Original Research Article

DEMOGRAPHIC AND SOCIOECONOMIC FACTORS INFLUENCING UPTAKE OF STRIGA WEED CONTROL TECHNOLOGIES IN KENYA

1.1 ABSTRACT

Over the years, new technologies have been tested and introduced to control Striga in maize producing areas but adoption has remained low. The study done in 2013, determined the demographic and socioeconomic factors that influenced the adoption of Striga control technologies in Kisumu West, Bumula and Teso South sub counties of Western Kenya. Through Multi stage sampling technique, 40 households were selected per sub county for questionnaire administration; to gather information on demographic profiles of the sample population, type of fertilizer and seed variety used, income of the household, source of credit facilities and challenges faced in weed control. Chi square test at $P<0.05$ and logistic regression analysis, using R software was used to determine the relationship between demographic and socioeconomic factors and uptake of Striga control technologies. Farmers cited high cost, poor availability of improved varieties and lack of adequate knowledge as reasons for non-adoption of the Striga control strategies. Farmer's age, education, land size, and hiring of labour were found to significantly influence the adoption of the Striga control technologies. The low levels of adoption of modern technology indicate that they were not meeting farmers' expectations, thus, researchers should put into consideration farmers' education, age, land size and ability to high labour in their planning for an informed technology adoption. In addition, alternative options should be extended to farmers who are not able to use expensive technologies.

Key words: Social-economic factors, Striga control technology, Technology adoption.

1.2 INTRODUCTION

Striga and stem borers are among the major biotic constraints to increased maize production in eastern Africa (Khan et al., 2003). The other constraints involve labour requirement in the season and low soil fertility (Odhiambo et al., 2001). In western Kenya, there is increasing evidence that Striga is the main constraint to increased food production, food security and poverty reduction (De Groote et al., 2007; Kanampiu et al., 2006; Manyong et al., 2008; Woomer and Savala, 2007).

Recommended control methods to reduce Striga infestation have been established, although seriously limited by the reluctance of farmers to adopt them, for both biological and socio-economic reasons (Lagoke et al., 1991). Determination of decision to use improved technologies by farmers has been described as a complex one involving first whether to adopt or not and secondly the level of the use of the technology (Sall, 2000). Several authors (Rogers, 1983; Neupane et al., 2002) have proposed a theoretical model where farmers first go through a stage of awareness or being knowledgeable of a new technology to forming a positive or negative attitude about a technology and ultimately deciding whether to adopt a technology or not.

Several adoption studies concentrate on cross sectional analysis of the determinants of agricultural adoption at the farm level (Mwangi et al., 1998; Doss, 2003). For instance, the CIMMYT studies in Kenya and other East African countries (Mwangi et al., 1998; Doss, 2003) examined adoption decision processes for maize seed and fertilizer technologies and showed that farmer characteristics such as age, gender, and wealth are keys to adoption decisions. Suri (2011) showed that technology profitability, farmers' training as well as observed and unobserved differences among farmers and across farming systems were the major determinants affecting maize technology adoption in Kenya. A comprehensive understanding of the farmers' behaviour on adoption of technologies in diverse agro-ecological and socio-economic environments is therefore necessary to design appropriate strategies to harness potential benefits in the target areas (Shiyani et al., 2000). This study aims at identifying factors that hinder adoption in order to provide efficient recommendation on the best scientific approaches that can be employed to effectively improve their farm fertility levels and control of Striga weed.

1.3 MATERIALS AND METHOD

1.3.1 Site description

The study was conducted in Kisumu and Busia County (Kisumu West, Bumula and Teso South sub counties), in western Kenya. The Sub Counties fall under ecological zone IV (Jaetzold and Schimdt, 2005), with varying climatic conditions and annual rainfall ranging from 800 mm to 2,000 mm and average temperatures ranging between 14° to 34°C in January and 14° to 30°C in July. Most farming activities follow the rainfall patterns. The annual rainfall is bimodal in nature with long rains commencing in February to July while the short rains come in August to October. The altitude ranges from 1,216 to 1, 520 m above sea level (Mariara et al., 2007).

