Journal of Agricultural Science and Technology B 4 (2014) 237-248
Earlier title: Journal of Agricultural Science and Technology, ISSN 1939-1250

Knowledge, Attitude and Practices Used in the Control of *Striga* in Maize by Smallholder Farmers of Western Kenya

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Received: Novermber 8, 2013 / Published: March 20, 2014.

Abstract: The production of maize is constrained by parasitic weeds, particularly *Striga*. A study was carried out to document farmers' knowledge, attitude and practices on *Striga* control among smallholder farmers across three districts: Kisumu West, Busia and Teso South of Western Kenya. A multistage sampling technique was used to select the locations and farmers to be interviewed. A semi structured, open and closed ended questionnaire was administered leading to field experiment. Besides village meetings (39.2%), farmers got informed on farming methods under *Striga* weed farms and its control technologies through neighbours (2.5%), workshops and trainings (5.0%), field schools (3.7%), media (7.5%) and extension agents (10.8%). The attitudes of farmers towards *Striga* control varied but frequently cited: long term viability of the *Striga* seed (12.5%), difficult to control sharing of farm tools (10.8%), expensive technologies (13.3%), lack of adequate information (18.3%), labour intensive (15.0%), large farms for use of push and pull technology (1.7%) and time consuming (12.5%). Framers used various *Striga* control practices but traditional methods (25%) were among the most used (25%). Concerted effort involving researchers, extension agents and private sector are, therefore, required for wide scale dissemination and adoption of the existing modern control technologies.

Key words: Attitude, knowledge, practice, striga control technologies.

1. Introduction

Maize, a staple food for most households in Kenya, is grown on both large and small-scale farms in almost all agro-ecological zones. Smallholder farmers take over 80% of the land under maize but produce over 70% of the total production [1]. Average farm sizes for maize production continue to shrink due to increasing rural population. This consequently negatively affects the production of maize. Production is also constrained by low soil fertility due to continuous cropping [2] and nitrogen deficiency [3] with no replenishment of mined nutrients. This is in addition to pests such as stem borers and parasitic weeds, particularly *Striga* [4, 5].

Striga weed hinders the efforts to attain food security and economic growth in the continent. Nearly 300 million people in sub-Saharan Africa are adversely affected by *Striga* weed, and up to 50 million hectares of crop lands in the continent show varying degrees of *Striga* infestation [6]. *Striga* weed infestation causes 30%-100% loss in maize yield in Eastern Africa [7-9]. In Kenya, *Striga* weed infestation is most severe in Siaya, Vihiga and Busia Counties. The parasitic weed

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is found in about 75,000 hectares of farmland and results in crop losses estimated at about US$10-38 million per annum [10]. Lately, yield losses of over 80% have been attributed to *Striga* weed [11]. As a result, some farmers abandoned their fields or switched to production of other crops such as cassava and sweet potatoes [12].

In response to the threat and effects of the weed, several methods of *Striga* weed control have been developed but farmers have not adopted them to any appreciable extent [5, 13]. The reasons for non-adoption include poor farmers' economic conditions which are below the cost of the required *Striga* control technologies together with the non-availability of economically feasible and effective technologies that are adapted to these conditions [14]. Besides the efficacy of a technology, the severity of existing constraints determines the decision to invest in a technology [15, 16]. Against this back drop, an evaluation of farmers' knowledge, attitude and practices on *Striga* weed control techniques among smallholder farmers of Western Kenya was conducted for informed dissemination and subsequent adoption of new *Striga* control technologies.

2. Materials and Methods

The study was conducted in Kisumu West, Busia and Teso South districts of Western Kenya. The districts fall under ecological zone IV [17]. The three districts have slightly varying climatic conditions with annual rainfall ranging between 800 mm to 2,000 mm, average temperatures range between 14 °C and 34 °C in January and 14 °C and 30 °C in July, altitude range between 1,216 m and 1,520 m. The soil varies across the region and comprises of *Ferralsols* (Busia), *Vertisols* (Kisumu West) and *Nitosol* (Teso South) [18]. A multi-stage sampling technique was applied to select the study sites that represent diverse ecological and socio-economic conditions and varying farming systems in the moist mid-altitude districts. This involved selecting a district, then narrowed down to a division, keeping in mind that the divisions selected should be highly infested with *Striga* than others. At the division level, also a district heavily populated with striga was considered. At that point, the villages and the farmers to be interviewed were randomly selected. The sampling size was done by proportion in line with the population size of the location based on Cochrane formulae [19]. A total of 120 farmers were interviewed using a semi structured questionnaire in the study. Data collected from the field were edited (reviewing data, completeness checking and error detection) and coded then analysed for means, descriptive statistics, correlations and tables, using SPSS, Version 17.0. Chi square test at $P < 0.05$ was applied to determine the relationship between measured parameters.

