Effective Adoption of *Striga* Control Technologies in Maize by Association and Non-Association Farmers in Bungoma County, Kenya

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Abstract

Striga species also known as witchweeds decimate agriculture in most parts of Africa, attacking the major cereal grains and legumes, and halving the already very low yields of subsistence farmers in Kenya, Bungoma County in particular. Several researchers have provided promising technologies and a range of potential control options for striga based on the fundamental biology of the parasite host associations, for dealing with this scourge. The question however still remains on whether these methods have been effective in the control of the striga weed. This paper thus describes and discusses some of the control options with a focus on technology adoption. It seeks to establish how effective the adoption of striga technology is in control of the striga among association and non-association farmers in Bungoma County, Kenya. The study employed a survey approach on a sample size determined by proportionate sampling method of small scale farmers in Bungoma County. A sample size of 110 respondents from Farmers Associations and 100 non-FAs farmers was selected using snowball sampling method. Questionnaires and interview schedules were used to collect data from the Farmers in Associations (FAs) and Non FAs farmers. Analysis of the collected data was done using quantitative statistics which enabled computation of means, percentages and standard deviations. A t-test was also performed and a hypothesis tested at 5% significant level. The study identified use of herbicides, seed selection, proper land preparation, compost fertilizer and proper weeding as weed control methods in order of preference. The findings of this study hoped to help extension officers in Bungoma County in providing information on the preferred forms of striga control strategies in maize production.

Keywords: *Striga,* Farmer's Association, Striga control technologies, Maize, Kenya.

INTRODUCTION

Agriculture, a mainstay of Kenya's economy, is the main source of food which accounts for about 60% of the country's total employment and provides livelihood for about 80% of the country's rural population (Kenya economic report, 2013). Kenya increased its maize imports to 600,000 metric tons in 2013 to meet increased food demand for the growing population. Maize is Kenya's staple food with its per capita consumption estimated at 98 kilograms (USAID, 2013). Maize production was 3 million metric tons in year 2013, down by 100,000 metric tons from previous year's crop production and above the five year average of 2.8 million metric tons (GOK, 2013). The decrease in the production can be linked to the challenges encountered by farmers including but not limited to infestation by such parasites as *striga*; poor access to credit and market; limited access to information on modern technologies; low and fluctuating prices; storage facility problems; low farm productivity and unpredictable weather conditions (Olwande, 2008).

Agricultural information is an important factor that interacts with other production factors such as land, labour, capital and managerial ability. The factors of production can be improved by the relevant, reliable, and useful information (Demiryurek, 2010). Many actors are involved in developing and disseminating agricultural information on *striga* control in maize production and marketing. Rees *et al.* (2000) noted that in Kenya the major local sources of agricultural information for farmers were extension services, neighbours, family, markets and community based organizations. Other sources of information included non-governmental organizations, churches, community meetings, family and friends and agricultural companies.

The diverse nature of Kenya with its wide variety of agro-climatic regions and broad range of socio-economic conditions in the rural population, calls for agricultural extension approaches that are context- and situation-specific. Despite *striga* control technologies being available there is low adoption by some farmers in the associations in Western, Kenya and there is no clear attribute to this problem among the FAs' members. This may not only belinked to the farmers'reluctance on information uptake (Juma, 2009), but more to it that need further investigation. The low adoption rates may thus be attributed to, among others, poor channels of information dissemination, negative perception of the control technologies by farmers, lack of skills to integrate the available control methods and / or economic factors. There is an increasing need for stronger intermediaries that can facilitate information access for diverse smallholder farmers. Further progress in poverty and hunger reduction crucially depends on the increased productivity and profitability of these farmers, which in turn depends on the successful delivery of agricultural information on *striga* technology in Western, Kenya.

Farmers in Associations (FAs) in Bungoma County have been accessing information on agricultural technologies from various sources like University of Eldoret, using Information Communication Technologies and the conventional extension methods. One of the technologies scaled out to farmers was used for this study which is? state this technology.

Range of Potential *Striga* Control Technologies

The University of Eldoret through the 'Outreach' Project funded by The Regional Universities Forum (RUFORUM) through funds obtained from EU/ACP Economic Partnership Program has implemented the University Outreach Program that aims at improving the link between the University and farmers either directly or through their farmer associations.