1.3.2 Study approach

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 Sub Counties. This involved selecting sub counties, then narrowed down to a divisions/ wards, keeping in mind that the divisions selected should be highly infested with striga than others. At the division level, also a sub location heavily populated with striga was considered. At that point the villages and the farmers to be interviewed were randomly selected.

1.3.3 Sampling size

The sampling size was done by proportion in line with the population size of the location based on Cochrane formulae (Cochran, 1977).

Cochran's formula

$$SS = \frac{Z^2 * (p) * (1-p)}{c^2}$$

Where:

Z = Z value (e.g. 1.96 for 95% confidence level)
p = percentage picking a choice, expressed as decimal (0.5 used for sample size needed)
c = confidence interval, expressed as decimal (e.g., 0 .04 = ±4)

1.3.4 Data collection methods

Two methods of data collection namely household interviews and Key Informant Interview (KII) were used. Key data collected using the questionnaires included; demographic profiles of the sample population, type of fertilizer and seed variety used, income of the household, source of credit facilities and type of services obtained from Non-Governmental Organizations and government institutions.

1.3.5 Data analysis

Data collected from the field were edited to correct mistakes, coded and recorded. Data were analyzed using R software to generate descriptive statistics, means and logistic regression. Chi square test at $P<0.05$ was applied to determine the relationship between the key data collected.

1.4 RESULTS AND DISCUSSION

A total of 120 farmers interviewed were represented by, 58% men and 42% women, giving a better representation of gender. 40 farmers were randomly picked from each Sub County. A total of 24 farmers were interviewed in Maseno division, 16 in Kombewa division, 20 in Matayos division, 20 in Township division, 20 in Amukura division and 20 in Chakol division. The results were categorized in key sub-objectives and were outlined in 1.4.1 and 1.4.2.

1.4.1 Non availability of Striga resistant maize seeds and fertilizer use

Non-availability of Striga resistance maize seeds was reported by 30.8% of farmers as a constraint to adoption. Improved maize seeds were popularly grown by farmers compared to local seeds (Table 1); 65.8% of respondents used improved seeds with Teso South and Bumula Sub County having majority of farmers. Local breed are mostly used by farmers in Kisumu west Sub County, followed by Bumula. A small population, which is almost negligible use both local and hybrid maize in all the sub counties. Teso South and Bumula had adopted the use of hybrid maize based on the existence of KARI-Alupe that provides technical advice to farmers as well as carrying out participatory field experiments of which farmers got to learn of the existing maize varieties.

Table 1: Farmers (in percentage) growing different maize varieties in Western Kenya.

Sub Counties of respondent	Commercial/hybrid	Local	Both local and hybrid
Kisumu west	9.2^{bB}	19.2^{aA}	5.0^{aC}
Bumula	24.2^{aA}	8.3^{bB}	0.8^{bC}
Teso South	32.5^{aA}	0.8^{cB}	0.0^{cB}
Totals	65.9^{A}	28.3^{B}	5.8^{C}

Mean values marked with same small letters within a column indicate no significant differences among the sub counties, mean values marked with same capital letters within a row indicate no significant differences among maize varieties ($p > 0.05$, ANOVA, LSD test).

In Kisumu West, farmers preferred to use their own (local) seeds referred as Nyamula/nyamilambo, which were obtained from previous harvests. This is because the local varieties were cheaper and more readily available. This is in addition to their capacity to withstand Striga weed pressure in comparison to hybrid maize.

The results are not in agreement with those obtained Manyong et al. (2008), that showed farmers mostly plant local maize seeds and the quantities of maize seed used by farmers often vary from those recommended by the extension service providers. For IR maize the average seed quantity per hectare was 27 kilogram, that is 2kg above the recommended 25kg/ha. The worst situation was for the local maize where farmers put in more than 35kg/ha. A study conducted by Vanlauwe et al. (2015), showed that the potential way of reducing Striga damange is by use of tolerant/resistant varieties and surface mulch. The varieties may also depend on the accessions used (Sattler et al., 2017).