3. Results and Discussion

3.1 Demographic Characteristics

There were similarities of responses among the farmers across the districts in relation to age, sex of the household, marital status and occupation (Table 1). About 68.3% of the farmers interviewed practiced farming as the main economic activity. Mixed farming was the dominant farming system in the districts. The farming fraternity was evenly distributed across the district but Kisumu West showed many (12.5%) being employed. This was due to existence of institutions and organizations at Maseno town and Kisumu city that provided room for employment. This is also in agreement with a past survey conducted in Ref. [20], who found that most households (about 76%) in the study areas were farmers.

Most of those practicing farming fell between ages of 36-55 years old, comprising of 48.3%, whereas 36.7% are aged between 18-35 years old, and 15% above 55 years old. Busia district had the largest number of those from 36-55 years old and Kisumu district showed those with 18-35 years old being many. This shows that the youths were getting involved into farming unlike in the past where the majority of farmers were above 55 years. The youths

Table 1 Percentages of farmer's occupation against their age and marital status in the districts.

Occupation and district		Age of respondent			Marital status of HH head					Total
		18-35	36-55	> 55	Married	Divorced	Widow	Widower	Single	
Farmer	Kisumu West	6.7	8.3	3.3	15	0	5	0	0	20
	Busia	7.7	13.3	5	20	0	5	0	0	25
	Teso South	12.3	9.2	2.5	22.5	0	0.8	0	0	23.3
	Total	26.7	30.8	10.8	57.5	0	10.8	0	0	68.3
Employed	Kisumu West	4.2	5	3.3	10.8	0	1.7	0	0	12.5
	Busia	0	5	0	4.2	0	0	0	0.8	5
	Teso South	2.5	4.2	0	4.2	0.8	0.8	0	0.8	6.6
	Total	6.7	14.2	3.3	19.2	0.8	2.5	0	1.7	24.2
Both farmer and employed	Kisumu West	0.8	0	0	0.8	0	0	0	0	0.8
	Busia	0.8	0.8	0.8	2.5	0	0	0	0	2.5
	Teso South	0.7	2.5	0	0.8	0.8	0.8	0.8	0	3.3
	Total	2.5	3.3	0.8	4.2	0.8	0.8	0.8	0	6.6
Business man/woman	Kisumu West	0.8	0	0	0.8	0	0	0	0	0.8
	Busia	0	0	0	0.8	0	0	0	0	0
	Teso South	0.8	0	0	0	0	0	0	0	0.8
	Total	1.6	0	0	1.6	0	0	0	0	1.6
Total	Kisumu West	13.3	13.3	6.7	26.7	0	6.7	0	0	33.3
	Busia	8.3	19.2	5.8	27.5	0	5	0	0.8	33.3
	Teso South	15.1	15.8	2.5	27.5	1.7	2.5	0.8	0.9	33.3
	Total	36.7	48.3	15	81.7	1.7	14.2	0.8	1.7	100

ought to be encouraged further since they were good in technology understanding, adoption and implementation. Most (81%) of the households were married. There were more women headed household in Kisumu West district than in Busia and Teso South, as reflected by widowhood data. In a separate study, Manyong [21] reported that the highest number of female-headed households which was reported in Siaya district of Nyanza province could have been as a result of high incidence of HIV/AIDS and out-migration of youths. However, in this study, no data was available to attribute the high incidence of women headed households in Kisumu West to HIV/AIDS related widowhood.

In all districts, 58% of the interviewed farmers were men and 42% were women giving a better representation of gender. This was a good indication that decisions on farming issues were mostly made by both couples but in case of widows and widowers, decision was by household heads. Thus, females were also involved in decision making at the house hold level. The past result by Ndufa et al. [22] shows that household heads were either monogamous or polygamous, i.e., 50% of the households were monogamous male-headed household, 16% polygamous male-headed household, 4% female headed household absentee husband, 17% monogamous female-headed household widow and 11% polygamous female-headed household widows in Western Kenya.

The study area showed that about 50% of the farmers had primary education, 35% had acquired secondary education and 15.8% tertiary education. Only 3.3% of the farmers claimed to have never gone to school. Unlike the findings of Ndufa et al. [22] who found out that about 10% of the farmers were illiterate while the majority of the farmers had acquired primary education. This level of illiteracy has gone down due to the fact that the government has introduced free primary education to all forcing even the "old" people to seek education.

