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ASSESSMENT OF PULL MECHANISM AT ENHANCING MAIZE FARMERS' UTILISATION OF AFLASAFE BIO-CONTROL MEASURES IN OYO STATE, NIGERIA

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Abstract

There is the need to rethink how technology is being disseminated to end users in order to ensure adoption and utilisation. This study assessed how pull mechanism is enhancing the utilisation of Aflasafe bio-control measures among maize farmers in Oyo State, Nigeria. Multi-stage sampling procedure was used to select 91 maize farmers for the study. Data was collected from maize farmers through interview schedule and analysed using descriptive statistics (means, frequencies and percentages) and inferential statistics (Pearson Product Moment Correlation and Regression analysis). The result showed that 89% of the farmers indicated Implementers as the outlet for the purchase of Aflasafe. Also, premium payment and provision of technical assistance were the highly ranked incentives to utilisation of Aflasafe among the farmers. The study also revealed low access to credit as major constraint to the utilisation of Aflasafe bi-control measures. Meanwhile, 54% of the farmers had full utilisation of Aflasafe in maize production. Significant correlation was found between incentives and utilisation of Aflasafe (r-value = 0.274; p≤ 0.01). The study therefore recommends that governments and non-governmental organisations should ensure availability of Aflasafe bio-control to the maize farmers either through loan provision or price subsidy.

Key words**:** *Aflasafe bio-control, maize production, production incentives, pull mechanism*

INTRODUCTION

Feeding the estimated world population that is projected at 8.5 billion in 2030 would be a mirage without intensive utilisation of research outputs by smallholder farmers. According to [3], the number of people suffering from chronic hunger and undernourishment in the world has increased from 804 million in 2016 to 821 million in 2017. The situation is precarious in most regions of South America and Africa. Thus, without concerted efforts, the sustainable development goal of eradicating hunger in the world by 2030 may become an illusion. Ironically, a good number of improved technologies have been generated to tackle hunger and malnutrition. Nonetheless the modus operandi of conception, design and implementation of these innovations has prevented them from achieving their intended objectives. It is either they are developed without adequate consideration of the end users (often the smallholder farmers) or the methods of delivery are in defiant with social norms and values. Thus, despite the huge potentials, the adoption of agricultural innovation to transform agricultural landscape in sub-Saharan African by smallholder farmers seems to be slow [7]. The challenge now lies not in existence of innovation but in scaling them up in ways that are inclusive while overcoming the challenges in their uptake [10].

The innovation in pull mechanism according to [5] was to eliminate the constraints in demand and supply of agricultural technologies. Limited awareness about the technology, cost of the technology and risk of the technology may lead to low demand. Whereas, the costs and risks of investment in developing appropriate products or services, low demand by smallholder farmers, poor infrastructure may serve as constraints on the supply side. In order to overcome these challenges, pull mechanisms deviate from donor dependent-market designed specifically to meet the specification of the donors who usually contribute majorly to the development of the product through push mechanisms [4]. In this regard both the donor and innovator are stakeholders that jointly share the risks in product development. Pull mechanisms in this context are seen as a possible complement or even alternative to traditional donor-funded development approaches that seek to "push" promising technologies to beneficiaries through grants or contracts that pay in advance for recipients' efforts.

Maize is the most widely-grown staple food crop in sub-Saharan Africa (SSA) occupying more than 33 million hectares each year [6]. The crop covers nearly 17% of the estimated 200 million hectares of cultivated land in SSA, and it is produced in diverse production environments and consumed by people with varying food preferences and socioeconomic backgrounds. More than 300 million people in SSA depend on maize as a source of food and livelihood. The top 20 countries, namely South Africa, Nigeria, Ethiopia, Tanzania, Malawi, Kenya, Zambia, Uganda, Ghana, Mozambique, Cameroon, Mali, Burkina Faso, Benin, Democratic Republic of Congo, Angola, Zimbabwe, Togo, and Cote d'Ivoire account for 96% of the total maize production in SSA [6].

