



Farmers' Perceptions and Management Strategies for Striga in Maize Farming: A Regional Survey

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Striga hermonthica is a serious biotic stress in Sub Saharan Africa. A survey was conducted in 2024 in five districts of Iganga, Bugweri, Luuka, Namutumba and Bugiri, of Uganda to understand the economic and agricultural impact of Striga on the communities, identify the challenges, guide intervention strategies and improve crop management in Striga affected areas. Data were collected using a questionnaire from a stratified random sample of 250 diverse farm households and analyzed by cohort method. A high percentage of farmer in Iganga & Bugweri districts had farming experience of more than 21 years and Iganga had less experienced farmers. Maize was the major crop followed by cassava and sweet potatoes. Groundnuts was not commonly grown in Iganga

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while, beans were a major crop in Iganga district. Crop rankings were based on food security, market demand, easy to cultivate, soil health improvement, crop rotation and resilience. *S. hermonthica* was known to all farmers with high severity levels in all districts. Adopted Striga control methods included hand pulling, crop rotation, deep ploughing, fertilizer, intercropping, frequent weeding and use of herbicides. Striga control adoption rates were high in all districts except Bugweri. The percentage of farmers controlling *Striga* was high in Iganga, Bugweri, Luuka and Bugiri but low in Namutumba district. Sources of *Striga* control methods included fellow farmers and extension staff and high declines in maize yields were reported in all districts which had an average grain yield of 1.3–5.0 Mt ha⁻¹. Extension workers and Non government organization conducted limited farmer trainings. Based on the findings *S. hermonthica* is a serious problem in Uganda and farmers have made efforts to control it using various methods. However, there is need for a government policy to deliberately train Extension workers and farmers especially the youths in order to contain the negative impact of *Striga* on maize and other crop yields in Eastern Uganda.

Keywords: Challenges; crop management; intercropping; severity; strategies; Uganda.

1. INTRODUCTION

Striga hermonthica is a notorious pest in many agroecology and the primary biological constraint to the production of cereal crops namely; maize, rice, millet and sorghum. (Kamara, et al., 2020) and (Akaogu, et al., 2019) have reported *S. hermonthica* to cause crop yield losses of up to 100%. *S. hermonthica* is a parasitic weed that causes an estimated 7-10 billion USD losses across sub-Saharan Africa (SSA) annually in crop productivity (Yacoubou, et al., 2021) and food scarcity to 100 million people (Oula, et al., 2020) & (Dafaallah, 2019). *Striga* belongs to the family *Orobanchaceae* and can't survive on its own without a host. It depends solely on its host plant for nutrients, growth and photosynthesizes (hemiparasite). Its growth pattern, is complex and closely associated with the host and results into substantial damage like chlorosis, thin stalk, reduced height and total crop losses (Menkir, et al., 2020). A single *Striga* plant can produce up to 500,000 seeds capable of remaining viable in the soil for 20 years. The adaptability of the pest to a wide range of hosts and environmental conditions has made it one of the widespread and successful parasitic plants (Mohamed, et al., 2006). The above attributes make controlling *Striga* Spp. being difficult (Lobulu, et al., 2019). The life cycle of *Striga* Spp. involves germination, host attachment, haustoria formation/ penetration, vascular connections, nutrient absorption, flowering and production of seeds. The seeds germinate only in the presence of a host derived chemical signal called Strigalactone and germination is pre conditioned by warm and moist conditions (Marro, et al., 2021). Yacoubou et al., (2021) observed that *Striga* spp. complete their life cycle in 10 weeks, normally after the host plant has been harvested. Maize (*Zea mays*

L.) is an annual crop that belongs to the family *Poaceae/ Gramineae* (Saboor, et al., 2021). It is produced globally and one of the top three important cereals after wheat and rice in the world. Maize is cultivated on over 40 million hectares in SSA countries and constitutes more than 25% of daily caloric intake in both southern and eastern Africa (Acevedo-Siaca & Goldsmith, 2020). It is a major food security crop in SSA (Stanley, et al., 2021) and the most highly grown crop for food security in Eastern Uganda (Uganda Statistical Abstract, 2023) but currently most affected by *S. hermonthica*. (Dafaallah, 2019) reported that over 50 million hectares of cultivatable land under cereals have been infested by *Striga* spp. Maize is similarly a staple food in Uganda, feed for livestock and a means of livelihood and food security for about 75% of the Ugandan population (Uganda Statistical Abstract, 2023). Maize is also used in the food industry for paints, papers, biodiesel, textiles and adhesives (Chukwudi, et al., 2021). Small holder farmers in Uganda perceive the severity of *S. hermonthica* which is the predominant species as very high and as a witch weed responsible for their increased food insecurity and poor livelihoods.

Several methods have been used to combat this parasitic weed. The cultural practices include hand pulling, crop rotation, intercropping, trap or catch crops and soil fertility (Nitrogen) improvement. Chemical methods like use of imazapyr resistant crop varieties, suicidal germination and biological control agents such as fungi and bacteria have been attempted (Aly, 2007). None of these methods have been able to eradicate the incidence of *S. hermonthica* alone, but integrated approaches of using two or more practices have proven effective in reducing *Striga*

(Jamil, et al., 2021). The detrimental effects of chemicals have led to research in use of allelopathic compounds which have no adverse effects and yet control the noxious weed (Kaiira, et al., 2021). Integrated management of *Striga* has caused significant output (Jamil, et al., 2021) with less negative effects but the farmers willingness and commitment are vital for the effective control of *Striga*. There is however need for further research on integrated strategies to control *Striga*. The adoption of *Striga* management strategies is dependent upon the accessibility of resources, skills, technical knowhow, time and labor among subsistence farmers. Removing *Striga* weeds by hand is the most affordable cultural control method but it is tedious, and less efficient in mitigating crop damage (Rich, 2020). Chemical control is quite expensive and lacks clear protocols and the formulations are not simple to utilize. The use of soil microorganisms like bacteria and fungi has been adopted to reduce the adverse effects of chemicals but have not recorded corresponding increase in yield (Lendzemo, et al., 2005). A survey was therefore conducted to understand the impact of *Striga*, identify the challenges, interventions and crop management strategies being used to manage *Striga* in Eastern Uganda. The specific objectives were to evaluate the farmers' awareness and understanding of *Striga* weeds infestation and its effects on crop yields and to identify the different methods and practices used by farmers to manage and control *Striga* weeds in cereal crops. The objectives also included assessing farmers' perceptions of the effectiveness and challenges of current *Striga* control methods in the region and understanding the impact of *Striga* infestations on farmers' livelihoods and overall community welfare.