3.2 Farming Activities of Farmers in Western Kenya

The main crops grown were maize, sorghum, finger millet and beans with 92% of the farmers growing maize alone or alongside other crops (Table 2). The major cash crops were sugarcane and tobacco. Most crops were, however, grown as both cash and subsistence crops, but in most cases subsistence given that most farmers hold small farmers meant to grow crops to be consumed by the family. Studies in Refs. [23, 24] showed that the major cash crops are sugarcane, tobacco and cotton. Most of the other crops serve a dual purpose as cash and subsistence crops, but mainly subsistence. Also, Hearne [25] showed that maize was both subsistence and a commercial crop in Kenya grown on an estimated 1.4 million hectares by large-scale farmers (25%) and smallholders (75%).

Livestock kept were mainly indigenous cattle (64.2%) and chicken. This is because the community recognizes their economic gain (milk and eggs). Other livestock kept included, sheep, goats and pigs. Earlier reports in Refs. [23, 24] also showed that livestock comprised mainly local breeds of cattle (zebus), chicken, sheep and goats pre-dominated the smallholder farming systems.

3.3 Farmers' Knowledge on Striga Weed Control

The farmers displayed unparallel led knowledge on *Striga* weed in regard to its life span, differences among the existing species, the host plants and *Striga* menace, although this was not captured in the questionnaire but was seen to be very important information to be discussed since it came from most of those farmers interviewed. This is mainly due to the long term prevalence and adverse effects of *Striga* weed in their farms. Ref. [21] showed that respondents had the correct perception about the damage *Striga* could cause to maize yield, the reasons could be the high incidence of pest and diseases in the sampled villages.

Farmers in the study sites mentioned various pathways of agricultural information and dissemination (Fig. 1) either at group levels or household level. Besides village meetings (45.9%), farmers also got informed through neighbours (2.5%), who were good implementers of technologies, through attending free workshops and trainings (5.0%), field schools (3.3%), media (7.5%) from extension workers belonging to both international and local NGOs, Ministry of Agriculture and Kenya Agricultural Research Institute (10.8%). This information trend cuts across the districts.

Village meetings were an important (45.9%) source of information, probably because most people prefer attending these meetings than any other organized meetings that are held to discuss and address human rights and security issues with farming issues being relegated to the periphery. Little information was got from neighbours probably because of poor communication and the self-interest of farmers. Debrah et al. [14] also found that the major source of farmers knowledge on *Striga* was informal (personal observations, relatives, parents and other farmers) with only 10% of the farmers getting knowledge from formal sources (research, extension and media).

Most farmers (81%) were aware of the mode of spread of *Striga* seeds and thus explained it easily. They identified the agents of *Striga* weed dispersion (Fig. 2) as: wind (25.8%), animals (25%), farm implements (10%) and water runoff (6.7%).

Water runoff was rated least because most farms have gentle slopes and hence experienced less soil erosion. Wind and animals dominated the dispersal means because farm crops are harvested at the time when the *Striga* weed had flowered and some at the seed forming process thus easily dispersed. Since, in grazing management animals are left to wander from one farm to another, they move along with the *Striga* seeds. The seeds that are not dispersed by animals are

Table 2 Percentages of farmers growing crops, the purpose of crops and keeping animals in the districts.

Crops	Percentage (%)	Animals kept	Percentage (%)	Purpose of growing maize	Percentage (%)
Maize	92.0	Cattle	64.2	Own consumption	49.6
Sorghum	40.8	Poultry/chicken	83.3	Commercial	1.6
Finger millet	12.3	Goat	35.0	Both consumption and commercial	48.8
Soybeans	32.5	Sheep	20.8		
Common beans	30.8	Pig	15.8		
Ground nuts	1.8				
Tobacco	3.5				