All farmers in the study area use inorganic fertilizer on their farms (Table 2). Inorganic fertilizers were mostly preferred by many farmers while organic manure (animal wastes) use alone accounted for 20% of the farmers, thus we focused and presented data on inorganic fertilizers. From the findings, more than half (58%) of the farmers use below 2 bags of inorganic fertilizer which is far below the recommended rates (an equivalent of 2 bags per acre not hectare). De Groote et al. (2005) showed that although the number of farmers using fertilizer has increased, the average amount used has gone down dramatically where only in the moist transitional zone, do farmers use more than 100 kg/ha, while in all other zones the average dose was less than 30 kg/ha. The sub optimal levels could be because of the inability of the farmer to purchase high costly inorganic fertilizer (Suri 2006). Misko et al. (2011), suggests the use of more fertilizers should go hand in hand with improvement of soil properties for better results to be realized by farmers.

The number of farmers who don't know the amount of fertilizer they apply is wanting, 14% is a number that shows some are not accountable in maize farming and are not regarding the activity as income generating or business.

Table 2: Farmers (in percentage) using different rates of fertilizer in western Kenya

Sub County	<1.0 bag/ha	1.1-2.0 bags/ha	2.1-3.0 bags/ha	3.1-4 bags/ha	4.1 -5 bags/ha	>5 bags/ha	Don't know
Kisumu west	17.5	2.5	2.5	0.0	0.0	0.8	10.0
Bumula	5.0	10.8	5.8	3.3	0.8	5.8	1.7
Teso south	12.5	10.0	2.5	0.8	0.8	4.2	2.5
Total	35.0	23.3	10.8	4.1	1.6	10.8	14.2

One bag = 50kgs

The main constraints regarding use of inorganic fertilizers were lack of knowledge on the recommended rates, high cost of fertilizers especially during planting time, a perception of sufficient soil fertility and lack of cash or credit (Ariga and Jayne 2012; Kanampiu et al., 2018).

These findings are in contrary to those of Suri (2006) who reported that the use of inorganic fertilizer and hybrid seed was minimal and intermittent with only a small proportion of farmers indicating ever using these inputs. Suri (2006) and Duflo et al. (2008) reported that less than 30% of farmers used fertilizer and seed with many switching back and forth between use and non-use of fertilizer and hybrid seed. The husbandry practices in use are founded on 'blanket recommendations' i.e. recommendations derived from secondary information and research work in distant locations or on basis of regional soil surveying and agro ecological zoning for a given crop and area or soil type (Titonell et al., 2008).

1.4.2 Socio-Economic Factors influencing adoption of Striga control technologies

Determination of relationships between variables and the adoption (dependent variable) was carried out using logistic regression analysis.

1.4.2.1 Farmer's Age

Based on the regression analysis, the age of the farmers was significantly correlated (0.026) to the technology use and thus influenced technology adoption. The farmer's ages as outlined in Nambafu et al., 2014, showed 36% of the farmers were below 35 years, thus the youths may have a direct influence on choice, adoption and use of a particular technology and this can lead to farmers being innovative and ready to initiate change. Young farmers are likely to be attracted to technologies that are self driven, clean and highly profitable while old farmers can easily adopt simple or less complex technologies. In addition, it is known that some technologies needs physical labour input and thus correlates well with young and middle aged farmers who are challenged with labour hiring. Our study shows that, young farmers are likely to adopt Striga control strategies for they are easily shifted into using of technologies and innovative ideas that may control a problem. In western Kenya striga is still a menace based on the fact that most of the farmers are old and highly resistant to try new technologies or those that may seem to be complex to them. The choice of technology should go easy to understand, practice and not time consuming (Kanampiu et al., 2018).

The importance of age in influencing adoption is also in agreement with several studies (Ayuk, 1997; Salasya et al., 1998; Lapar and Pandey, 1999; Gockowski and Ndumbe, 2004) but also disagrees with many other studies (Odera et al., 2000; Iqbal et al., 2006). Farmers' age had been found to increase as well as decrease the probability of adoption. Older farmers who had more experience in the use of available soil nutrient management technologies are in a better position to assess characteristics of new technologies than younger farmers (Odera et al., 2000). On the other hand, Barham et al. (2004) argued that younger farmers are more receptive towards newly introduced technologies than older farmers.