2. METHODOLOGY

A survey was conducted during 2024 with 250 farmers in 25 parishes of five districts in Eastern Uganda to understand the economic and agricultural impact of *Striga* on the communities, identify the associated challenges, possible intervention strategies and affected cereal crops management options.

2.1 Attributes for Data collection

Data were collected by questionnaire on background information, major crops grown, knowledge about *S. hermonthica* weeds, ranking of major crops and *S. hermonthica*, control practices. The questionnaire also documented data on sources of control technologies, effects

of the *Striga* weed on maize yield and training conducted on *S. hermonthica* weed control.

2.2 Sampling

2.2.1 Stratified sampling

The population was stratified into small (3-5 acres), medium (6-10 acres) and large (over 10 acres) farmers to capture variability based of farm size. It was assumed that large scale farmers had more experience on *S. hermonthica* with a higher variety of crops than small scale farmers

2.2.2 Random sampling

From each of the 25 selected parishes, a random sample of 10 farmers was taken as the selected population sample to ensue diverse farming households

2.3 Data Collection

2.3.1 Questionnaire survey

Structured questionnaires were used to gather both qualitative and quantitative data from the stratified population. The questions covered areas in section 2.1 above.

2.3.2 Key informant Interviews

Interviews with experts like agricultural extension officers and other stakeholders provided additional information.

2.3.3 Ethical considerations

The purpose of the survey was communicated to the respondents who agreed to participate voluntarily with confidentiality

2.4 Data Analysis

The collected data were analyzed by cohort analysis. Farmer's age, education, experience in farming, maize yield trends and percent farmers trained were analyzed using time-based cohorts, while knowledge and experience about *Striga* were analyzed by identifying patterns and insights. The data on major crops, *Striga* control technologies and quality attributes of the major *Striga* control technologies were analyzed by ranking method and expressed in figures.

3. RESULTS

3.1 Background Information

3.1.1 Gender

In all the 5 districts namely; Iganga, Bugweri, Luuka, Namutumba and Bugiri the total number

Table 1. Gender, age groups, education levels and experience in farming for farmers

District	Gender		Age group								Education level								Years of farming			
	M	F	18-30		31-45		46-60		61+		None		Primary		Secondary		Tertiary		<5	6-10	11-20	21+
			M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	T	T	T	T
Iganga	28	22	8	2	12	8	5	10	3	2	1	4	11	13	10	8	3	0	6	10	7	27
Bugweri	30	20	9	3	9	6	8	8	4	3	2	5	13	5	10	8	5	2	3	16	13	18
Luuka	23	27	8	4	13	6	7	7	3	2	2	4	12	10	11	5	4	2	4	15	18	13
Namutumba	25	25	6	9	11	9	6	8	1	0	1	1	8	9	10	13	4	4	9	21	13	7
Bugiri	32	18	7	5	12	7	10	7	2	0	1	3	10	7	12	9	4	4	5	18	8	19
Key informants	12	4	0	0	5	3	5	3	0	0	0	0	0	0	0	0	10	6	0	0	4	12

T= Total number of males and females

of males (132 farmers) were more than the females (118 farmers) as indicated in Table 1.

3.1.2 Age group

Data on the age groups of respondents in the 5 districts is indicated in Table 1. The number of farmer respondents differed from the age groups of 18-30 years (61 farmers), 31-45 years (93 farmers), 46-60 years (76 farmers) and only 20 farmers were above 61 years in all the 5 districts. Namutumba and Bugiri districts recorded no females aged above 61 years and all the key informants were above 30 years of age.

3.1.3 Education level

The data on Education levels is indicated in Table 1. The majority of interviewed farmers had gone to school and only Iganga district recorded no females that had received tertiary education. Namutumba and Bugiri districts recorded similar higher numbers (16%) of farmers with tertiary education. Similarly higher numbers of farmers who acquired secondary education were found in Namutumba (46%) and Bugiri (42%) districts. The highest numbers of farmers who had no education were found in Bugweri (14%) and Luuka (12%) districts.

3.1.4 Experience in farming

A high number of farmers (54%) with farming experience of more than 21 years, were in Iganga followed by Bugweri (36%) district (Table 1). Iganga had lower (14%) farmers with farming experience of 11-12 years and a higher number of farmers (18%) with less than 5 years' experience were recorded in Namutumba district.

3.2 Major Crops Grown and Level of Knowledge about *Striga hermonthica*

3.2.1 Major crops

The major crops grown in all the districts were maize (100%), cassava (75%) and sweet potatoes (51%) (Table 2). Groundnuts crop (70%) was grown in only 4 districts of Bugweri, Luuka, Namutumba and Bugiri while beans (84%) were a major crop in Iganga district.

3.2.2 Knowledge about *Striga hermonthica*

S. hermonthica was reported to be known to all farmers (100%) in the 5 districts (Table 2).

3.2.3 Level of severity of *S. hermonthica*

The results on *Striga* severity per square metre is indicated in Table 2. The severity levels were indicated as medium to high by 90% of the farmers in the districts of Luuka and Namutumba. This was similar to the response (90%) from key informants. The severities reported were lower in Bugweri (88%), Bugiri (86%) and Iganga (84%) districts.

3.2.4 Methods used to control *S. hermonthica*

The data on the percent number of farmers who use a particular method or combination of methods is indicated in Table 2. The major control methods are hand pulling/rouging (82%), crop rotation (78%), deep ploughing (67%) and fertilizer/manure application (62%). Intercropping maize with legumes (37%), continuous/frequent weeding (22%) and use of herbicides (17%) were the least adopted technologies for *Striga* weed control in the 5 districts. Only 4% of the farmers in the 5 districts indicated that they were not controlling *Striga* weeds in anyway. Iganga (78-92%) and Luuka (64-90%) districts farmers indicated higher adoptions of the *Striga* weed control technologies followed by farmers in Namutumba (73-86%) and Bugiri (56-84%) districts and lower adoption levels (40-60%) were recorded in Bugweri district.