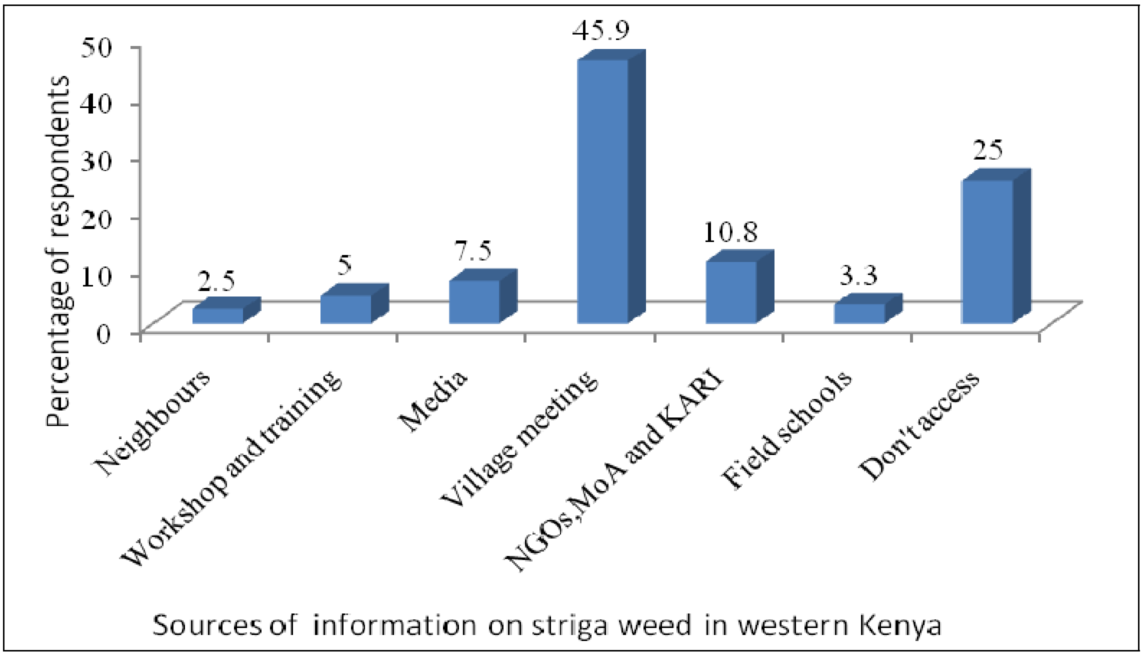

Fig. 1 Information sources on *Striga* weed control and technologies.

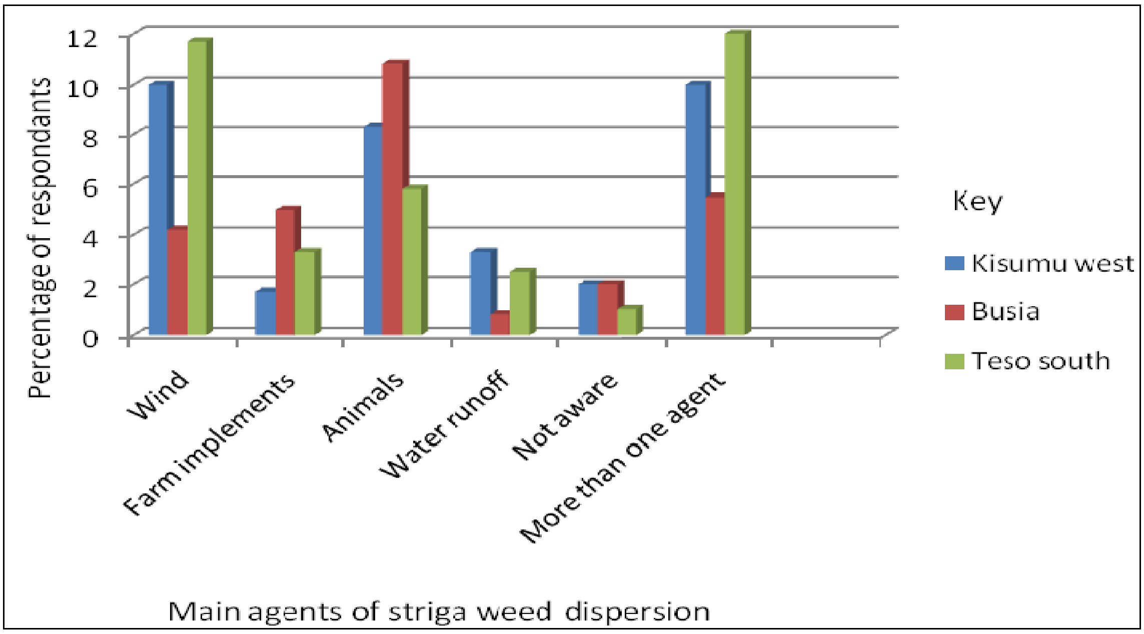

Fig. 2 Major *Striga* weeds dispersion modes in the districts of Western Kenya.

usually blown by wind to the neighboring fields. Oswald [5] and Hearne [26] also found that the major agents of seed dispersal were human beings through tools used for land preparation and weeding and animals during grazing.

Most farmers belonged to social groups. It was noted that those who attended group meetings were better placed to get new information's regarding farming and other trainings. It is also through attending these group meetings that farmers arranged for study tours and sites for demonstration plots/field schools. Since men were reluctant to join social groups, they miss most of the information passed through the groups and yet they are the most dependable members of household on decision making.

