associated with the technology

Technology adoption is defined by t; with $_{t=2}$ for new technology and $_{t=1}$ for the old technology. This means that the utility derived from adopting the new technology depends on **M** and **A**. Variables $\boldsymbol{M}_{ti}$ and $\boldsymbol{A}_{ti}$ are not observable, but a linear relationship is postulated between utility **U** derived from the t^{th} technology, a vector of observable farm and farmer characteristics X_i and a random disturbance term μ_t with zero mean:

$$U_{ti} = \alpha_t X_{ti} + \mu_{ti} \qquad t=1, 2; i=1,\ldots, n \qquad (2)$$

$\boldsymbol{U}_{ti}$ are random and, therefore, the i^{th} farmer will select the alternative t_2 if $U_{2i} > U_{1i}$ or if the latent random variable $y^* = U_{2i} - U_{1i} > 0$. (3)

A qualitative variable Y_i can represent the i^{th} farmer's adoption decision where $Y_i = 1$ if $Ut_2 > Ut_1$ and new technology t_2 is adopted replacing t_1 and $Y_i = 0$ otherwise.

The marginal effect of a variable X_j on the probability of adopting new technology can be calculated by differentiating Pi with respect to X_j:

$$\partial P_i / \partial X_{ij} = f(X_i\beta).\ \beta_j, \quad (4)$$

Where $f(.)$ is the marginal probability density function of γ_i and j = 1, 2,……J is the number of explanatory variables. The general form of the univariate dichotomous choice model is expressed as:

$$P_i = P_i(Y_i = 1) = G(X_i, \theta) \text{ where } i = a, 2, \ldots.n. \quad (5)$$

Equation (5) states that the probability that the i^{th} farmer will adopt a specific technology is a function of the vector of explanatory variables X_i and the unknown parameter vector θ.
To specify G, three alternative functional relationships have been widely used by researchers: Linear Probability (LP), Probit, and Logit models.

This study uses the logit model to evaluate factors associated with a sweet-potato grower's decision to grow or not to grow OFSPs as the logit model has less restrictive assumptions and a simpler functional form than the probit model (Gujarati & Sangetha, 2009). According to the logit model, the probability of an individual farmer adopting a new technology t_2, given a well-defined set of socio-economic and physical characteristics (X), is represented as:

$$P(t_2 \mid X) = \exp^{(X\beta + \mu)} / [1 + \exp^{(X\beta + \mu)}] \quad (6)$$

Likewise, the probability of not adopting the new technology $\mathbf{t_2}$ (continuing with technology **t1**) is given by:

$$P(t_1 \mid X) = 1 - P(t_2 \mid X) = 1 - \{\exp^{(X\beta + \mu)} / [1 + \exp^{(X\beta + \mu)}]\}$$
$$= 1 / [1 + \exp^{-(X\beta + \mu)}] \quad (7)$$

In a logit model, the parameter estimates are linear and, assuming a normally distributed disturbance term (μ), the logit maximum likelihood (LML) estimation procedure is used to identify explanatory variables affecting the adoption of OFSPs.

The intensity of adoption in this paper is defined as the proportion of area under OFSP and is estimated as a fraction of total area under sweetpotatoes. Wale (2010) used logit transformation regression to explain land share allocated to local coffee varieties in Ethiopia which was the response variable. In the present study, the proportion under OFSP varieties (P_{OFSP}) would be defined as a function of the prevailing factors in farmers' working environment (ϖ_1) stated as:

$$(P_{OFSP}) = f(\varpi_1) \quad (8)$$

For proportion data with 0, 1 extremes and continuous values in-between, use of OLS regression is inappropriate because predictions are likely to go beyond the 0-1 range. Papke & Woodridge (1996), indicate that the drawbacks of linear models for fractional data are analogous to the drawbacks of the LP model for binary data. To further identify factors determining intensity of adoption, this study employs logit transformation regression.