Aflatoxin is among the most carcinogenic substances known in nature and produced by the ubiquitous fungus, Aspergillus flavus. It is highly toxic and is capable of colonizing and contaminating major staples like maize and groundnut at the pre-harvest, harvest and post-harvest stages of the crops rendering them unsafe for consumption. Aflatoxin contamination is a global problem affecting 4.5 billon people in developing countries. In Nigeria where smallholder farmers produce over 70 percent of the nation's maize crops, about 60% of maize production may be aflatoxin contaminated [5]. This therefore posts a great danger for smallholder farmers who derive their livelihood from maize production. In order to combat this toxic infection, Aflasafe biocontrol measure was developed. Aflasafe is an innovative aflatoxin solution developed by International Institute of Tropical Agriculture (IITA) in collaboration with the Agricultural Research Service of the United States Department of Agriculture (USDA-ARS), University of Bonn, Germany and University of Ibadan, Nigeria. While deviating from the traditional push method of technology dissemination, pull mechanism incentivise adoption of the bio-control through premium per-unit payment for maize verified to contain a high prevalence of Aflasafe at designated maize aggregation centers.

The elements of pull mechanisms in Aflasafe bio-control begin with developmental problem that requires technological solutions. In this study, aflatoxin contamination in maize is the developmental problem that needs solutions to ensure food safety and sustainable livelihood to maize farmers. Next is technological solution with potential to have a significant impact if adopted on a large scale. The technological solution in this case is Aflasafe bio-control. The developmental problem and technological solution will interest the solvers (private sector actors) to take the advantage of market opportunity. The incentives structure is the targeted outcome and parameters in the pull mechanisms that will motivate the solvers to invest in the design, development and drive the adoption of the technological solution. Being an innovative approach that was piloted in Nigeria in 2013 and currently at various levels of adoption and commercialization in the country, this study then assessed the utilisation of Aflasafe bio-control among maize farmers in Oyo State, Nigeria. The specific objectives of the study were to: determine farmers' awareness of Aflasafe bio-control; identify sources of purchase of Aflasafe, examine incentives at utilisation of Aflasafe bio-control; ascertain the extent of utilisation of Aflasafe bio-control; determine constraints faced by farmer in utilising Aflasafe bio-control and factors influencing the utilisation of the bio-control measures. The study hypothesised that there was no significant relationship between incentives and utilisation of Aflasafe bio-control.

MATERIALS AND METHODS

Study Area

The study was carried out in Oyo state, Nigeria. The state is an in-land state. The climate is equatorial, notably with dry and wet seasons with relatively high humidity. The dry season lasts from November to March while the wet season starts from April and ends in October. Average daily temperature ranges between 25^0C and 35^0C almost throughout the year. The tropical nature of the climate favours the growth of variety of food crops such as; yam, maize, cassava, millet, plantain, banana, rice and fishing. Population of the study comprised of maize farmers in the state.

Data and sampling technique

Multi-stage sampling procedure was used in the selection of the respondents. The first stage involved purposive sampling of two Local Government Areas (LGAs) in Oyo state based on expert recommendation and these were Iseyin and Akinyele LGAs. The second stage involved random sampling of five farming communities from each local government area. The selection of these communities was based on the quantum of maize production in the ten communities. Then, using systematic random sampling, 10 maize farmers were selected from each community to give a sample size of one hundred. Interview schedule was used to obtain information from the maize farmers. Meanwhile, only 91 questionnaires were found suitable for data analysis. Data was analysed using SPSS version 15.

Farmers' awareness was measured using Yes (1) and No (0) to awareness statements on Aflasafe bio-control technologies. In measuring incentives to Aflasafe bio-control, farmers' responded to a list of available incentives on Yes (1) and No (0). Utilisation in this study is the final stage of adoption process. This is the stage at which farmers have already adopted the technology and use it consistently. Utilisation of Aflasafe bio-control was measured based on recommended rate of 10kg/ha [9]. The level of utilisation was then computed as the ratio of quantity of Aflasafe (kg) and farm size (ha). This then gave a range of 0.0 – 1.0 where 0.0 – 0.3 = poor utilisation, 0.4 - 0.9 = moderate utilisation and 1.0 = full utilisation. Constraints to utilisation of the bio-control was measured by farmers indicating appropriately on various constraints statement on a 4-point rating scale of "to a very great extent", "to a great extent", "to some extent" and "to no extent". The values of the response categories were 0, 1, 2 and 3 respectively.

Data Analysis

Data was analysed using descriptive statistics (means, frequencies and percentages) and regression analysis.