3.2.5 Trends in using the different *S. hermonthica* control Technologies

The trends in controlling *Striga* in the different districts are indicated in Table 2. Increasing trends were recorded for Iganga (92%), Namutumba (85%), Bugiri (73%) and Luuka (72%). Bugweri scored a lower (46%) positive trend in the use of the *Striga* control technologies amongst the districts. The percent number of farmers controlling *Striga* was high in Iganga (47%), followed by Bugweri (37%), Luuka and Bugiri (34%) and low in Namutumba (27%) district.

3.2.6 Number of farmers controlling *Striga hermonthica*

The data on number of farmers controlling *S. hermonthica* weed is indicated in Table 2. In all districts moderate to high (79%) numbers of farmers were reported to control *Striga* weed with Iganga (79%) leading followed by Bugweri (77%), Luuka (76%), Namutumba (72%) and Bugiri (72%) being at par.

Table 2. Major crops grown, level of knowledge about *Striga*/ severity, number of farmers controlling *Striga* and trend of the control measures

District	Major crops (%)	Knowledge about <i>Striga</i> (%)		Level of severity by <i>Striga</i> as count m ⁻² (%)			Methods used to control <i>Striga</i> in combination (%)								Trend in using <i>Striga</i> control methods (%)		Number of farmers controlling <i>Striga</i> (%)		
		Yes	No	Low (<10)	Mod (10-20)	High (20+)	P	R	D	F	I	C	H	N	Increase	Decline	Few	Mod	Many
Bugiri	Maize (100)	100	0	14	26	60	84	72	82	56	42	18	12	5	73	27	23	38	34
Bugweri	G/nuts (50)																		
	Cassava (82)																		
	S/Potatoes (38)																		
Iganga	Maize (100)	100	0	12	54	34	60	56	42	40	36	28	24	3	76	24	20	40	37
	G/nuts (70)																		
	Cassava (74)																		
Luuka	S/Potatoes (42)																		
	Maize (96)	100	0	16	22	62	92	90	74	78	36	20	16	3	92	8	8	32	47
	Beans (84)																		
Namutumba	Cassava (72)																		
	S/Potatoes (60)																		
	Maize (100)	100	0	10	26	64	90	82	58	64	38	24	15	6	72	28	18	42	34
Key Informants	G/nuts (80)																		
	Cassava (84)																		
	S/Potatoes (62)																		
Key Informants	Maize	100	0	10	20	70	90	82	45	50	38	30	12	8	50	50	50	30	20
	Cassava																		
	S/ Potatoes																		
	G/nuts																		

Mod = Moderate, P=Hand pulling/ Rouging, R= Crop Rotation, F= Fertilizer/ manure, D = Deep ploughing with oxen, I= Intercropping maize with legumes, C=Continuous/ frequent weeding, H= Herbicides, N=None

Table 3. Crop priority ranking by farmers in Bugiri, Bugweri, Iganga, Luuka and Namutumba Districts of Eastern Uganda (1 as highest & 5 being lowest)

Crop	Bugiri	Bugweri	Iganga	Luuka	Namutumba	Key Informants	Reasons for ranking
Maize	1	1	1	1	1	1	Food security market demand, easy to cultivate
Cassava	2	3	3	2	4	2	Food security, market demand, risk/ resilience
Sweet potatoes	3	2	4	3	3	3	Food security market demand, easy to cultivate
Groundnuts	4	4	5	4	2	4	Food security, risk. resilience & improves soil health
Beans	5	5	2	5	5	5	Food security, ease of cultivation, crop rotation, improves soil health

3.3 Ranking of Crops by Farmers in the Districts and Reasons for the Ranks

The data on ranking and reasons for the ranking of the 5 major crops in the districts is indicated in Table 3. The ranking was based on the profitability, market demand, ease of cultivation, climate suitability, risk and resilience, storage/ shelf life, crop rotation/ soil health, labor requirements and yield. The most popular crop was ranked number 1 and the least number 5 in descending order. Maize crop was ranked as the most popular crop in the region followed by cassava, sweet potatoes, groundnuts and beans in a descending order. The main reasons given by the farmers for the rankings were food security, market demand easy to cultivate, improvement of soil health, crop rotation and risk/ resilience'.

3.4 Ranking of *S. hermonthica* Control Technologies by Farmers

The ranking of technology use by farmers to control *S. hermonthica* weed are indicated in Fig. 1.

Hand pulling/ hoeing was ranked as the most popular method (82%) followed by crop rotation with non host plants to the noxious parasitic weed (78%). The practice of deep ploughing of *Striga* into the soil was ranked less popular (67%) with the application of manures and organic fertilizers as less commonly adopted (62%) by farmers in the 5 districts. The other less frequently used methods included intercropping maize with legumes (37%), continuous/frequent

weeding (22%) and use of herbicides (17%). About 4% of the farmers in the 5 districts did not control *S. hermonthica*. Most adopters integrated two to three technologies into their farming practices.

3.5 Sources, Benefits, Strengths, Efficacy and Accessibility of the Major *Striga* Control Technologies

The sources of the technologies, strength and quality attributes of the control technologies for *Striga* weeds are indicated in Table 4.

3.5.1 Sources of *Striga* control technologies

The major source of *Striga* control method was reported as fellow farmers (52%) followed by extension staff (23%) and family members (13%). Farmers also expressed self initiative (12%) as a source method by which they coped up with *S. hermonthica* pandemic.

3.5.2 Strengths of *Striga* control methods

The advantages of the different *Striga* control methods expressed by the farmers were majorly to reduce the weed population and seed bank, reduce the crop/weed competition for soil nutrients, promote the non host plants, improve soil health and crop growth, reduce pest and disease infestations. The disadvantages included high costs, labor intensity, hard to pull weeds that caused more weed sprouts, incompatible crop rotations and mixtures that required extra skills and more land and seed.