Some of the technologies that have been disseminated include:-.

Use of fortified compost

A technology used to recycle plant nutrients; it involves fortification of these residues with nitrogen (N) and phosphorus (P) fertilizers to improve the quality of manure (Okalebo *et al*., 2014).

Use of MBILI cropping system

A two-by two staggered intercropping arrangement of maize-legume to increase crop yields by disrupting pest cycle and improving the opportunities for symbiotic nitrogen fixation. Managing Beneficial Interactions in Legume Intercrops (*MBILI*) is a modified intercropping where….this is incomplete…, while maize (*Zea mays*) population holds constant, the space adjustment provide better growing condition for the understory legumes. It consists of a staggered paired row arrangement with twin rows of maize 50 cm apart adjacent to 1 m strip reserved for the legume. It thus allow the introduction of additional higher values pulses such as groundnuts (*Arachis hypogaea*) and green gram (*Vigna radiata*) as intercrops with maize (*Zea mays*), both of which have higher light requirements and a greater capacity for symbiotic N-fixation than beans (*Phaseolus spp.*). This altered intercropping, besides improving soil fertilization, could also disrupt pest cycles resulting in an increase crop value and thus cash income (Ndung'u *et al*., 2005).

Push -Pull technologies

The 'push–pull' technology is a novel pest management strategy developed for control of stem borers and *striga* weed, *Striga hermonthica*, in maize-based farming systems in Eastern Africa, where maize is intercropped with desmodium, a forage legume, and Napier grass is planted as a border crop. Desmodium repels stem borer moths while Napier grass attracts them. Desmodium also suppresses the parasitic *striga* weed through a series of mechanisms ranging from shading to allelopathy through the root system (Amudavi *et al.*, 2008).

Use of a kayongo maize variety

Recently, the University of Eldoret documented the use of fungus, *Fusarium oxysporumf.spstrigae* (Foxy FK3), either coated or un-coated using a soluble Phosphorus-based fertilizer (Gro-plus). This technology can be used to make *striga* -tolerant to maize seeds

Striga plant *MBILI* system *Striga* affected maize plants

Figure 5: *Striga* weed control

Source :(Bungoma, 2015)

Improved Legume Varieties

In Bungoma County Kenya, a variety of new legume seeds including the promiscuously-nodulated SB19 & SB20 soyabeans from IITA, rosette-resistant CG2 groundnuts from ICRISAT, climbing bean varieties Kenya *Mavuno* and Kenya *Tamu* and the farmer-selected 'golden gram' (*Vigna aurus*) have a number of advantages.

METHODOLOGY

Bungoma County located in Western Kenya was the area of study (specify the latitude and longitude of your study area). The county covers an area of 2,207 km² with a population 1.375 million according to the 2009 population and housing census, most of who depend on maize farming either for consumption or as a cash crop. Maize is life to some communities in Kenya, Bungoma in particular for its famous use to prepare the staple dish "*ugali*". The study focused on areas that host farmers' association of Bungoma Small Scale Farmers Organisation (BUSSFO) and regular farmers (non-members) involved in maize production.

A cross-sectional survey design was adopted for the study to help gather data over the stipulated time. This would help achieve a logical finding based on circumstantial evidence of the farmer's (target population) activities in adoption of the *striga* technology. Both primary data through field survey and secondary data from websites, journals, and books, published and unpublished documents were obtained. Data analysis was then done with respect to the target population.

Semi- structured questionnaires consisting both open-ended and closed questions were used for data collection. Observation was also used to establish the adoption rate of *striga* control technologies by sampled farmers based on objectives achieved through the project.

Simple random sampling technique was used to determine the sample size that constituted farmers from one farmers association (Bungoma Small Scale Farmers Organization (BUSSFO) 100 farmers not affiliated to any of the farmer associations was also selected purposively.