A recent study by Odhiambo et al. [27] showed that women farmers learnt more willingly from men resource persons while men were reluctant to learn from women groups. It was further reported that men were more recognized as trainers than women, also they might have more available time for follow ups and consultations than women. Besides, women farmers registered higher adoption rates (70%) compared to 30% in men [28]. Given that the illiteracy level was high, where majority (45%) of farmers have gone up to primary level of education, the knowledge passed is forgotten easily before the farmer implements on the farm since no record or notes are taken and thus poor ways of implementation may be adopted.

3.4 Farmers Attitude towards Striga Control Technologies

Farmers ranked *Striga hermonthica* (72.1%) as the first and soil fertility as second major hindrance to cereals production. This was followed by pests and diseases, input acquisition and lastly drought (Fig. 3).

Striga was ranked first as it comes with devastating effects that farmers have longed to overcome, among their yield losses. Study by Hassan et al. [29] showed that *Striga* was still the number one constraint for Western province while low and erratic rainfall was for Nyanza. Probably, the reason for the high ranking of this climatic factor in Nyanza was because the survey was conducted at the period when there was a severe drought.

Farmers attitude on *Striga* were differently expressed by the respondents (Fig. 4). Farmers understood that *Striga* weed seeds had a tendency of staying in the soil for longer periods before losing their viability and would sprout once a cereal (host plant) becomes available. This attitude is killing the efforts of 13%, of the study population. Study by Odendo et al. [30] showed that the constraints reported were declining soil fertility, high *Striga* infestation and vagaries of weather (drought, unreliability and hailstones), poor infrastructure and poor marketing.

Lack of enough money to purchase farm implements such as hand hoe and ox-plough had necessitated 11% of the farmers to share farm tools with their close and even far away neighbours leading to the spread of the weed from one farm to the other. Ref. [1] showed that the most attitudes farmers develop in *Striga* control are in line with lack of farm tools, low soil fertility, lack of financial resources to purchase inputs and the active nature of *Striga* seed over time.

About 13% of the respondents noted that some technologies like push and pull and use of striga resistant maize were too expensive for small scale farmers. The cost can be traced right from the implementation stage to the final stage. Lack of adequate information (18%) about specific technologies was another factor that contributed to the low technology adoption. Most of the information farmers needed existed but in forms farmers cannot access. As argued by Asfaw et al. [31] awareness in technology transfer is very important. In most of the adoption cases in developing countries, adoption is hampered by lack of awareness of the end users of the technologies. Farmers' awareness about the available improved varieties is, therefore, critical in the adoption programme.

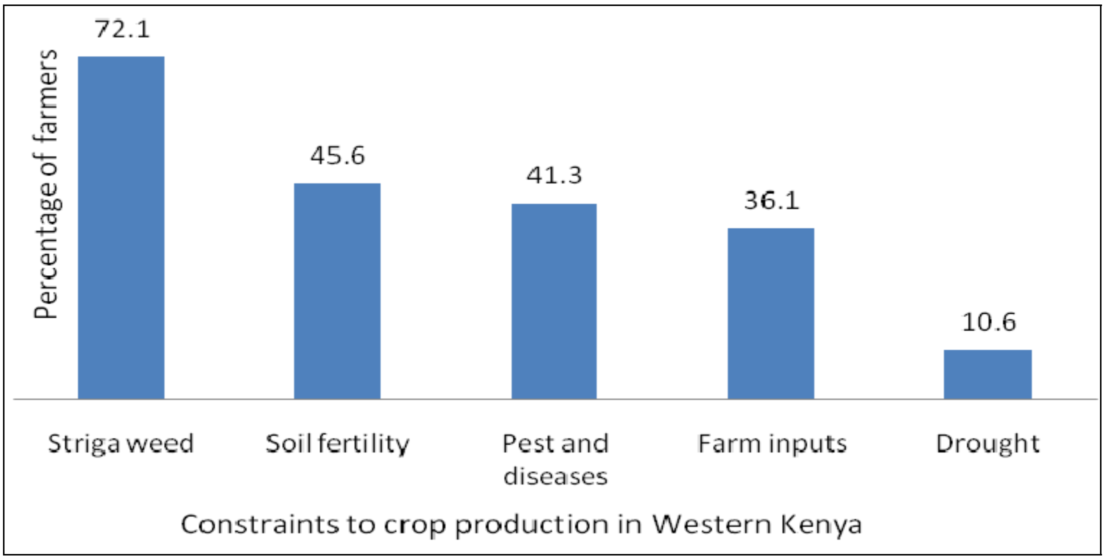

Fig. 3 Factors that hinder maize production in three districts of Western Kenya.