Logit transformation is performed on the dependent variable as shown below (Wale, 2010; Grigoriou et al., 2005; Birkhaeuser et al 1991):

$$\text{TransP}_{OFSP} = \text{In}\left(\frac{P_{OFSP}}{1-P_{OFSP}}\right) \quad (9)$$

However, this procedure cannot be applied directly if the dependent variable takes the extreme values of 0 and 1 i.e the transformed variable cannot be evaluated. Hence, to deal with this problem the extreme values (0 and 1) are substituted with close approximations (Wale, 2010; Pryce & Mason, 2006; Grigoriou et al., 2005). After this OLS regression is conducted on the transformation dependent variable:

$$\text{TransP}_{OFSP} = \beta_0 + \sum_{i=0}^{m} \varpi_{1i}\beta_i + \varepsilon_i, \; i = 1, 2, 3, \ldots, n \quad (10)$$

where ϖ_{1i} are the explanatory variables postulated to influence rate of intensification.

3 Empirical implementation

3.1 Study site

Data were collected in Rachuonyo (Nyanza province) and Busia (Western province) districts of Kenya. The Rachuonyo site is an area where sweetpotato is most commercialized in the country. Nyathiodiewo, a local variety which is yellow fleshed, is the most commonly grown variety accounting for over 90% of total production in the area. Traders from major towns of the country (Nairobi, Kisumu, and Nakuru) buy sweetpotatoes from the district and transport them using large trucks. Sweetpotato is also regarded as a food security crop in the area and is particularly important when there is an undersupply of maize. The site is located in the lower midland tea zone (LM2), with elevation ranging from 1300 to 1700 metres and mean annual precipitation of 1300 to 1700 mm. The long rains occur in February to June while short rains occur from August to November.

The Busia site is an area where sweetpotato is less commercialized although sweetpotato is an important crop as a food security crop and farmers produce it on a small scale mainly for home use and only sell when there is excess or when there is a pressing demand for cash. The area falls within the marginal sugarcane zone (LM1), with elevation ranging from 1200 to 1300 metres and annual precipitation of 1400 to 1550 mm. The mean annual temperature ranges from 20.4 to 22.3 ^{o}C. Sweetpotato is planted in the months of April through June during the long rains and September through mid-November during the short rains. Sweetpotato varieties grown are mainly white fleshed, such as Bungoma and Kampala, and none is predominant in the area.

3.2 Survey design, sampling and data collection

Farmers were grouped into participants if they participated in the Traditional Food Program and non-participants if they did not. Baseline and adoption survey data were collected for the purpose of impact assessment by comparing both participant and non-participant farmers before and after the programme implementation.

The Baseline survey was conducted in September-October 2007 while the adoption survey was conducted in November-December 2009. The two surveys used structured questionnaires which were developed in collaboration with socio-economists, agronomists, breeders, nutritionists and specialists in gender and value chain approaches from CIP, FCI and UH in Kenya, AVRDC in Tanzania and the University of KwaZulu-Natal in South Africa, and pre-tested with farmers. The questionnaires were revised and refined using feedback from the field to help capture information relevant to the study. The two surveys gathered information on cultivation, consumption and marketing of target crops by the households.

Each site had four Commercial Villages (CV) comprising of about seven farmer groups each and with an average of 18 participants per group. Representatives of participant farmers (beneficiaries) and non-participant farmers (non-beneficiaries) were interviewed during the baseline and adoption surveys. During the baseline survey four farmers were randomly sampled per group per CV. The same farmers in the baseline survey were targeted during the adoption survey, but due to high attrition additional participants were sampled for the adoption survey. The non-participant farmers who acted as the 'control' for the study were sampled from villages with similar characteristics as those from which participant farmers in CV originated. Twenty non-participant farmers were randomly sampled to act as control for each CV. A total of 340 farmers were interviewed during the adoption survey, of which 205 were participants and 135 were non-participants. Data collected were entered and "cleaned" using CSPro,SPSS software package (Norusis, 2005) was used for data processing and logit regression analysis while STATA package was used for transformed logit regression (STATA, 2008)) analysis.