The regression analysis is explicitly represented below:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + \ldots\ldots\ldots. + b_8X_8$$

where:
Y = Aflasafe utilisation (0-1)
X_1= Farmers' age (years)
X_2= Household size (number of persons)
X_3= Years in formal education (years)
X_4 = Farm size (hectares)
X_5= Farming experience (years)
X_6 = Output of maize (kilograms)
X_7 = Price of Aflasafe (naira)
X_8 = Years of using Aflasafe bio-control

RESULTS AND DISCUSSIONS

Farmers' awareness of Aflasafe bio-control

Pre-harvest operations with high level of awareness were: sourcing for maize seeds from reliable agro dealers ($\bar{x}$ =1.0) and planting of improved maize variety ($\bar{x}$=0.98) (Table 1). This means that the farmers are already conscious that good yield start from right selection of good seeds. Similarly, the table also indicates that plucking maize cobs directly into bags ($\bar{x}$=0.94) and determining properly dried maize through cracking the kernel between the teeth (x=0.93) are the most post-harvest activities that the farmer were aware of. The grand mean indicates that the maize farmers had high awareness of pre-harvest activities ($\bar{x}$ = 9.29) than post-harvest activities ($\bar{x}$ = 8.93). It is therefore expected that the high awareness of Aflasafe bio-control practices will translate into high utilisation. This agrees with [8] that found significant relationship between farmers' awareness of improved plantain technologies and its adoption.

Table 1. Distribution of farmers' on awareness of Aflasafe bio-control

Agronomic Activities	Aware		Not Aware		Mean	Rank
	Frequency	Percentage	Frequency	Percentage		
Pre-harvest activities						
Right source of maize	91	100.0			1.00*	1st
Planting improved varieties	90	98.1	1	1.1	0.98*	2nd
Broadcasting method	89	97.8	2	2.2	0.97*	3rd
Application on wet soil	87	95.6	4	4.4	0.95*	4th
Delay planting	86	94.5	5	5.5	0.94*	5th
Proper timing for weeding	86	94.5	5	5.5	0.94*	6th
Apply 10kg/ha	80	87.9	11	12.1	0.87*	7th
Apply at first flag leaf/flowering	84	92.3	7	7.7	0.92*	8th
Do not apply when flowering is full	80	87.9	11	12.1	0.87*	9th
Do not bury Aflasafe into the soil	73	80.2	18	19.8	0.80*	10th
Post-harvest activities						
Plucking maize cobs into bags	86	94.5	5	5.5	0.94*	1st
Properly dry maize before storage	85	93.4	6	6.6	0.93*	2nd
Store old and new stock maize separately	85	93.4	6	6.6	0.93*	3rd
Harvest while plant still standing	85	93.4	6	6.6	0.93*	4th
Sun-dry on a raised platform	84	92.3	7	7.7	0.92*	5th
Do not thresh by beating with sticks	83	91.2	8	8.8	0.91*	6th
Heap together to form a cone	81	89.0	10	11.0	0.89*	7th
Damaged cobs should be separated	77	84.6	14	15.4	0.84*	8th
Transport using leak proof vehicle	74	81.3	17	18.7	0.81*	9th
Store threshed maize on pallets	73	80.2	18	19.8	0.80*	10th

Grand Mean
Pre-harvest activities = 9.29
Post-harvest activities = 8.93
Source: Field survey, 2018.

Farmers' sources of purchase of Aflasafe bio-control

Results in Table 2 show that, most (89%) of the maize farmers sourced for Aflasafe from Implementers. This could be because they are the anchors used by IITA to integrate producers in the chain. Also, 4.4% sourced from IITA, 3.3% from Agro-dealer, and 3.3% from other farmers. The business drive of this private actor (Implementers) whose gain is dependent on the quantum of aflatoxin free maize aggregated will definitely lead to high utilisation by the farmers. This supports the findings of [1] that identified implementers as the main promoter of Aflasafe bio-control measures in Nigeria.

Table 2. Distribution of farmers' sources of purchase of Aflasafe

Sources of purchase	Frequency	Percentage
Implementers	81	89.0
Agro-dealers	3	3.3
IITA	4	4.4
Other farmers	3	3.3

Source: Field survey, 2018.