1.4.2.2 Education Status

There was a significant correlation (0.01) between age and striga weed technology adoptions. Majority of farmers (about 45.5%) have a lower level of education having gone up to primary level (Fig. 1). Kisumu West and Teso South Sub County had the highest number of farmers with secondary education while majority of those with tertiary education came from Kisumu West.

Education levels influenced decision-making. Well-educated farmers are more acquisitive, hence access and assimilate information better and are therefore more likely to adopt Striga weed control strategies. None educated farmers however can't follow the right procedure or measure when it comes to technology implementation unless they participate in the demonstrations physically

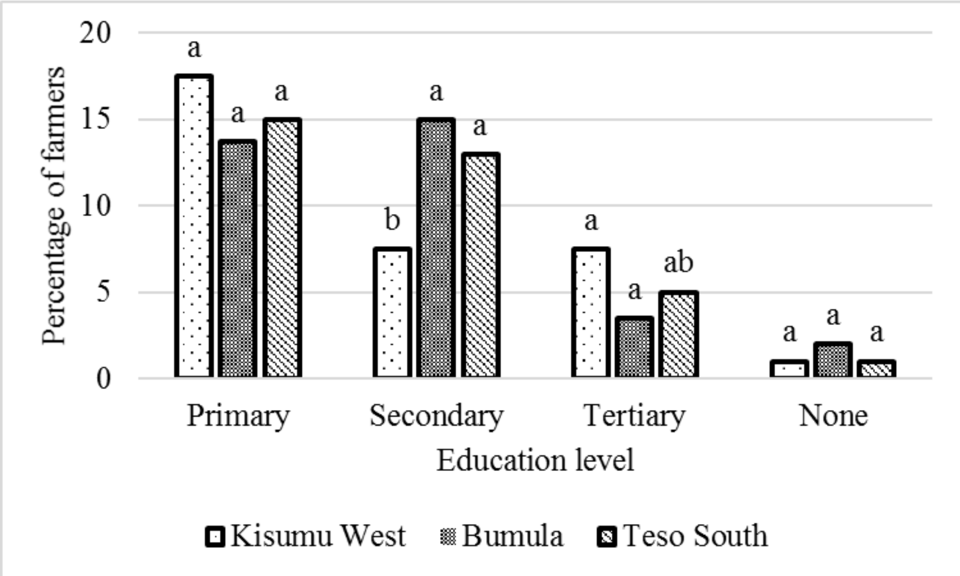

Figure 1: Distribution of education levels (in percentage) of farmers in Western Kenya.

Mean values marked with same small letters within education levels indicate no significant differences among the Sub Counties ($p > 0.05$, ANOVA, LSD test, n = 4).

During trainings the low educated farmers takes long to comprehend some facts and thus end up being discouraged on a method or technology they are trained on. Past researches, reported that education goes hand in hand with technology adoption. Thus educated farmers have been found to b In the study area, the education level was found to be significantly influencing adoption of technologies (0.01). Salasya et al. (1998), however found that households with secondary school education were less likely to adopt an improved variety which was attributed to preference for clean jobs. Nonetheless, others have also found that schooling had a positive impact on the adoption of fertilizer (De Groote et al., 2005). In Laikipia and Suba Sub Counties of Kenya, Mwabu et al. (2006) found that the price of maize, education level, and distance to the roads were the main determinants of hybrid maize adoption by farmers. Since, Ongachi et al. (2017), found that amalgamation of farmer field school and video mediated learning significantly influenced adoption of striga control technologies, this calls for farmers to have formal education in order for the approach to yield fruits, thus education is a critical measure in today's farming unlike in the past.