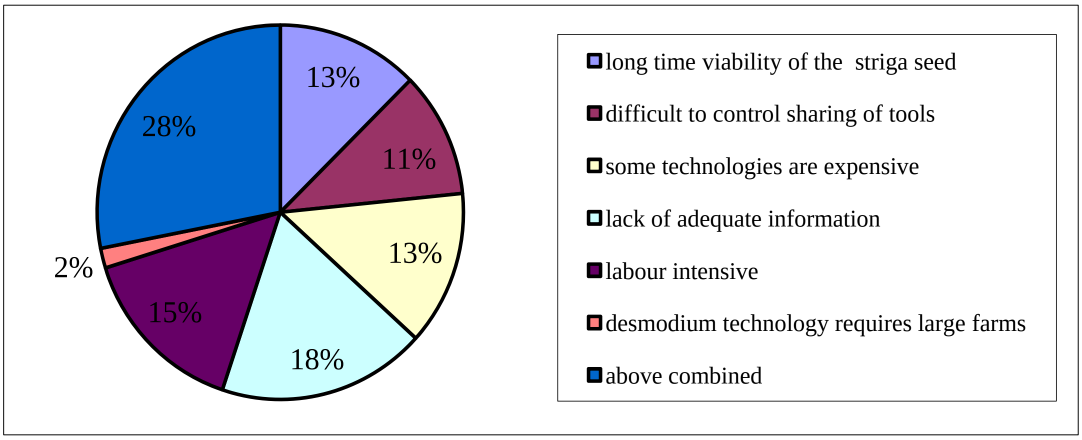

Fig. 4 Farmers' attitudes towards *Striga* control technologies.

Most of these technologies (weeding and uprooting) required labour (15%), both hired and family labour for effective control of the weed. Families with few members were unlikely to adopt technologies that were labour intensive unless where they could pay for hired labour. This was also noted in the past research, where large households had the capacity to relax the labour constraints required during the introduction of new technologies [32].

A small number of farmers (2%) had tried intercropping desmodium with maize but abandoned it because the system required more land, i.e., at least 25% of an acre to be able to implement effectively. This makes those with small farms to shy away from the technology. The technology required livestock to feed on the desmodium, but given that farmers have small farms with no or very few animals thus the farmers see no use of having desmodium in their farms. Studies by Khan et al. [33, 34] showed that the push and pull strategy for integrated pest management had shown that fodder legumes (*Desmodium uncinatum* and *D. intortum*) intercropped with maize to repel stem borers reduced *Striga* infestation in Western Kenya.

3.5 Striga Control Technologies and Practices in Western Kenya

About 67.5% of the farmers did not use the existing

Striga control technologies (Fig. 5). This is because most farmers preferred to use cheap means rather than engaging in expensive methods that will not provide complete solution. *Striga* resistance maize seed was used by very few (3.3%) farmers as opposed to 65.8% of the farmers who used hybrid non resistant maize seed. Farmers reported that the *Striga* resistant seeds were only available in few shops. About 2.5% of the farmers reported that *Striga* resistant maize seeds had a problem with germination in some areas and with heavy rains the chemical coated on the seeds was easily lost.

According to a survey by Odendo et al. [30], about 80% of the respondents predominantly grew local varieties, whilst only 20% grew improved maize varieties, often in addition to the local varieties. The Imazapyr-resistant maize (IRM) technology, though introduced on a large scale in 2004 only 28% of the sampled households in Western Kenya adopted it and the reasons for this low adoption were unclear [35]. Also, Odendo et al. [27] further indicated that farmers were willing to buy new varieties that were resistant to *Striga* if availed as long as the price was equal to current market price of other commercial maize seed.

Intercropping was another technology used by farmers, mostly farmers intercropped maize and beans or sometimes with soybeans and groundnuts but this was not done consistently. The intercropping of maize followed by cassava was a technology used by 1.7% of the respondents. This is because farmers are not persistent in case of any crop failure in the previous season would like to try different crops without examining the root cause of the problem. A study in Ref. [36] showed that intercropping maize with legumes between the rows significantly reduced *Striga* numbers when compared to maize grown as pure stand. Odhiambo and Ariga [37] further proved that these using on-farm trials which showed that planting maize and beans in the same hole, in *Striga* infested farms increased maize yields by 78.6% in Western Kenya.

Push and pull technology, promoted by International Centre of Insect Physiology and Ecology (ICIPE), involves intercropping cereals like maize and sorghum with desmodium. Desmodium roots produce chemicals that stimulate germination of *Striga* seeds, but then prevent them from attaching successfully to maize roots. The *Striga* eventually dies and the number of seeds in the soil is also reduced. This was another technology that farmers reported to be using on their farms. Besides, the benefits brought by this technology, few (2.5%) farmers have adopted it. This has been largely attributed to the big farm that the technology requires and that one is forced to keep livestock in order to enjoy the full benefits of the technology. According to Khan et al. [38], those farmers who adopted push and pull technology had positive impact to *Striga* control. About 19% of the farmers in the villages under assessment had adopted “push-pull”, citing the technology’s ability to address the major cereal production constraints concurrently as the main attraction.