3.3 Empirical model and the variables

Descriptive statistics are used to analyze the survey households' socioeconomic characteristics. The wealth index (WID) was calculated from cultivated area of land, total livestock units and number of equipments and tools owned by the farmer using PCA, and then used as an explanatory variable in the logit regression analysis. Data gathered during the adoption study were used to define respondents into two categories of farmers for the dichotomous dependent variable (Adoption):

Adopter: a farmer who was growing OFSP in 2009, and took a value of 1.

Non-adopter: a farmer who was not growing OFSP in 2009 and took a value of 0.

The model was specified as:

Adoption= $\beta_0 + \beta_1$Site + β_2Participant + β_3Valueadd + β_4Knowvit_A + β_5Vineconst + $\beta_6$hheadage + β_7Labour + β_8WID + μ_i

The explanatory variables included site (**Site**) which is specified as a dummy taking a value of one if Rachuonyo district and zero if Busia district. This variable captures the difference in average annual precipitation, productivity and commercialization of sweetpotato between the two districts. Variables included for controlling social factors included gender of the household head (**Gender**), taking the value of one if the household head was female and zero otherwise, having a child (**Haschild**), taking a value of one if the household has young children of five years of age or less and zero otherwise, age of household head (**Hheadage**), level of education of the household head (**Hheadeduc**), which is measured as the number of years of formal education completed by the household head, family size (**Familysize)**, measured as the number of people who lived in the household at least nine months during 2009.

Variables accounting for institutional influences were participation in the value chain intervention programme (**Participant**) and the variable is specified as a dummy, taking a value of one if the farmer was a participant and zero otherwise. Knowledge of vitamin A (**Knowvit_A**), taking a value of one if the respondent was aware that OFSP is associated with vitamin A. This was important because the message delivered to farmers indicated that children of up to five years old benefited the most from consumption of OFSPs.

Variables controlling for economic factors are earning off-farm income (**Off-farminc**), taking a value of one if any member of household earned income from off-farm activities and zero otherwise, use of value addition techniques (**Valueadd**), specified as a dummy, taking the value of one if the household had made at least one sweetpotato processed product and zero otherwise, commercialization (**Sellsp**), taking a value of one if a farmer is selling any type of sweetpotato and zero otherwise. Constraints of vine (**Vineconst**) is also specified as a dummy, taking a value of one if the household is vine constrained and zero otherwise, labour available (**Labour**), which is specified as number of household members available to provide labour and a wealth index (**WID**), which was calculated using Principal Component Analysis.

4 Results and discussion

4.1 Adoption and programme membership by site

In all sites 38.2% of respondents had adopted growing of OFSP, with 66.1% of 168 households and 11.0% of 178 households adopting in Busia and Rachuonyo district, respectively. The level of adoption in the two districts was statistically different and factors such as high commercialization and relatively high yields from local variety in Rachuonyo were hypothesized as reasons for low adoption of OFSP (Table 1). The proportion of programme participants in Busia district (58.9%) and Rachunyo district (61.6%) were not statistically different.

Table 1: Adoption of OFSP by site in two Districts of Kenya (2009) (%)

	Group	Busia	Rachuonyo	All sites
Adoption*	Non-adopters (%)	33.9	89.0	61.8
	Adopters (%)	66.1	11.0	38.2
Participants	Non-participants (%)	41.1	38.4	39.7
	Participants (%)	58.9	61.6	60.3
Sample size		168	172	340

*Statistically significant at 1% level using Chi-square test

Most adopters were from Busia District (85.4%) while only 14.6% of adopters were from Rachuonyo District (Table 2). About 34.1% of household head were female and there was no statistically significant difference between adopters and non-adopters by gender. Households with off-farm income were also not statistically different between adopters and non-adopters. More adopters than non-adopters were doing value addition of sweetpotato and also more adopters knew that OFSP contain vitamin A (beta carotene).

The mean age of non-adopters was slightly higher than that of adopters but the difference was not statistically significant. The number of years of formal education for adopters was significantly higher than that of non-adopters indicating possible association between education and adoption of OFSP. The other significantly different attributes between adopters and non-adopters were total number of household members and available labour.