1.4.2.3 Labour availability

Most farmers (75.8%) hired labour for land preparation, planting, weeding and harvesting (Table 3). The study further revealed that 35.8% of the farmers depended on hired labour for up to 9 months of the years. This sometimes led to shortage of labour during peak months especially when planting and weeding begins. Use of hired labour increases opportunities to undertake other farm activities.

Table 3: Number of farmers (in percentage) who hire labour and months they depend on hired labour.

Percentage of farmers hiring labour			Percentage of farmers who high labour in respect to months				
Sub County	Yes	No	First 3 months	6 months in a row	9 months	Througho ut the year	Don’t no/ don’t use
Kisumu West	26.6	6.6	3.4	8.8	10.8	3.4	6.7
Bumula	25	8.3	5.8	5.9	11.7	1.8	8.3
Teso South	24.2	9.2	2.5	5	13.3	3.4	10
Total	75.8	24.2	11.7	19.7	35.8	8.6	24.2

The ability to hire labour is also an indicator of wealth and hence increases probability of adoption. For proper control of Striga weed by weeding or up-rooting it has to be done 3-4 times in a season, but due to labour shortage a farmer does it once or twice in a season.

Despite the fact that family labour exists in some house hold, it is not reliable because children go to school during day time when farm work ought to be done. Although some may be available during the weekend it was seen that they get engaged in other chores like fetching for firewood and water, looking after animals and general cleanness in the house. Women are also looked upon us providers of labour in the house hold but they carry a big burden on their backs. Statistics show that the number of members involved in full time farm activities and those partially involved significantly affected technology adoption.

The results are in agreement with Ayuya et al. (2011) who found that, large households had the capacity to relax the labour constraints required during the introduction of new technologies. Suri (2011) showed that technology profitability, farmers’ training as well as observed and unobserved differences among farmers and across farming systems were the major determinants affecting maize technology adoption in Kenya, while Okuro et al. (2000) showed that the ability to hire labour and months in a year a household bought food were found to be significantly 10% probability level influence adoption. The importance of labour in influencing adoption also agrees with findings of Keil (2001) who found adoption of improved fallows of leguminous trees to increase with increasing availability of labour.

1.4.2.4 Farm size and Cultivation methods

Most of the farmers live in small pieces of land (Table 4). Nearly a half of the respondents had farm size between 0.51-1.2 hectares of land (24.2% in Kisumu West, 23.3% in Teso South and 20.8% in Bumula). Only about 6% of the farmers in the three Sub Counties had farms large than 2.0 hectares. The small land size is based on the subdivision into small portions depending on the number of children the then head of the family sired. The subdivision will further continue in future, as the children of the current heads of the family become adults. Thus, the size of land is likely to reduce with time. Oswald (2005) also reported that the average farm sizes will continue to shrink due to increasing rural population and consequently affecting production of maize.

Table 4: Proportions of land size owned by farmers (in percentage) in Western Kenya.

Sub Counties of the respondent	**Land size**	**Percentages**
Kisumu West	< 0.5ha	5.8[b]
	0.51-1.2 ha	24.2[a]
	1.21 -2.0ha	1.7[c]
	2.1-4.0 ha	1.7[c]
	>4.0 ha	0.0[d]
Bumula	< 0.5ha	3.3[c]
	0.51-1.2 ha	20.8[a]
	1.21 -2.0ha	7.5[b]
	2.1-4.0 ha	1.7[d]
	>4.0 ha	0.0[e]
Teso South	< 0.5ha	2.5[c]
	0.51-1.2 ha	23.3[a]
	1.21 -2.0ha	5.0[b]
	2.1-4.0 ha	0.0[d]
	>4.0 ha	2.5[c]

Mean values marked with same small letters within a column indicate no significant differences among the farm sizes, ($p > 0.05$, ANOVA, LSD test, n = 4).

This has been as a result of land inheritance hence subdivision. The size of the farm can influence the ability to adopt a technology. Small farms are easily manageable and thus those with small pieces of land have greater ability to use the technology that needs close watch and even expensive ones than those with large farms. Although past research contradicts by asserting that having a large land contributes to perceived security and increased willingness to invest in new technology (Caveness and Kurtz, 1993). Cultivation methods go hand to hand with land size; mixed cropping, prolonged fallow and crop rotation which reduces the effect of striga on yield (Midega et al., 2016) are dependent to land size.