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Incentives to utilisation of Aflasafe bio-control in maize production

Results in Table 3 reveal that, most (97.8%) of the maize farmers indicated premium payment for Aflatoxin-free maize as an incentive to its utilisation. Also, 94.5% indicated provision of technical assistance and improved health from consuming Aflatoxin-free maize. This shows that the presence of tangible incentives has motivated the farmers to utilise Aflasafe in maize production. This supports the finding of [2] that posits that incentivizing disseminating farmers through material rewards aided diffusion of pit and composting technologies among farmers in Malawi. Almost half (49.5%) of the maize farmers indicated guaranteed market for Aflatoxin-free maize as an incentive. This means that the farmers do not recognise this as an incentive as there is no better market outlet than selling to aggregating vendors to enjoy premium payment. The results further show that 33.0% of the respondents indicated discount on other inputs e.g. fertilizer for purchasing Aflasafe. This result may akin to the fact that just a few got discounted on the purchase of other inputs along with Aflasafe bio-control.

Table 3. Distribution of maize farmers' incentives for utilising Aflasafe bio-control

Incentives	Yes		No		Mean	Rank
	Frequency	%	Frequency	%		
Premium payment for Aflatoxin-free maize	89	97.8	2	2.2	0.98*	1st
Provision of technical assistance	86	94.5	5	5.5	0.94*	2nd
Improved health from consuming Aflatoxin-free maize	86	94.5	5	5.5	0.94*	3rd
Effective public health awareness against Aflatoxin contamination	85	93.4	6	6.6	0.93*	4th
Expected increase in maize yield	85	93.4	6	6.6	0.93*	5th
Enforcement of Aflatoxin regulation	84	92.3	7	7.7	0.92*	6th
Enhanced access to input distribution system	81	89.0	10	11.0	0.89*	7th
Subsidy on the cost of Aflasafe	71	78.0	20	22.0	0.78*	8th
Discount on other inputs e.g. fertilizer for purchasing Aflasafe	30	33.0	61	67.0	0.33	10th
Guaranteed market for Aflatoxin-free maize	45	49.5	46	50.5	0.49	9th

Source: Field survey, 2018.

Level of Utilisation of Aflasafe

Result in Table 4 show that 54% of the maize farmers were fully utilising Aflasafe bio-control as recommended. Also, from the results, 12% and 34% had moderate and poor utilisation of the product respectively. Meanwhile, the mean of 0.7 indicates a fairly good utilisation of Aflasafe bio-control measures. With this level of utiliation, maize produced is expected to be aflatoxin free with high Aflasafe content to attract premium prices.

Table 4. Distribution of farmers according to level of utilisation of Aflasafe bio-control

Level of Utilisation	Frequency	Percentage	Mean
Poor utilisation (0.1-0.3)	31	34.0	0.7
Moderate utilisation (0.4-0.9)	11	12.0	
Full utilisation (1.0)	49	54.0	

Source: Field survey, 2018.

Constraints to the Utilisation of Aflasafe

Results in Table 5 show that low access to credit facilities ($\bar{x}$=2.5), inadequate sources of purchase ($\bar{x}$=2.4) of the bio-control and lack of storage facilities ($\bar{x}$=2.3) were rated as the highest constraints toward its utilisation. This means that as the farmers may be willing to utilise Aflasafe, lack of credit may limit the extent of utilisation as this determines the volume they would be able to purchase with their limited finance. Similarly, inadequate storage facilities may as well serve as a discouraging factor for the farmers to expand maize production.

Table 5. Constraints to utilisation of Aflasafe bio-control

Constraints	Severe constraints		Mild constraints		Not a constraint		Mean	Rank
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage		
Low access to credit facility	58	63.7	19	20.9	14	15.4	2.5*	1st
Inadequate sources of purchase	59	64.8	13	14.3	19	20.9	2.4*	2nd
Lack of storage facilities	48	52.7	18	19.8	25	27.5	2.3*	3rd
Lack of prerequisite skills	47	51.6	19	20.9	25	27.5	2.2*	4th
High cost of technology	40	44.4	32	35.2	19	20.9	2.2*	5th
Lack of access to other essential inputs	35	38.5	38	41.8	18	19.8	2.2*	6th
Weak interaction	38	41.8	22	24.2	31	34.1	2.1*	7th
Lack of labour	35	38.5	25	27.5	31	34.1	2.0*	8th

Source: Field survey, 2018.