The mean for wealth index for non-adopters was negative indicating that a high proportion of non-adopters had negative deviations from the sample mean.

Table 2: Summary statistics of characteristics of adopters and non-adopters of OFSP, Kenya, 2009

			Adoption		
			Non-adopters	**Adopters**	**Total**
Site*	.00 Busia	%	27.1	85.4	49.4
	1.00 Rachuonyo	%	72.9	14.6	50.6
Participant or not*	.00 Non-participant	%	48.1	26.2	39.7
	1.00 Participant	%	51.9	73.8	60.3
Gender of hh head	.00 male	%	62.6	71.1	65.9
	1.00 female	%	37.4	28.9	34.1
Has off_farm or not	0 no	%	31	36.2	32.9
	1 yes	%	69	63.8	67.1
Has done value addition*	0 no	%	90	66.9	81.2
	1 yes	%	10	33.1	18.8
Know that OFSP contains vitamin A*	0 no	%	80.5	51.5	69.4
	1 yes	%	19.5	48.5	30.6
Is vine constrained*	0 no	%	34.3	73.1	49.1
	1 yes	%	65.7	26.9	50.9
Has child of up to 5 years	0 no	%	22.9	21.5	22.4
	1 yes	%	77.1	78.5	77.6
Age of hh head	Mean		47.93	45.6	47.03
	Standard Deviation		13.82	12.3	13.29
Years of formal education for hh head*	Mean		6.65	7.62	7.02
	Standard Deviation		4.16	4.24	4.21
Area under sweetpotato	Mean		0.20	0.17	0.19
	Standard Deviation		0.23	0.25	0.24
Total number of hh members *	Mean		6.64	7.28	6.89
	Standard Deviation		2.45	2.61	2.53
Labour*	Mean		3.08	3.43	3.21
	Standard Deviation		1.36	1.51	1.43
Wealth index (WID)	Mean		-0.04	0.065	0
	Standard Deviation		0.95	1.07	1
	Sample size		**210**	**130**	**340**

*Statistically significant at the 1% level (using Chi-square test for binary variables and ANOVA for continuous variables)

4.2 Binary logit and logit transformation regression results

The value from the Hosmer and Lemeshow Chi-square test was non-significant (0.454), which indicates that the binary logit model adequately fitted the data while Omnibus tests of model coefficients at 5% level of significance indicated that all predictors jointly predicted the dependent variable well. The classification table also showed good prediction performance of 85.1% (Table 3), which compared well with Count R^2 of 89.5%.

Table 3: Prediction performance of logit regression model

		Predicted		
		Adoption		Percentage
	Observed	0	1	Correct
Step 1	Adoption 0	185	21	89.8
	1	29	100	77.5
	Overall Percentage			85.1

a. The cut value is .500

Some variables hypothesized earlier to explain adoption of OFSP, such as the number of children in the household, family size, number of years of formal education for household head and number days in a week the household consumed sweetpotatoes, family size and selling any type of sweetpotato were dropped from the model either because including them in the regression analysis reduced the goodness of fit of the model and their estimated coefficients were not statistically significant at 5% level, or they were correlated with some of the factors with more significant coefficients. Table 4 presents the estimated logit regression model results.

Table 4: Coefficient estimates of variables in the logit equation, adoption of OFSP, Kenya

	B	S.E.	Exp(B)
Site	3.913*	.467	50.054
Participant	.971*	.394	2.640
Valueadd	1.572*	.518	4.817
Knowvit_A	1.097*	.371	2.994
Vineconst	-2.236*	.385	.107
Hheadage	-.025**	.014	.976
Labour	.151	.131	1.164
WID	.270	.187	1.310
Constant	-2.304*	.762	.100

Used SPSS package

*Statistically significant at the 5% level of significance, **statistically significant at the 10% level.