1.4.2.5 Access to credit facilities:

Half of the farmers (50%) did not have access to credit facilities (Table 5). Those who can access credit listed table banking (18.3%), micro finance institution services (15.8%), private money lenders (9.9%) and banks (4.9%) as the main sources of credit. The first two were the most preferred because their services are gotten within the social groups that they belong to within the region.

Table 5: Farmers (in percentage) who get access to credit sources in Western Kenya

Sub County	Source of credit					Total
	Table banking	Micro finance	Private lenders	Others (bank)	Don't get	
Kisumu West	5.8	5.0	3.3	2.5	16.7	33.3
Bumula	5.0	5.0	5.0	1.6	16.7	33.3
Teso South	7.5	5.8	1.6	0.8	17.5	33.3
Total	18.3	15.8	9.9	4.9	51.9	100

Banking was the least as the interests attached is always high hence unmanageable for farmers given that farming is an unpredictable business. The accessibility to credit facilities increases the chances of farmers either adopting a technology or not. Given that the credit was obtained from social groups showed that, the money was not enough for farmers to adopt modern Striga control technologies. Studies by Dorward et al. (1998) and Morduch (1999) showed that a few microfinance institutions in Africa had interest in providing loans to support smallholder agricultural production, because the seasonal nature of agricultural cash flows does not fit well with their current strategies for ensuring loan repayment. Hence they consider such lending to be too risky. Also, Ndufa et al. (2005) findings showed that a majority of farmers who got fertilizer on credit applied the nutrients to maize. Access to fertilizer (technology) through credit increased maize yield by 694 kg/ha when used alone and 762 kg/ha when inorganic fertilizer was combined with organics and this is likely to reduce the manifestation of striga weed by two fold in striga prone areas (Kanampiu 2018).

1.5 CONCLUSION

The education level, age and land size were the major factors seen to influence the adoption of Striga weed control technologies. Education and age were critical because they play a big role in decision making and choice of the best Striga control strategies. Given that a majority of farmers had low level of education in the representative Sub Counties, simple practical oriented and quick to take home technologies should be initiated for ease of adoption. The young people are now involving themselves in farming due to limited job options and should be taken advantage of by decision makers and planning. For them (young) to be fully drawn into the system, clean and non-manual technology should be the way to go. Since most house-holds had less than 1.5 hectares of land, which may still dwindle with time. Farmer should be encouraged to adopt farming as a business in order to maximize farm profits that will make technology adoption easier and inexpensive.

1.6 REFERENCES

Ariga J and Jayne S.T (2012). Factor driving the increase in fertilizer use by smallholder farmers in Kenya.

Asfaw A. and Admassie A. (2004). The role of education on the adoption of chemical fertilizer under different socioeconomic environments in Ethiopia. Agric. Econ., 30: 215-228.

Ayuk E.T. (1997). Adoption of agroforestry technology. The case of live hedges in the central plateau of Burkina Faso. Agricultural systems 54:189-206.

Ayuya O.I., Lagat J.K. and Mironga J.M. (2011). Factors Influencing Potential Acceptance and Adoption of Clean Development Mechanism Projects: Case of Carbon Trade Tree Project among Small Scale Farmers in Njoro District, Kenya. Res. J. Environ. Earth Sci., 3(3): 275- 285.

Berner D.K., Kling J.G. and Singh B.B. (1995). Striga research and control: a perspective from Africa. Plant Dis. **79**, 652–660.

Cochran W.G. (1977). Sampling Techniques. John Wiley & Sons: New York, pp.74-76

Debrah S.K., Defoer T. and Bengaly M. (1998). Integrating farmers' knowledge, attitude and practice in the development of sustainable Striga control interventions in southern Mali. Agronomy Journal 35-136

De-Groote H., Wangare L. and Kanampiu F. (2007). Evaluating the use of herbicide-coated imidazolinone resistant (IR) maize seeds to control Striga in farmers' fields in Kenya, Crop Prot., 26: 1496-1506.