Traditional technologies (25%) such as uprooting only, uprooting and burning and uprooting then removing from the field were the most used technologies by farmers to control *Striga* in maize. These methods were commonly used since they were affordable and easily done. Labor was the only resource required, with farmers depending mostly on family labour as well as hired labour which was sometimes lacking. Due to labour constraints, these traditional technologies were either applied once or twice thus not effective for better yields.

Most (47.5%) of the farmers used uprooting to get rid of *Striga* in their farms (Fig. 6). This was for the fact that *Striga* weed sprouted evenly, to occupy a large area within a short time, after the host plant had emerged from the ground therefore uprooting becomes effective on young *Striga* seeds. This practice also targets on the weed areas unlike weeding where the digging must be done in areas where weeds have not grown. Weeding was practiced by 4.2% of the farmers.

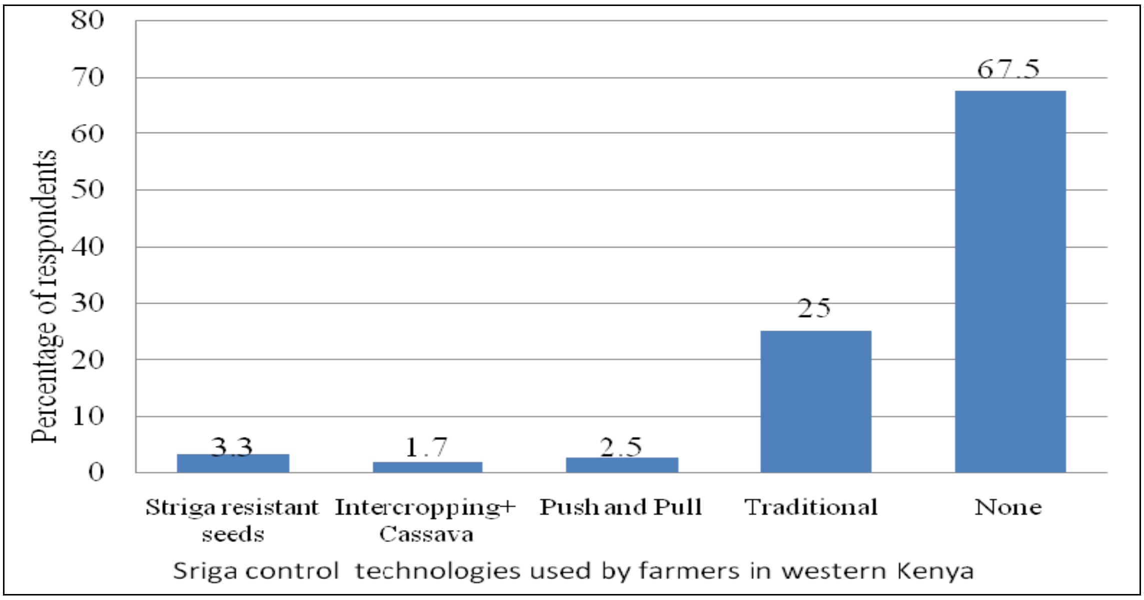

Fig. 5 ***Striga* weed control technologies used by farmers in Western Kenya.**

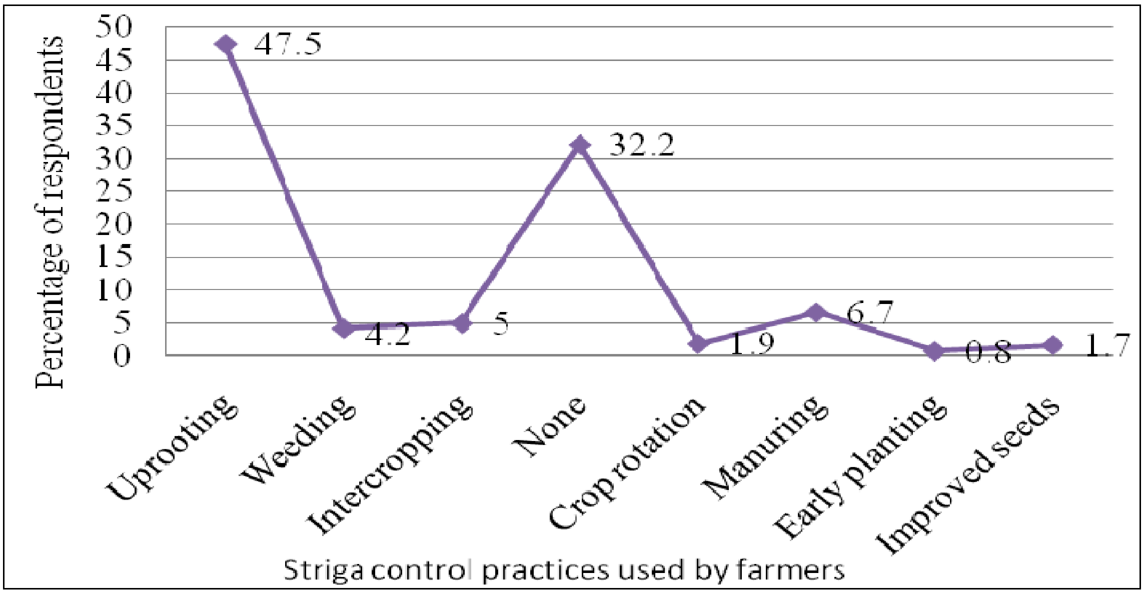

Fig. 6 **Farmers' *Striga* control practices in Western Kenya.**

These are mostly farmers who can afford hired labour or have enough family labour.

Other cultural practices were: manuring (6.7%), intercropping (5%), crop rotation (1.9%), improved seeds (1.7%) and early planting (0.8%). Manuring and intercropping rated high, this had been contributed through training and field days that farmers do attend. These methods are good remedies to *Striga* control if integrated with *Striga* control technologies. The practices can as well improve the soil texture and moisture. A study by Vanlauwe et al. [11] showed that manuring, crop rotation and intercropping also helped in improving soil fertility and enhancing soil health and quality besides weed control.

Early planting was practiced by 0.8% of the farmers to thwart the growth pattern of the weed so that by the time the weed emerges the crops would have grown to the stage where they were able to resist the effects caused by the weed and thus high yield may be expected. Manyong et al. [21] found uprooting of

Striga weed to be the most common used (more than 80% of respondents). Manuring was the second while burning appeared to be an uncommon control method. Suri [39] in their preliminary findings noted that farmers depended on cultural practices like closed season and planting non-host plants.

4. Conclusions and Recommendations