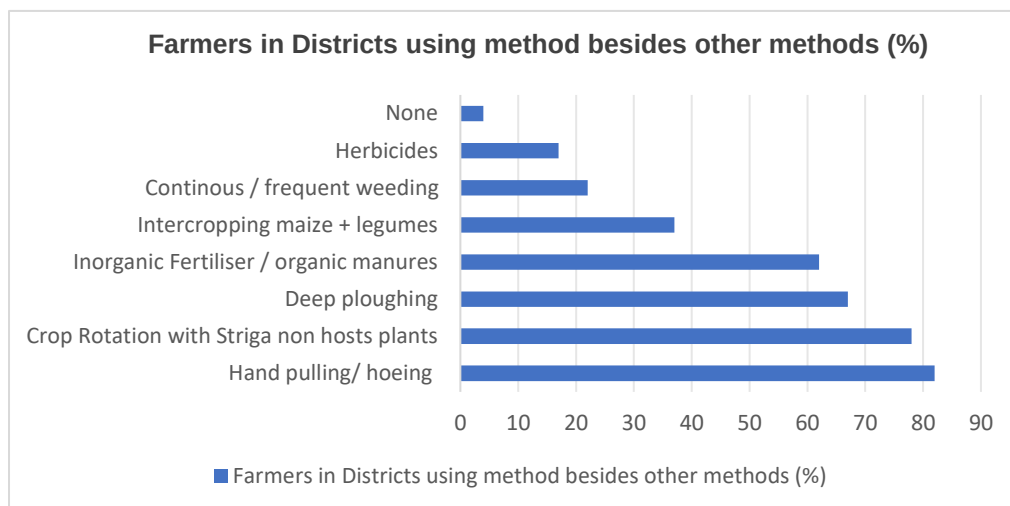


Fig. 1. Farmers in districts using major method besides other methods to control *Striga* weed

Table 4. Sources, strengths and quality attributes of the major *Striga* control technologies in the districts of Bugiri, Bugweri, Iganga, Luuka and Namutumba in Eastern Uganda

Sources of <i>Striga</i> control technologies (%)	<i>Striga</i> control method	Advantages of control method	Disadvantages of control method	Labor intensity	Effectiveness	Availability
Farmers (52%)	Hand pulling	i) Reduces weed seed bank & population if done early	i) Tedious	High	High	High
Extension staff (23%)		ii) Reduces competition between crops + weeds	ii) Expensive iii) Weeds break iv) Spreads seeds if done late			
Family/parents (13%)	Crop Rotation with non hosts	i) Reduces <i>Striga</i> seed bank	i) Incompatible crops in some soils under rotation	High	High	High
Self initiative (12%)		ii) Promotes growth of non host plants for <i>Striga</i> iii) Improves soil fertility iv) Reduces pests & diseases	ii) Limited land iii) Requires extra skills iv) Shortage of seed for sequential crops			
	Inorganic Fertiliser /	Improved crop growth	Expensive	Low	High	Low
	Deep ploughing	i) Reduces weed density	i) Expensive	High	Low	Low
		ii) Improves crop growth iii) Buries weed seeds deep in soil	ii) Rough seed beds iii) Propagate <i>Striga</i> seeds iv) Difficult in mixed cropping			

3.5.3 Quality attributes of the *Striga* control methods

Hand pulling of weeds and crop rotations with *Striga* non-host plants were found as common methods since they were easily accessible, relatively effective though labor intensive. The use of inorganic fertilisers and organic manures were considered not readily accessible though effective though not labor intensive. Deep ploughing of *Striga* weeds was noted to be labor intensive, not effective in *Striga* weed control and was associated with labor scarcity.

3.6 Effects of *Striga* on Maize Yield and Types of Farmer Trainings

The effects of *S. hermonthica* on maize yield and trainings conducted by Agricultural Extension staff are indicated in Table 5.

3.6.1 Maize yield in past 5 years

The majority of respondents in the survey reported an increased (73%) reduction in maize

grain yield in the past 5 years. Respondents who did not recognize any changes in the trend of maize yield constituted only 27% in the survey. Nobody reported an increase in the yields of maize in the past 5 years. The highest decline (80%) in maize yield was in Iganga followed by Bugweri (75%) and the lowest maize grain yield reduction was in Bugiri (58%) district (Fig. 2). All the key informants (100%) reported decline in maize grain yields. The average maize grain yield reported in the 5 districts was 1.3–5.0 Mt per hectare with high yield (3.0-5.0 Mt ha⁻¹) reported from Iganga and lower harvests in Bugiri (1.8-2.0 Mt ha⁻¹) district. Male farmers reported higher maize grain yield (2.5 – 5.0 Mt ha⁻¹) compared to female farmer (1.3-3.0 Mt ha⁻¹).

3.6.2 Farmers trained in *Striga* control

The farmers trained and subjects of training are indicated in Table 5. The majority of respondents (55-65%) had received some trainings on *Striga* control from Agricultural Extension workers and Non government organization in the past 5 years.

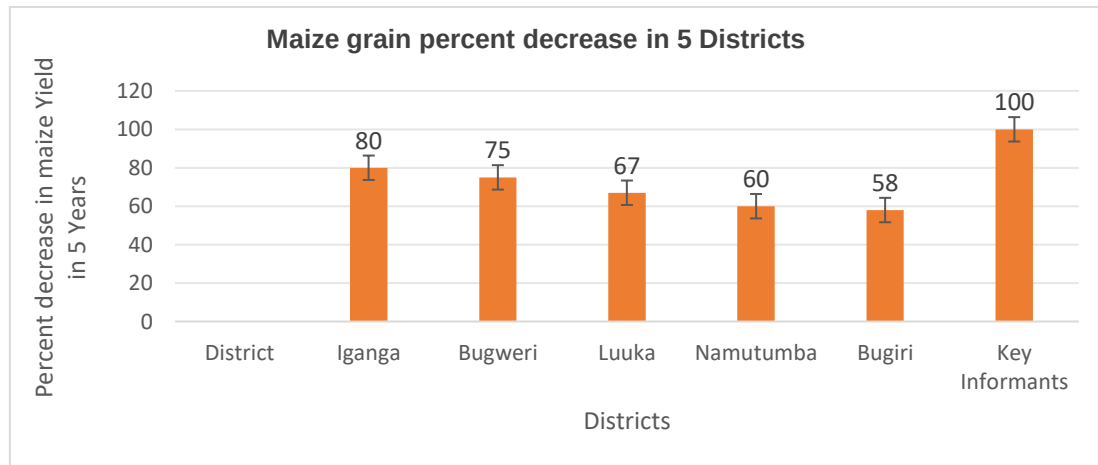


Fig. 2. Percent decrease in maize grain yield over 5 years in the 5 districts

Table 5. Effects of *Striga* on maize yield and types of farmer trainings

District	Percent farmers trained in <i>Striga</i> control during past 5 years		Subjects of farmers training	Average Yield of maize (Mt ha ⁻¹)	
	Yes	No		Male	Female
Iganga	60	40	i) Crop rotation	5.0	3.0
Bugweri	60	40	ii) Hand pulling of <i>Striga</i> and burning	4.0	3.0
Luuka	70	30	iii) Inorganic fertiliser use	3.0	2.0
Namutumba	55	45	iv) Improved seeds / IR maize	2.5	1.3
Bugiri	65	35	v) Use of 2-4 D Herbicides	2.0	1.8
Key Informants	10	90	vi) Intercropping maize with legumes	3.5	3.4
			vii) Deep ploughing		
			viii) Frequent weeding		