Dorward A., Kydd J. and Poulton C. (1998). Cash Crop Production under Market Liberalization: A New Institutional Economics Perspective. Wallingford: CAB International.

Doss C. (2003). Understanding farm level technology adoption: Lessons learned from CIMMYT's Micro surveys in East Africa. CIMMYT Economics working paper, CIMMYT, D.F, Mexico City.

Duflo E., Kremer M. and Robinson J. (2008). How High Are Rates of Return to Fertilizer? Evidence from Field Experiments in Kenya; American Economic Review. 98, 482-488.

Gockowski J. and Ndoube J. (2004). The adoption of intensive horticulture in Southern Cameroon.

Iqbal S.M.M., Ireland C.R. and Rodrigo V.H.L. (2006). A logistic analysis of the factors determining the decision of smallholder's farmers to intercrop. A case study involving Rubber-tea intercropping in Srilanka. Agricultural Systems 87: 296-312.

Jaetzold R. and Schmidt H. (1983). Farm Management Handbook of Kenya. Part B: Rift Valley and Central Provinces. Ministry of Agriculture, Republic of Kenya, Nairobi, Kenya.

Kanampiu F., Makumbi D., Mageto E., Omanya G., Waruingi S., Musyoka P., Ransom J. (2018). Assessment of Management Options on Striga Infestation and Maize Grain Yield in Kenya. Weed Sci 66:516–524. doi: 10.1017/wsc.2018.

Kanampiu F.K., V. Kabambe, C. Massawe, L. Jasi, D. Friesen, J.K. Ransom and Gressel J. (2003). Multi-site, multi-season field tests demonstrate that herbicide seed-coating herbicide resistance maize controls Striga spp. and increases yields in several African countries. Crop Protection 22 (5):697-706.

Keil A. (2001). Improved fallows using leguminous trees in Eastern Zambia. Do initial testers adopt the technology? MSc. Thesis George-August University of Goettingen. Faculty of Agriculture Institute of rural development Goettingen, Germany.

Khan Z.R., A. Hassanali J.A. Pickett L.J. Wadhams and Muyekho F. (2003). Strategies for control of cereal stem borers and striga weed in maize-based farming systems in eastern Africa involving 'push-pull' and allelopathic tactics, respectively. African Crop Science Conference Proceedings, Vol. 6. 602-608.

Lagoke S.T.O., Parkinson V. and Agunbiade R.M. (1991). Parasitic weeds and their control methods in Africa. In: Combating Striga in Africa, 3–14 (Ed S. K. Kim). Ibadan, Nigeria: International Institute of Tropical Agriculture.

Lapar M.L.A. and Pandey S. (1999). Adoption of soil conservation: the case of Philippine uplands. Agricultural economics 21:241-256. Maize stem borers in Uganda. International Journal of Tropical Insect Science, 26, 71-77.

Manyong V.M, Nindi S.J, Alene A.D, Odhiambo G.D, Omanya G, Mignouna H.D and Bokanga M. (2008). Farmer Perceptions of Imazapyr-Resistant (IR) Maize Technology on the Control of Striga in Western Kenya.

Mariara J.K. and Karanja K.F. (2007). The Economic Impact of Climate Change.

Midega A.O.C., Pickett J., Hooper A., Pittchar J., and Khan R.Z. (2016). Maize Landraces are Less Affected by Striga hermonthica Relative to Hybrids in Western Kenya. Weed Technology 2016 30:21–28.

Misiko M., Tittonell P., Giller E. K and Richards P (2011). Strengthening understanding and perceptions of mineral fertilizer use among smallholder farmers: evidence from collective trials in western Kenya. Agric Hum Values (2011) 28:27–38 DOI 10.1007/s10460-010-9264-z.

Mwabu G., Mwangi W., Nyangito H. (2006). Does adoption of improved maize varieties reduce poverty? Evidence from Kenya. Poster paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18, 2006, p. 15.