Testing the results of the OLS regression of the transformed dependent variable for heteroscedasticity using the Breusch- Pagan-Godfrey test rejected the OLS model with homoscedasticity (χ^2_7 tabulated = 14.07 and χ^2 calculated= 89.99). To remedy the heteroscedasticity, a weighted least square regression was run using White's heteroscedasticity-corrected variances (Robust standard errors) using Stata (Gujarati and Sangetha (2009).

Results of the transformed logit model revealed that participating in the programme and nutritional knowledge of OFSP did not influence the intensity of adoption of OFSP. However, in addition to site, value addition, constraints of vines, and having a child of up to five years also significantly influenced intensity of adoption (Table 5).

Table 5: Logit transformation results

	Robust HC3	
	Coef.	Std. Err.
Site	2.1155*	0.3961
Participant	0.4216	0.3765
Valueadd	1.3934*	0.5371
Knowvit_A	0.5194	0.3874

Vineconst	-0.9337*	0.3256
Sellsp	1.1523*	0.4476
Haschild	0.8856*	0.3825
_cons	-8.0661*	0.61599
	Number of obs =	340
	F(7, 332) =	9.4
	Prob > F =	0.00
	R-squared =	0.2177
	Root MSE =	2.8656

*Statistically significant at the 5% level of significance.

Used STATA package

The regression results of the two models revealed seven factors that are important in influencing adoption of OFSP and its intensity. These factors include (1) district where the farmer resides, (2) know-how on value addition, (3) knowledge on nutritional value, (4) availability of vines, (5) selling sweet-potato, (6) having a child, and (7) age of household head. Some of these variables mirrored the findings from Mazuze (2005), who observed that adoption of OFSP varieties is affected by the district where the respondent resides, effectiveness of extension and availability of vines to farmers. It was further observed that to spur adoption of OFSP, it is important to identify market opportunities for processed products and link farmers to potential processors and market outlets.

Site (site)

According to the results, being in Busia district increased the odds of adopting OFSP than being in Rachuonyo. A farmer in Busia is 50 times more likely to adopt. This could be due to several underlying factors, which include the fact that sweetpotato was more commericialized in Rachuonyo District than in Busia District and the yields of the local varieties grown in Rachuonyo are comparable to the yields of OFSP varieties being introduced. More importantly, the short time of programme implementation may not have had sufficient effect on traders' preferences who may not be willing to trade in the less familiar OFSP in Rachuonyo District. Increasing promotion campaigns targeting traders and consumers may increase the probability of farmers in Rachuonyo adopting OFSP. Site had a positive and statistically significant coefficient in logit transformation regression results indicating that being in Buisa had positive effect on intensity of adoption. The same site specific reasons affecting adoption are suspected to affect intensity of adoption.

Participation The estimated coefficient for participation variable was statistically significant at the 5% level and had a positive sign (in reference to participants), as hypothesized. The odds for the farmers who were in the programme adopting OFSP were 2.64 times higher than those who were not. This is according to the expectation of the programme implementers and researchers. Although the programme was implemented for about 2.5 years, it means that farmers participating in the programme had a higher probability of adopting OFSP. This result offers justification for impact analysis i.e. researchers can conduct a more robust econometric analysis to evaluate intensity and impact of adoption using differences in differences (DD) as earlier planned. However, results of the logit transformation regression indicated that participation did not influence the intensity of adoption. This means once the programme influenced farmers to adopt new varieties, other non-programme factors were more important in determining the proportion of land allocated to OFSP.

Value addition

As hypothesized, farmers who had the know-how of processing sweetpotatoes were about 5 times more likely to adopt OFSP than those who did not have the know-how. The OFSP products are tastier, nutritious and appealing to farmers and hence farmers are more likely to prefer them for further value addition. This means if dissemination of value addition techniques was included in intervention programmes, the adoption rate is likely to increase. Results of the logit transformation regression also suggest that having know-how of value addition had a significant positive effect on intensity of adoption.

Farmer knowledge on vitamin A

The regression results suggest that farmers who had the knowledge about the nutritional content of OFSP are about three times more likely to adopt OFSP than those who did not know. This is in conformity with *a priori* expectation as knowledge of the nutritional value of OFSP is likely to motivate adoption of OFSP, especially for home consumption. This means any programme that includes effective training on nutritional value of OFSP is likely to enhance its adoption. Results of the logit transformation regression indicated that although nutritional knowledge had a positive effect in intensification it did not play a significant role.