The study revealed that farmers perceived *Striga* weed to be a big menace and major cause of cereal yield losses in their farms. It was also found that the most common source through which farmers got information was village meetings. The meetings comprised of other agendas, thus, do not provide full details of alternative *Striga* control options. Full adoption of *Striga* control technologies is likely to increase farm yield, meet family food and income needs and improve soil fertility if access to information include seminars and workshops for farmers, on farm demonstrations and trainings, field visits and use of brochures' translated in local language understood by farmers. Farmers showed different attitudes towards the exiting *Striga* control technologies and that was the key reason as to why the technologies were not adopted and implemented by farmers. These attitudes included, in order of highest to lowest, lack of adequate information by farmers, followed by labor intensive and expensive technologies, long time dormancy and viability of *Striga* seeds and large farms needed for the case of push and pull technology.

More than five modern *Striga* control technologies were in existence in the study area. The results showed that they are not used by farmers but instead farmers prefer using traditional methods which were not result best oriented. The adoption of technologies like, use of *Striga* resistant maize, intercropping followed by cassava and push and pull technology were to improve farmer's livelihood if fully implemented for a longer period because it brings crops and animals on board. This suits in a mixed farming situation to which most farmers belong.

Despite the farmers' knowledge of the devastating effects of *Striga*, their control strategies vis-à-vis the many technologies that had been developed to control the weed were limited. Concerted efforts involving researchers, extension agents and private sector are required for wide scale dissemination and adoption of the already developed *Striga* control technologies. To develop successful *Striga* control technologies in the area, focus should be on those factors that affect farmer's decision to adopt technology. These factor are technological knowhow, capital/credit access, information barriers and attitudes and social and cultural aspects, putting into consideration escalating poverty and small farms holding, which continue to escalate as a result of farm sub-divisions.

Acknowledgments

The authors acknowledge Alliance for Green Revolution in Africa (AGRA) for supporting the studies of the first author. Special thanks goes to the International Institute of Tropical Agriculture (IITA) and the Swedish University of Agricultural Sciences (SLU) for their additional support, made possible through funding from Sida/FORMAS and the Swedish Ministry of Foreign Affairs in their special initiative on food security (UD40). Last but not least, tribute to the district agricultural officers in Busia district, administration offices in Kisumu west district, KARI-Alupe in Teso South district and all farmers who voluntarily expressed their views.

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