Mwangi W.M., Lynam J. and Hassan R. (1998). Current Challenges and Strategic Future Choices for Maize Research and Policy in Kenya, In: Hassan, R. (ed.). Maize Technology Development and Transfer: A GIS Application for Research Planning in Kenya, Wallingford: CAB International, UK. [http://www.escholarship.org/uc/item/9666220j.pdf].

Nambafu N.G., Onwonga N.R., Karuku N.G., Ariga S.E., Vanlauwe B and Roing de Nowina K (2014). Knowledge, Attitude and Practices Used in the Control of Striga in Maize by Smallholder Farmers of Western Kenya.

Ndufa J.K., Cadisch G., Poulton C., Noordin Q. and Vanlauwe B. (2005). Integrated Soil Fertility Management and Poverty Traps in Western Kenya.

Neupane R.P., Sharma K.R. and Thapa G.B. (2002). Adoption of agroforestry in the hills of Nepal: a logistic regression analysis. Journal of Agricultural Systems 72, 177-196.

Nkamleu G.B. and Adesina A.A. (2000). Determinants of chemical input use in peri-urban lowland systems: Bivariate Probit analysis in Cameroon. Agric. Syst., 62: 1-11.

Odera M.M., Kimani S.K. and Musembi, F. (2000). Factors influencing adoption of integrated use of manure and inorganic fertilizer in central highlands of Kenya. In Proc 7 th Biennial conference eds Mukisira EA, Kiriro FH, Wamuongo JW, Wamae LW, Muriithi FM and Wasike W. Kenya Agricultural Research Institute Head quarters, Nairobi, Kenya 45-55.

Odhiambo G.D. Agundan J. and Oswald A. (2001). Development and diffusion of integrated Striga control practices for small-scale farmers in western Kenya. CGIAR Program on Participatory Research and Gender Analysis for Technology Development and Institutional Innovation.

Ongachi W., Onwonga R., Nyanganga H., Okry F. (2017). Comparative Analysis of Video Mediated Learning and Farmer Field School Approach on Adoption of Striga Control Technologies in Western Kenya. Int. J. Agr. Ext. 05 (01) 2017. 01-10.

Rogers, E. (1983). Diffusion of Innovations, 3rd ed. New York: The Free Press.

Salasya B.D.S. Mwangi W., Verkuijl H., Odendo M.A. and Odenya J.O. (1998). An assessment of adoption of seed and fertilizer packages and the role of credit in smallholder production in Kakamega and Vihiga Districts, Kenya. CIMMYT. Kenya Agricultural Research Institute.

Sall S., Norman D., Featherstone A.M. (2000). Qualitative assessment of improved rice variety adoption: the farmer's perspective. Agricultural systems 66 (2):129-144.

Sattler F.T, M.D. Sanogo, I.A. Kassari, I. I. Angarawai, K.W Gwadi, H. Dodo and Haussmann B.I.G (2017). Characterization of West and Central African accessions from a pearl millet reference collection for agromorphological traits and Striga resistance. Plant Genetic Resources: Characterization and Utilization (2018) 16(3); 260–272, doi:10.1017/S1479262117000272.

Suri T. (2011). Selection and Comparative Advantage in Technology Adoption, Econometrica, 79 (1), pp. 159-209, January 2011.

Tittonell P., Vanlauwe B., Corbeels M. and Giller K. E. (2008). Yield gaps, nutrient use efficiencies and response to fertilizers by maize across heterogeneous smallholder farms of western Kenya. Plant Soil. 313, 19–37.

Vanlauwe B., Descheemaeker K., Giller K.E., Huising J., Merckx R., Nziguheba G., Wendt J., and Zingore S. (2015). Integrated soil fertility management in sub-Saharan Africa: unravelling local adaptation. SOIL, 1, 491–508, 2015 www.soil-journal.net/1/491/2015/ doi:10.5194/soil-1-491-2015.

Woomer P.L and Savala C.N. (2007). Striga Management through Herbicide Resistance: A Public-Private Partnership in Action. AAAE Conference Proceedings. pp. 489-496.