Constraint of vines (planting material)

As hypothesized, the results suggest negative impact of constraint of vines i.e. farmers who have limitations in accessing vines are less likely to adopt OFSP. However, the odds of not adopting due to constraints of vines were not high (0.107). Results of the logit transformation regression also indicated that constraints of vines affect intensity of OFSP adoption negatively and significantly. The two results mean an intervention programme that includes training farmers on how to preserve their vines and how to source vines is more likely to increase both adoption and intensity of adoption.

Age of household head

The age of the household head had a negative sign as expected. According to the results, if age of the household head increases by one year, the odds in favour of not adopting increases by 2.4%. The main reasons given for older people being less likely to adopt new technologies is that they are said to be less receptive to new ideas and are less willing to take risks. This means there may be a need to review methods of technology dissemination used in the intervention programme to ensure that they are attractive to both young and old farmers. However, age of household head was not included in the logit transformation regression because it did not have a significant coefficient

Farmers marketing sweetpotato

The variable on marketing any type of sweetpotato did not seem to affect adoption of OFSP but the results of the logit transformation regression suggest that it had a positive impact. This means that farmers who were already selling any type of sweetpotato are likely to intensify adoption compared to those who were not selling. Since OFSP was promoted for both home consumption and marketing, it emerged that farmers who commercialize any type of sweetpotato are more likely to increase the intensity of use of improved OFSP than those who are not.

Having a child of up to 5 years old Although having a child of up to five years of age did not seem to affect adoption of OFSP (because it did not have a significant coefficient or improve the logit model), its estimated coefficient in the logit transformation regression was positive and statistically significant. This means that, once the farmer has made decision to adopt OFSP, having a child of up to five years of age affects the rate of intensification positively. This could mean awareness that children benefited the most from consumption of OFSP, which was one of the messages delivered by the programme, affected intensification positively.

5 Conclusions

This study evaluated the factors affecting adoption of OFSP and intensity of adoption in Busia and Rachuonyo District in Kenya using adoption data collected from 340 farmers in 2009. The main objective was to determine the adoption rate of OFSP, the key factors determining adoption of OFSP and intensity of adoption, and to investigate whether participation in an extension intervention program significantly increased probability of adopting OFSP. The empirical results estimated seven factors that must be considered to promote adoption and intensification of OFSP in the study areas: (1) site (district) where the farmer resides, (2) know-how on value addition, (3) knowledge on nutritional value, (4) availability of vines, (5) selling sweet-potato, (6) having a child, and (7) age of household head.

The site variable means that when planning for adoption intervention of OFSP, site specific issues should be appraised first and the intervention package should address them to increase the likelihood of adoption. Yield performance of OFSP in Rachuonyo District is one of the possible areas that need to be addressed to increase adoption in the site. Awareness of the potential benefits of OFSP needs to be communicated among the market players in Rachuonyo District and consumers at large to facilitate competitiveness of OFSP in the market. The negative effect of age of the household head on adoption means the promotion messages and extension approach should be appropriate to both the young and the aged. More importantly, the attributes of the technology need to be stressed and adapted to all ages of farmers. A technology appealing to the young may not be attractive to the old and more experienced farmers.

In addition to site specific issues, value addition and nutritional knowledge were key strategic factors to be considered in planning adoption intervention for OFSP. To boost the likelihood of adoption, farmers could be trained on how to implement value addition and also informed about the nutritional superiority of OFSP over local varieties. Targeting households with young children, especially when the main concern is increased consumption of OFSP, is likely to increase the intensity of use.

The results also revealed that programme participation helped to increase adoption rates at the two sites. This means farmers who participated in the Traditional Foods Program were more likely to adopt OFSP than those who did not. Finally it is recommended that the benefits and costs of the programme should be comprehensively studied considering financial, environmental, poverty and food security dimensions.

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