The farmers were trained in various *Striga* control technologies that included: crop rotation, hand pulling of *Striga* + burning, use of inorganic fertilisers and improved seeds (IR maize), weed control using 2-4 D herbicides, intercropping maize with legumes, deep ploughing and frequent weeding. The highest number of trainings were in Luuka (70%) and least in Namutumba districts (55%). Only 10% of the key informants had been trained in *Striga* weed management.

3.6.3 Average yield of maize (Mt ha⁻¹)

The reported yield by male farmers was higher (2.0-5.0 Mt ha⁻¹) than female counterparts (1.3-3.0 Mt ha⁻¹) and an average yield of only 1.3 -3.0 Mt ha⁻¹ was observed. This yield was relatively low compared to the normal average (3.5-4.0 Mt ha⁻¹) for the region.

4. DISCUSSION

4.1 Gender and Age group

More males (53%) than females (47%) were respondents to the interview. This is attributed to cultural norms. In many regions, farming is traditionally viewed as a male dominated occupation and men are the decision makers leaving the women to take on domestic roles. This cultural expectation limits women's involvement in formal agricultural activities. Men often have greater access to resources like land, financing and networks that support their participation in agricultural activities. In contrast women face barriers like access to limited land or credit, restricting their opportunities to participate in agricultural activities. Women particularly in rural areas, often have multiple responsibilities, such as household chores, childcare which limit their availability to surveys and training especially if they are scheduled at times that conflict with these duties. Lack of empowerment could have contributed to less participation by women in the interview as they often don't have the same level of confidence to participate in rural programs or may not be aware of opportunities. Addressing these issues requires creating inclusive policies and providing targeted support to ensure that women have equal access to agricultural training and resources. The results are similar to that of a survey by (Mthi, et al., 2021) who observed more males (59.6%) participants in a survey than females (40.4%) but the majority (74%) were between 20 - 35 years. The youths (18-30 years) constituted about 25% of the respondents, with

the majority of farmers (68%) in the age bracket of 31-60 years). The low percentage of youth farmers in the current survey could reduce adoption of sustainable practices / technologies, entrepreneurship, community engagement, leadership and advocacy and reduce innovations in farming practices, resulting into low productivity and increased environmental footprints of agriculture. The low percentage of youths in the current survey could also be ascribed to minimal youth involvement by the local governments in agricultural activities and shared understanding of their roles in agricultural growth. (Geza, et al., 2021) in a similar survey reported that the youths have pessimistic perceptions about agriculture's capability to improve their living standards. Similarly (Girdziute, et al., 2021) reported that youths believe that work in Agriculture does not provide any opportunities for self-realization. The low number of elderly above 61 years (8%) signified lack of farmers with decades of experience and traditional knowledge about farming techniques and management of biotic and abiotic stresses including *S. hermonthica*. While some older farmers may initially be resistant to change, many adapt to new agricultural technologies particularly those that lead to improved yields. like *Striga* control methods. The absence of female farmers aged 61 years and over in Namutumba and Bugiri districts implies that some indigenous knowledge passed down through generations, about suitable farming practices by female farmers such as local ecological systems and crop management could be lost making it harder to maintain traditional farming methods and relying on external less sustainable, agricultural techniques. Elderly women often play important roles in maintaining social structures, offering mentorship to young farmers and helping with community cohesion. Their absence in Namutumba and Bugiri districts could lead to breakdown in these social roles, reducing intergenerational knowledge transfer and weakening community bonds. Food security issues could also be jeopardized especially if the young generations are less willing to take up farming or lack the required experience. The absence of elderly women in farming deepens gender disparities, as young women are pushed out of the agriculture due to changing gender roles as they get less access to resources, training and land. Women play an important role in growing specific crops or preparing food in ways tied to cultural identity. Absence of the elderly women may result in the erosion of cultural heritage linked to agriculture. More

respondents (37%) were in age group 31-45 than 46-50 years (31%), 18-30 years (24%) and over 61 years (8%). This may be attributed to the peak productivity in that age bracket. They typically have the energy, physical capability and experience to manage the demands of farming. This age group is likely to have acquired farming skills, resources, financial stability and confidence, allowing them to manage the complexities of agricultural work effectively. The age bracket also has experience and knowledge that will have accumulated over time sufficiently and can deal with farming challenges like could be asked in an interview than younger or older individuals who may have retired from farming or shifted to other activities. The 31-45 years age group is also likely to embrace new technologies, balancing tradition with innovation unlike younger and older farmers who may be less inclined to change established practices. This age group may also be taking over farms or establishing their own, bridging the gap between the young (18-30 years) and elderly (46-60 + years). Overall the 31-45 age group is the most active in farming.

4.2 Education Level

The high numbers (16%) of farmers with tertiary education in Namutumba and Bugiri and more farmers with secondary education in Namutumba (46%) and Bugiri (42%) districts implied that the farmers in these districts were more equipped with modern farming technologies and best practices. Education allows them to improve productivity, adopt sustainable practices like *Striga* weed control and manage their farm operations and best practices. Education also enhances their ability to access and apply research and innovations in agriculture. The absence of women farmers with tertiary education in Iganga district and high numbers of uneducated farmers in Bugweri (14%) and Luuka (12%) districts implied that women farmers in Iganga and farmers in Bugweri and Luuka district are more likely not to access financial resources, technologies, government programs and subsidies. The farmers in the three districts are also less likely to efficiently manage finances, plan and run their farms as profitable businesses since they may not secure loans or market their produce. Higher education enhances problem solving and decision making on pests like *Striga* and disease such as Fall Army worm out breaks, climate change effects and fluctuating prices. Farmers with high education may have better communication and networking skills, allowing

them to engage more effectively in agricultural markets, cooperatives and industry associations for better prices and increased participation in value chains. Farmers with high education may also explore alternative activities like Agro-tourism and value addition to supplement their income and reduce risks. It is important to note that education alone does not always guarantee greater participation in farming. Other factors such as access to land, financial resources and local agricultural context may play significant roles in shaping a farmer's involvement in the sector. In some cases, less educated farmers may rely on traditional knowledge and experience which can also be highly effective. (Dunne & Troske, 2005) reported that education affects technology adoption and use depending on the type of technology.