Proportionate stratified random sampling was used to determine the sample of FFS participants. FFS Participants were stratified into their FFSs and simple random sampling method through the use of table of random numbers, applied in selecting the respondents. The total of FFS Participants was 735 and was distributed into eighteen FFSs as shown in Table 1. Assuming a sample of size n respondents from Farmers Associations (FAs) and an equivalent sample of non-members of FAs, the sample size was obtained by Tuchman's (1978) formula: $\frac{Ps}{\Sigma Ns} \times n = ns$

The sample of FFS respondents will be 180 and proportion will be worked out using the following formula derived from

Where: Ps = Population in the stratum

ΣNs = Total population of FFS Participants.

n= Required Sample

ns= Sample size per FFS

Example Siritanyi - is $\frac{30}{735} \times 110 = 4$

Table 1: FFS population and sample per Association

Name of FFS	Population	Sample
1) Siritanyi	30	4
2) Lusanyela Focal Area	47	7
3) Bakongolo	30	4
4) Nalutiri	35	5
5) St. Monica Masuno	22	3
6) Matunda	22	3
7) Lukala	100	15
8) Namawanga	23	3
9) Tunya CBO	100	15
10) Tumaini	51	8
11) Tabuti Lima	65	10
12) Biliso	30	4
13) Upendo	25	4
14) SengeliMukwa	30	4
15) YetanaBakokholo	25	4
16) Mbambe Rural Resource management programme		
17) Consultative children centre	30	4
18) Namikelo	20	3
	50	7
Total	735	110

Using the formula recommended by Kathuri and Pals, (1993) quoted from Krejcie and Morgan (1970) the sample size was calculated as follows:

Formula: - $$n = \frac{X^2NP(1-P)}{d^2(N-1) + X^2P(1-P)}$$

Where:

n = required sample size.

N = the given population size (735 – trained FFS farmers and 6,004 Non-FFS farmers estimated).

P = Population proportion assumed to be 0.5.

$d = \pm 1.96\ \sigma P$.

X^2 = table value of chi-square for one degree of freedom relative to desired level of confidence, which is 3.84 for the .95 confidence level/represented by entries in the table.

Table 2: Calculated and Chosen sample per category

Category	N	Calculated Sample N	Chosen sample N	Remarks
FFS-trained Farmers	735	110	105	Reduced by 2%
Non-FFS farmers	6,004	480	105	For comparison
Total	6,739	590	210	210 respondents.

Source :(Kathuri and Pals, 1993)

Two hundred and ten (210) farmers were chosen as the sample size instead of 590 farmers which is statistically justified since Kathuri and Pal (1993) recommends a minimum sample size of one hundred (100) for a survey research.

Data analysis and presentation was performed by use of SPSS version 20. Triangulation of quantitative and qualitative data analysis techniques was considered. A t-test was performed at 5% level of confidence. Descriptive statistics, percentages, including means, cross tabulations, pie charts and bar graphs, are used to present the results.

RESULTS AND DISCUSSION

Adoption Rate of *Striga* Control Technologies

Proportion of farmers who were able to control the striga weed in their farms

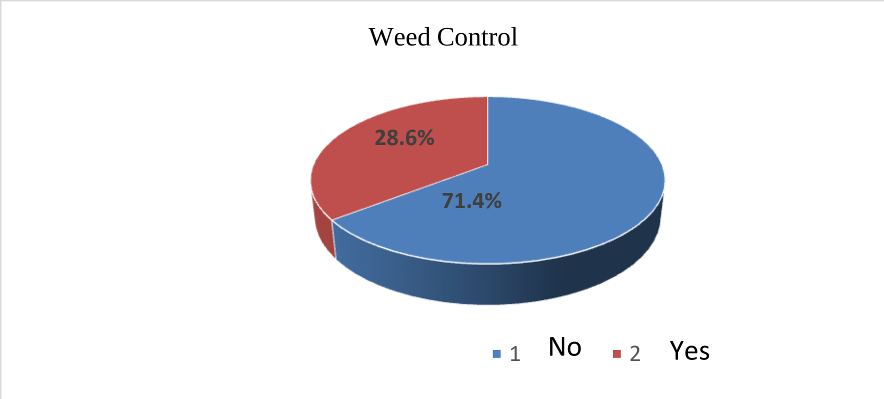

Figure 1: Weed control Proportions

From the interviewed participants, only 52 (28.6%) farmers were able to manage their farms and control the weed from affecting their crops, while a larger number 130 (71.4%) could not. These results could be a clear indication that farmers lack knowledge and training on the adoption of the *sriga* control technologies, the costs, improper application among others. Hearne (2009) reported that non adoption of *Striga* control options may be as result of reliability of technologies, poor access and cost of technologies, limited practicality of the methods, and poor information.