Factors influencing farmers' utilisation of Aflasafe bio-control measures

Kolmogorov-Smirnov was used to perform diagnostic tests on the data to ascertain the suitability of the regression model. The tests showed that the error term is normally distributed (p value = 0.100) and there were no problems of multicollinearity, autocorrelation and heteroscedasticity. Results in Table 6 indicates that six independent variables, namely: farmers' age (X_1), household size (X_2), educational level (X_3), farm size (X_4), maize production experience (X_5), and years of using Aflasafe (X_8) were found significant as factors influencing farmers utilisation of Aflasafe bio-control measures. The estimates of the model coefficients reveals that keeping other factors constant, a unit increase in household size, years of formal education, maize production experience and maize output will increase Aflasafe utilisation by 0.391, 0.404, 0.572 and 0.531 respectively.

Meanwhile, negative coefficients observed in farmers' age and years of using Aflasafe indicate that keeping other factors constant, a unit increase in these variables will reduce Aflasafe utilisation by -0.384, and -0.408 respectively.

This implies that as the farmers aged and also acquires more experience they may tend to be complacent in the utilisation of Aflasase bio-control.

Furthermore, Table 6 shows the value of R (that is correlation coefficients between all of the predictor variables and utilisation). In the model, the value is 0.736, which indicates that there is high variance between the independent variables and utilisation of Aflasafe bio-control.

Meanwhile, the R^2 of 0.541 indicates that 54.1% of the variance in utilisation of Aflasafe bio-control is explained by the independent predictor variables in the model.

Table 6. Result of linear regression model for factors influencing maize farmers utilisation of Aflasafe bio-control

Variables	Unstandardized coefficient		Standardized coefficient	T	Sig.
n = 91	B	Std. Error	Beta		
Constant	241.312	58.110		4.153	0.000
Farmers' age	-0.011	0.003	-0.384	-3.121	0.002*
Household size	0.036	0.012	0.391	3.010	0.003*
Education	0.029	0.007	0.404	3.994	0.001*
Farm size	-0.050	0.016	-0.723	-3.115	0.003*
Maize production experience	0.016	0.005	0.572	3.330	0.001*
Output	0.001	0.000	0.531	2.254	0.027*
Cost of Aflasafe	2.972	0.001	0.077	0.790	0.432
Years of using Aflasafe	-0.120	0.029	-0.408	-4.141	0.001*

R = 0.736 R^2 = 0.541 Adjusted R^2 = 0.497 *Significant at $p \leq 0.05$
Source: Field survey, 2018.

Relationship between incentives and utilisation of Aflasafe bio-control

The result of Pearson Product Moment Correlation in table 7 shows that there was significant relationship between incentives and utilisation of Aflasafe bio-control. The PPMC coefficient of 0.274 indicates a weak correlation between the two variables. This implies that farmers' utilisation of Aflasafe increases with increase in incentives. It is therefore a worthwhile endeavour to invest more in the incentives to utilisation which appears weak from the result in order to enhance full utilisation of the product.

Table 7. Significant relationship between incentives and farmers' utilisation

	Mean	r-value	p-value	Decision
Incentives	8.15	0.274	0.001	Significant
Utilisation	0.71			

*Significant at $p \leq 0.01$
Source: Field survey, 2018.

CONCLUSIONS

The incentives measures at both demand and supply sides of pull mechanism have proven innovative toward scaling the uptake of agricultural technology. The low uptake of agricultural technologies among the end users (particularly farmers) could be addressed by attaching tangible rewards as compensation for utilising the innovation. Meanwhile, farmers also need to be motivated prior the tangible reward with *ex ante* factors such as credit and storage facilities provisions. This will further activate the desire to utilise the product with the ultimate incentives in view. Thus, as food safety is a global phenomenon, it is imperative for governments and nongovernmental organisations to make loans available for purchase of Aflasafe or subsidised its cost to make it affordable for the farmers. Also, ministries and agencies of governments should create awareness of the incentives to Aflasafe through radio or television broadcast. This will further sensitise the public and the maize farmers on the health benefits of consuming and growing Aflatoxin-free maize respectively. Efforts should also be geared in selecting experienced maize farmers and those with high level of formal education in the upscale of the technology.

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