4.3 Experience in Farming

The survey revealed a high number of experienced farmers in Iganga (54%) and Bugweri (36%) districts coupled with low number (14%) of experienced farmers (11-12 years) in Iganga. A high number of farmers (18%) with less than 5 years' experience were in Namutumba district. The data implied that Iganga and Bugweri districts had farmers with a wealth of knowledge gained from years of trial and error, successes and failures. This probably allows them to make better decisions about crop selection, planting times, simple irrigation, pest and disease management, soil fertility management and marketing strategies than farmers in the other districts. Experienced farmers draw on their prior knowledge and adapt to changing circumstances. They are better at managing their resources such as land, labor, water and fertilizers for maximum output, sustainability and improved productivity. The experienced farmers are better at budgeting, record keeping, and labor management. They understand better market trends, pricing and consumer demands. These farmers are consulted for guidance by younger or less experienced farmers and that valuable knowledge is passed on to the whole community. However, while experience offers numerous advantages, it is also important for farmers to stay open to new ideas, technologies and methods. Farming practices evolve and the ability to combine experience with innovations is key to continued success. (Fasakin, et al., 2022) found that the key factors influencing the decisions of youths to participate in agriculture extensively include the number of years of

farming experience, access to credit, membership in social groups, income and land access.

4.4 Major Crops Grown

The crops grown by farmers were maize (100%), cassava (75%) and sweet potatoes (51%) across the 5 districts. Adoption of crops by farmers in a particular area is influenced by several factors, both internal (specific to the farmer) and external (related to the environment, market and policies). The adoption of maize as the major crop which is a major host plant to *S. hermonthica* weed in the 5 districts could be attributed to suitability of the crop to the local environment and soil conditions. Maize crop offers relatively high net profits with low production costs and readily available inputs. The crop has ready market though susceptible to *Striga* weeds and Fall army worm (FAW). However, the increased risks with the former pest has created a lot of uncertainty with growing the maize crop. The availability of quality maize seed, fertilizers and pesticides could have however supported the adoption of maize in Eastern Uganda. Traditional farming practices, cultural preferences and community norms possibly influence the adoption of cassava and sweet potatoes. Peer influence, local knowledge, low labor costs, sharing of best practices within the farming communities, access to agricultural extension services may have caused higher adoptions of the three crops. The long experience of farmers in growing a crop successfully over years makes a farmer continue growing the crop. Crop adoption is a complex decision-making process that considers both practical and socio-economic factors. Bugweri, Luuka, Namutumba and Bugiri farmers grew groundnuts (70%) as a second major crop (Table 2) possibly because of its profitability and suitability to the ecological zone. Groundnuts has been reported as an intercrop with highest synergy and recommended in the maize based cropping systems in Uganda (Kaiira, et al., 2025). The legume crop is a good false host that stimulates suicidal germination of *Striga* weeds, depletes the seed bank and improves soil fertility (Atera, et al., 2013). The adoption of groundnuts may be associated with experiences of the farmers in pest management of *S. hermonthica* and high productivity of the maize+ groundnuts intercropping system that has enabled them to make better decisions about crop selection, planting times, pest and disease management. (Feng, et al., 2021) & (Kaiira, et al., 2025) reported high total land equivalent ratios, overall

crop yield (Feng, et al., 2021) & (Kaiira, et al., 2025) and improved the N absorption and use capacity of maize (Zhang, et al., 2024, Jiao, et al., 2021). Beans were a major crop (84%) only in Iganga district possibly for similar reasons to groundnuts and possible ready market in the urban district.

4.5 Knowledge and Level of Severity of *S. hermonthica*

All the farmers knew *Striga hermonthica* weed. This is associated with the significant damage the weed has on crops' yield and quality reductions. Identifying *Striga* weed helps farmers to take proactive measures to protect their crops, minimize losses and ensure long term productivity, while promoting sustainable and economic viable farming practices. A high severity level of more than 20 *Striga* weeds m⁻² was reported by the majority (55%) of farmers, 32% indicated moderate (10-20 *Striga* m⁻²) and only 12% expressed a low level of severity for the parasitic weed. The severity levels imply reduction in the cereal crops yields and lower incomes. (Kamara, et al., 2020, Akaogu, et al., 2019) & (Stanley, et al., 2021) reported 100% yield reductions due to *Striga* in maize having high severity levels. Farmers may need to spend more on pest control measures such as pesticides, labor intensive methods etc. The lost revenue can be a financial burden. The high severity also affects crop quality eg. shrinked maize grains making it less marketable. Excessive use of chemical for *Striga* weed control may have adverse effects on the environment (soil contamination, harm to beneficial insects) and human health (exposure to workers). This can create long term sustainability challenges for farming practices. (Ahmad, et al., 2024) reported that pesticides can cause acute toxicity if a high dose is inhaled, ingested or comes into contact with the skin or eyes while prolonged exposure to pesticides lead to chronic carcinogenicity, teratogenicity and endocrine disruption. The scientists also reported soil, food, air and water contamination besides effects on the ecosystems by pesticides.