Forms of Striga control technologies used

The author sought to establish the commonly used and the most effective method of *striga* weed control technologies based on the respondents' agreement to the use of given *striga* weed control technology. Only cases, whose weed control responses were equal to Yes, were selected for this analysis. Explanatory Factor Analysis that seeks to obtain inter-correlations of a set of variables was used to determine the technologies that contribute significantly to *striga* weed control. Factors are estimated using a mathematical model, where only the shared variance is analyzed.

The first step was to assess the suitability of the data for factor analysis. This involved inspecting the correlation matrix for coefficients of 0.3 and above, and calculating the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) and Barlett's Test of Sphericity. In this study the KMO value is 0.916, and the Bartlett's test is significant (p=.000), therefore factor analysis is appropriate.

Table 3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.916
	Approx. Chi-Square	3267.735
Bartlett's Test of Sphericity	df	36
	Sig.	.000

To determine how many components to 'extract' a few pieces of information provided in the output was considered. Using Kaiser's criterion, we are interested only in components that have an Eigen values of 1 or more. From the Total Variance Explained in table 4 below, only the first component recorded Eigen values above 1 that is 7.593. This component explains a total of 84.367 per cent of the variance (see Cumulative % column). Therefore, the component 1 (Strongly Agree) is more significant. The responses were recorded to reverse the coding so that 5 becomes 1. Representing most participants

Table 4: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.593	84.367	84.367	7.593	84.367	84.367
2	0.725	8.052	92.419			
3	0.305	3.391	95.810			
4	0.112	1.241	97.051			
5	0.104	1.155	98.206			

Extraction Method: Principal Component Analysis.
a. Only cases for which Weed Control = Yes are used in the analysis phase.

Table 5: Component Matrix[a,b]

	Component
	1
MBILI System	0.846
Push & Pull	0.946
Weeding	0.957
Herbicides	0.965
Coated Seeds	0.958
Seed Selection	0.963
Compost Fertilizer	0.947
Proper Land Preparation	0.958
All Methods Effective	0.690

Extraction Method: Principal Component Analysis.
a. 1 component extracted.
b. Only cases for which Weed Control = Yes are used in the analysis phase.

Most factors load strongly (above .6) on the one component. In fact, none of the factors load on component 3, 4 and 5. These results confirm that most of the farmers who were able to control the weed strongly agree that all the control technologies are effective, though their adoption rates may vary. Use of herbicides, seed selection, proper land preparation, compost fertilizer and proper weeding were most preferred in that order. Proper land preparation and compost fertilizer application may be attributed to their cost effective nature attached to adopting these methods since compost manure is mostly locally available and most farmers also engage individually in preparation of farms before planting seasons.

Implication for Research and Practice

This study is deemed relevant to the society. Scientists in academia, industry and national agricultural services dealing with pests and diseases in general and parasitic weeds in particular; policy makers and regulators dealing with pests and genetic engineering; agricultural development agencies and personnel dealing with global agricultural and food security issues are hoped to benefit from the study.

CONCLUSION

The most effective and sustainable approach for *Striga* control is an integration of two or more control options. From the farmer field survey, this approach has proven to be the most successful with the resource-poor farmers being the keenest to adopt the technologies. The combination of these control options would increase yields and eliminate the need for alternative methods of eradicating the *striga* weed. Furthermore, farmers affected by the parasitic weed live in very heterogeneous biophysical, cultural, social, and economic environments which need to be taken into account in developing appropriate control strategies. The technologies therefore must be responsive to the different constraints faced by farmers and must fit in with their farming practices. They must also be readily available and preferably demand driven. The most affected crops include maize, sorghum, rice and sugarcane. Taking into account the peculiar nature of *striga* seeds, farmers are advised to control it before the weed emerges; the reason being that by the time it emerges, much damage will have been caused. Although various control methods have been proposed, few farmers are able to avoid yield loss by these means. For example, though manual removal reduces re-infestation, it is deemed uneconomical since most damage is done even before the weed emerges. Therefore, any control strategy has to begin within the soil.

RECOMMENDATION

Emphasis should not only be laid on technology transfer, but also on policies that will achieve sustainable productive growth and reduce food insecurity. It is absolutely essential that any interventions to increase crop production must be focused on the farmers.

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