4.6 Methods to Control *S. hermonthica*.

The *S. hermonthica* weed control methods and adopted levels by farmers in the 5 districts included hand pulling/ rouging (82%), crop rotation (78%), deep ploughing (67%) fertilizer/manure application (62%), intercropping maize with legumes (37%), continuous/frequent

weeding (22%) and use of herbicides (17%). About 4% of the farmers in the 5 districts did not control *S. hermonthica*. The adopted methods have limitations. The physical control (manual removal) that was reported adopted by the majority of farmers is labor intensive, time consuming and not always practical. The cultural control (crop rotation and intercropping) have limited impact as the methods alone might not completely eradicate *Striga* weeds, especially in heavily infested areas. The method is labor intensive, as proper crop rotation or intercropping requires careful planning and additional labor. Some crops may not be suitable for rotation or intercropping with *Striga* resistant crops and the method takes several years to show significant improvements. The use of chemicals (herbicides) is associated with high costs for the smallholder farmers and can lead to soil and water contamination. *Striga* can also develop resistance to certain herbicides and chemicals may harm the main crops. Soil fertility management (Fertilisers and organic matter) have the limitations of high costs, limited effectiveness and over reliance on chemical fertilizers can lead to soil degradation over time. *Striga* trap crops like cowpeas and groundnuts may be used to attract and kill *Striga* weeds. The crops however require additional land and resources that small holders may not afford and may not control *Striga* Spp, in areas with heavy infestations and some trap crops may not be adapted to areas where *Striga* weed is a problem. The use of Biological control (*Striga* resistant crops or natural enemies) was not reported in the survey but where practiced, is limited by the slow process of developing the resistant crop varieties and genetic development of the resistant varieties is still a challenge whereas biological control may not be effective across all environments and requires specific conditions. While each method has its strengths, *Striga* control often requires an integrated approach combining several methods to be effective. Research work conducted on *Striga* weed control by (Atera, et al., 2013) indicates trap cropping or growing of false hosts such as cowpeas, groundnuts, simsim and cotton stimulates suicidal germination and improves soil fertility were reported to deplete the seed bank. Combining trap crops and nitrogen fertilizers was also reported to significantly decrease *Striga* seed bank (Tadesse, 2018). meanwhile, cover cropping of the soil or mulching was reported to reduce the *Striga* seed bank (Randrianjafizanaka, et al., 2018). Intercropping cereals with legumes also reduced *Striga* weeds emergence by

improving soil fertility, organic matter and soil moisture content and releasing allelochemicals such as isoflavonoides, phenolics and terpenoids which might impact *Striga* germination, growth and development (Midega, et al., 2017) & (Hailu, et al., 2018). A combination of herbicide resistant maize varieties intercropped with legumes appeared more effective against *Striga* (Kanampiu, et al., 2018). There is therefore need to train farmers in integrated approaches to manage the *Striga* weed problem.

4.7 Adoptions of Different Technologies and Trends in Controlling *S. hermonthica*.

High adoption levels for *Striga* were in Iganga (78-92%), Namutumba (73-86%), Bugiri (56-84%), Luuka (64-90%) and Bugweri (40-60). The trends in increased *S. hermonthica* control was highest in Iganga (92%), and lowest in Bugweri (46%). The higher the adoption levels, the more *Striga* weeds were controlled. The increased adoptions and positive trends in control could be attributed to the perceived success in controlling *Striga* with improved crop yields. The affordability, accessibility and availability of the technologies greatly influenced the adoption of *Striga* control technologies. Awareness campaigns and extension services that provide services such as training and information are vital (Peansupap & Walker, 2005). Lewicka (2011) indicated that an individual's adoption of innovation not only depends on individual attitudes but also on organizational policies, approaches and actions such as trainings (Al-Gahtani & King, 1999), support & incentives (Igbaria, et al., 1996). The high adoptions in Iganga, Luuka and Namutumba may be associated to socio-cultural factors such as non-skeptical attitudes or quick adoption of technologies by farmers due to social influence. (Talukder & Quazi, 2011) referred to such influence as normative beliefs about the appropriateness of adoption of innovation. The districts of Iganga and Luuka had no farmers with Tertiary education and very low number of farmers with secondary education. On the contrary, Bugiri districts with highly educated farmers had low adoption levels for *Striga* weed control technologies. The low adoptions of technologies by Bugiri farmers (High education) and higher adoptions by farmers in Iganga (Low education) may be attributed to factors such as ability to purchase equipment (eg. seeds or training), fear of risks, lack of access to resources and cultural resistance and insufficient

support systems like extension services, training or experts to guide on using the technology. (Talukder, 2012) attributed the adoption of innovations to demographic factors, peer and social networks. Bugweri and Luuka had farmers with low education and low levels of technology adoption. The recommended methods of controlling *Striga* include; proper seed selection, use of seeds that are *Striga* seeds weed free, regular plant monitoring, intercropping with legumes, hoeing and weeding before the *Striga* weeds start to flower. These technologies when used in combination offer effective strategies to combat *Striga* infestations, improve maize productivity and support farmers' livelihoods. The integration of complementary Integrated *Striga* Management components can enhance efficiency and sustainability in managing this persistent parasitic weed. Since most adopters integrated two to three technologies into their farming practices, the findings provide insights into opportunities for promotion of broader uptake of ISM technologies. (Lloyd & Mohammad, 2025) reported that technology adoption and the intensity of its use are influenced by household socio-economic characteristics, farm level features, psychological traits and institutional factors. Some of these factors could have determined the adoption of *Striga* control technologies by the respondents in the districts.

4.8 Sources, Benefits, Strengths, Efficacy and Accessibility of the Major *Striga* Control Technologies

Fellow farmers were the major (52%) source of technologies followed by extension staff (23%) and family members (13%). The use of fellow farmers and farmers' self initiative (12%) as another method by which farmers coped up with *S. hermonthica* pandemic implies that there was poor extension service delivery in the districts. The advantages of controlling *Striga* mentioned were to reduce the weed population and seed bank, reduce the crop/weed competition for soil nutrients, promotion of the non host plants, improve soil health and crop growth, reduce pest and disease infestations. The ultimate aim of employing such practices were to prevent seed setting and realize better economic returns as a result of diminished infestation in the long run. The different methods for *Striga* weed control reported by farmers had disadvantages that included high costs and labor intensity besides hard to pull weeds that caused more weed sprouts and crop incompatibility. The

incompatible crop rotations and mixtures require extra skills and more land and seed. (Otto, et al., 2023) reported that weed density was not affected by crop rotation length and about 98% of the weed species were indifferent to the factors applied. The researchers observed that the effect of crop rotations on weeds is hard to detect and the dominance of some grass weeds were a consequent of inadequate management of late emergence and post-harvest weeds. The study therefore implied that extra skills were needed in weed control. (Adhikary & Gosh, 2014) reported that crop rotation modifies seed banks, especially their composition, making weed control technologies difficult and less efficient,

4.9 Quality Attributes of the *STRIGA* Control Methods

The common control methods were hand pulling of weeds and crop rotations with *Striga* non-host plants.

Hand pulling is not very effective as the *Striga* weed growth pattern, is complex, closely associated with its host root system and results into substantial damage like chlorosis, thin stalk, reduced height and total crop losses (Menkir, et al., 2020). A single *Striga* plant can produce up to 500,000 seeds capable of remaining viable in the soil for 20 years (Adhikary & Gosh, 2014). The *Striga* weeds life cycle is short and therefore the weed must be controlled early. (Yacoubou, et al., 2021) observed that *Striga* spp. complete their life cycle in 10 weeks, normally after the host plant has been harvested. The life cycle of *Striga* Spp. involves germination, host attachment, haustoria formation/ penetration, vascular connections, nutrient absorption, flowering and production of seeds. The seeds germinate only in the presence of a host derived chemical signal called Strigalactone and germination is preconditioned by warm and moist conditions Marro et al., (2021). (Lobulu, et al., 2019) indicated that the invasion of this parasite is hampered by the tremendous number and longevity of the seeds, vast genetic variability, complex life cycle, and subterranean nature of damage. (Huang, et al., 2012) *Striga* weed control is difficult due to the nature of the association between host plants and parasites, which requires highly selective herbicides. Inorganic fertilizers and organic manure technologies were considered not readily accessible though effective and not labor intensive. Deep ploughing of *Striga* weeds was reported to be labor intensive/ expensive and not

effective. (Huang, et al., 2012) observed that soil management in tilled systems can replenish the soil seedbank by burying the seeds on the surface and unearthing them in following seasons. *Striga* weed control is difficult due to the nature of the association between host plants and parasites, which requires highly selective herbicides.

4.10 Effects of STRIGA on Maize Yield and Types of Farmer Trainings

Increased negative effects on maize yield in the past 5 years were reported by 68% of the farmers as 32% of farmers did not recognize change in maize yields and maize yield. The reported yield by male farmers was higher than female counterparts and generally all the yield was relatively low compared to the normal average (3.5-4.0 Mt ha⁻¹) in the region. This could be attributed to the serious *Striga* incidences and severity reported in the districts. (Travlos, et al., 2020) reported 66% maize grain yield reduction due to *Striga* weeds and 100% yield reduction was reported by (Feng, et al., 2021, Zhang, et al., 2024) & (Jiao, et al., 2021) due to *Striga* in maize. The low yields by women could have resulted from the barriers they face such as access to land (fertile land) or credit, innovations and other resources restricting their opportunities to participate in profitable agricultural activities.

4.11 Farmers Trained in *Striga* control

Extension workers and non government organizations (NGOs) trained 55-65% of the farmers in *Striga* weed control during the past 5 years. The technologies included: crop rotation, hand pulling of *Striga* + burning, use of inorganic fertilizers and improved IR maize seed, weed control using 2-4 D herbicides, intercropping maize with legumes, deep ploughing and frequent weeding. The number of trained farmers should have been higher to enable the farmers manage the *Striga* weed more effectively as training is very vital in technology uptake. This was reported by (Al-Gahtani & King, 1999) who indicated that training leads to high adoption of technologies. Recognizing the importance of knowledge in combating *Striga* infestations, the Uganda government has to work in collaboration with Extension services and (NGOs) to provide targeted and accessible training to farmers across the country. The training programs should focus on practical, sustainable methods for controlling *Striga*, including crop rotation,

resistant crop varieties, intercropping with catch crops, soil health management and use of herbicides. The government should similarly enhance the capacity of Agriculture Extension staff with up to date knowledge on *Striga* management techniques. There is also need for the government to strengthen partnerships with (NGOs) in *Striga* weed control. Uganda government should also prioritize investment in Agricultural Research technologies under the National Agricultural Research Organisation (NARO) to be integrated into Extension and training programs for the farmers. The economic impact of *Striga* weeds should be made known to farmers by the government through media broadcasts in collaboration with research institutions.

5. CONCLUSION

Maize was the major crop in the study area and most susceptible to *Striga hermonthica* weed with high severity that was known to all respondents. The decline in maize grain yield was in all districts especially in Iganga (80%) and Bugweri (75%) districts. Farmers were controlling the *Striga* by hand pulling (82%), crop rotation (78%), deep ploughing (67%), fertilizer (62%), intercropping (37%), frequent weeding (22%) and use of herbicides (17%). The *Striga* adoption rates were high in Iganga and low in Bugweri districts. Generally, there were increasing trends (46%-92%) in the use of the *Striga* control technologies for all districts and the percentage of farmers controlling *Striga* was high in IG (47%) and low in Namutumba (27%) district. The major source of *Striga* control technologies was fellow farmers (52%), followed by extension staff (23%), family members (13%) and self initiative (12%). Only 10% of the Extension workers had been trained in *Striga* control. There is urgent need for a policy by Uganda government to train Extension staff in *Striga* control technologies in order for them to impart more knowledge to the farmers. Farmers were the major source of knowledge for the control technologies to each other. Efforts have been made to develop eco-friendly approaches to combat the increasing effects of *Striga* weeds on cereal crops. Sustainably, *Striga* control methods should target at least one of the following goals: (i) *Restraint*; Limiting new seed production by planting resistant varieties (Pre & post attachment), using fertilizers, applying appropriate herbicides, employing agronomic practices such as hand hoeing, burning, fallowing and seed coating with allelochemicals that reduce the release of

germination stimulants by the host. NERICA rice varieties use this principle to reduce Pre & post attachment. (ii) *Prevention*: Avoiding seed dispersal by using clean crop seeds, tools, fodder and controlling animal grazing or applying Phyto-sanitary measures and (iii) *Reduction*; Decreasing *Striga* seed bank in infested soils by using cultural practices such as trap crops, intercropping and crop rotations. Effective management of *Striga* weeds requires an integrated approach such as complementing host resistance with seed coating or integrating trap crops exhibiting suicidal germination and *Striga* specific herbicides with allelopathic potential to effectively deal with the *Striga* problem in African Agriculture.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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