Gender appropriateness of field days in knowledge generation and adoption of push-pull technology in eastern Africa

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ABSTRACT

Adoption studies have identified gender as one of the factors that determine technology uptake and this has been linked to women's access to farming information or lack of it. Technology scaling up systems should utilise pathways that are compatible with the needs of rural women, who have to juggle farming with other household chores. Unfortunately, there has been limited effort to evaluate the suitability of the information pathways used to specific gender. The current study evaluates the appropriateness of field days with respect to gender of the participants. Data were collected from selected farmers who attended field days in Kenya, Uganda and Tanzania in 2014. A total of 2 615 participants were interviewed out of 6 221 who attended field days. Descriptive analysis and ordered probit and logit models were used for analysis. The majority of the participants in Kenya and Tanzania were women (51.3% and 62.6%, respectively), whereas in Uganda the majority of participants were men (57.4%). Most participants were middle aged (42 years for women and 45 years for men). The majority of the women (54.1%) had primary level education, with only 29.1% having secondary education, whereas 41% and 40.1% of men had attained primary and secondary education, respectively. The results from the econometric models shows that gender, age, education, being push-pull farmers, perceptions on Striga severity were the main significant determinants of knowledge for the ordered probit. Conversely, gender of the participant, perception on stemborers and Striga weed severity and having mobile phones were the significant determinants of willingness to adopt. The two models were significant at 1% ($p < 0.001$). The significance of the gender variable in the two models shows that women farmers understood more about push-pull (coefficient of ordered probit = −0.112) when trained during field days. Furthermore, the willingness to adopt push-pull after the training was much higher for women (coefficient of logit = −0.367) compared with men. The findings demonstrate that field days can be more appropriate for training farmers, especially women who are often disadvantaged in information access, as a result of their socio-economic circumstances.

KEYWORDS

econometric models; knowledge accumulation; rural women; socio-economic circumstances; Striga; technology uptake

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Introduction

Research addressing food insecurity in Africa has mainly focused on the main staple crops, specifically maize, which account for 40% of the calories consumed mainly by the poor most of who are women and children (Pingali 2001; De Groote 2002; Nyoro 2002). Maize production is faced with numerous challenges, whose effects have been chronic food shortages affecting many households in the rural areas. One such challenge has been the high prevalence of stemborers (mainly Chilo partellus Swinhoe and Busseola fusca Füller) and parasitic Striga weeds (mainly Striga hermonthica (Del.) Benth. and Striga asiatica (L.) Kuntze), which cause 20% to 80% and sometimes up to 100% of maize yield losses, respectively (Hassan et al. 1994; Kfir et al. 2002). Efforts by many research organisations both national and international have come up with scientific break-throughs, such as the "push-pull" technology, a productivity enhancing innovation, devel-oped and promoted by the International Centre of Insect Physiology and Ecology (icipe) in collaboration with other research organisations (www.push-pull.net) for the control of stemborers, Striga weed (Striga spp) and improving soil fertility. The "push-pull" technol-ogy is based on stimulo-deterrent strategy where companion crops release behaviour mod-ifying stimuli that manipulate the distribution and abundance of pests (Miller and Cowles 1990; Cook et al. 2007). It involves intercropping cereals and desmodium (e.g. Desmodium uncinatum (Jacq)) with Napier grass (Pennisetum purpureum Schumach) planted as a border crop around this intercrop (Khan et al. 2001, 2004; Midega et al. 2010). The des-modium repels stemborers moths (push), whereas the surrounding Napier grass attracts them (pull) (Khan et al. 2001). In addition, desmodium suppresses Striga weeds by means of a number of mechanisms, with allelopathy (root-to-root interference) being the most important (Tsanuo et al. 2003). Although the main objective of the push-pull programme is to improve food security and incomes among farming households, the potential food security impact would only be achieved when adoption of a new innovation is attained at scale (Murage et al. 2015).

Despite the existence of such modern agricultural technologies like push-pull, agricultural productivity in Africa continues to be rated low. This has partly been attributed to gender-related constraints and unequal access to productive resources and opportunities, which undermine the adoption of new technologies (World Bank, FAO and IFAD 2008; FAO 2011). Women represent a crucial resource in agriculture and the rural economy through their roles as farmers, labourers and entrepreneurs, yet they face more severe constraints than men in access to productive resources (Doss 2010). Despite their high participation in farming, women have lower access to productive resources and opportunities, which results in a high inefficiency of the agriculture sector. This is coupled by historical bias where agricultural development planners, deliberately targeted men for agricultural training, with the assumption that because they are the household heads, they make the main production decisions (Staudt 1977). Women have generally been marginalised in all aspects of agriculture. Ukpabi (2004) noted that agricultural extension services do not attach much importance to reaching women on farms, whereas policy makers, technology developers and administrators typically assume that men are the farmers and women play only a "supportive role" as farmers' wives. Conse-quently, whenever policies were made or technologies developed, men tended to be con-sidered as the only end users, with little or no consideration given to women. Nonetheless,

with the increasing number of women in farming, deliberate efforts should be made to strengthen equitable access to technologies and information for both men and women. Understanding the gender issues in technology generation and dissemination is therefore important. The term "gender" refers to the social construct of female and male identity and is defined as "more than biological differences between men and women". It includes the ways in which those differences, whether real or perceived, have been valued, used and relied upon to classify women and men and to assign roles and expectations to them (Definition by World Health Organization).

One of the main determinants of technology adoption has been recognized as the use of effective information dissemination pathways especially for "knowledge-based" innovations (Padel 2001). Doss (2001) noted that although adopting a new technology might increase household incomes, some threshold of information might likely have to attained before a farmer decides to adopt such new technologies. Several studies have pro-vided evidence on the importance of information access and particularly on the role of dissemination pathways in influencing technology adoption (Burton et al. 1999; Genius et al. 2006; Morone et al. 2006). It has also been shown that gender undeniably plays a major role in influencing adoption of new innovations and this has partly been ascribed to women's access to farming information or lack of it (Burton et al. 2003; Murage et al. 2011a). Looking at the socioeconomic settings of men and women, it is important to ensure that the dissemination pathways used are appropriate and allow equal access to technology information. Bridging the gap in access to technology between men and women could increase productivity. Doss (2001) noted that access to information and farmers' knowledge is correlated with gender and this has an impact on technology adop-tion. For example, Rees et al. (2004) reported that men preferred radio and extension sources of information, which resulted in their adoption of new innovations, whereas women did show this preference.

Therefore, although emphasis has been laid in developing technologies tailored to the roles of men and women in society, equitable access to information about such innovations has been lacking (Austin et al. 2001). Rural women face greater difficulties than men in gaining access to agricultural information, because they have less contact with extension services, sometimes occasioned by socio-cultural restrictions or simply because they lack the time to participate, because of their heavier workload (World Bank 2000; Winrock 2001). Given that there is an increase of women in the farming sector, gender mainstreaming in technology dissemination and the methods used is essen-tial for the success of technology adoption (Deere and León 2003). Unfortunately, many agricultural training programmes have largely been skewed to benefit men with limited efforts to evaluate their gender appropriateness.

For the case of push-pull technology, a number of approaches have been used (Khan et al. 2008b), among them the field days, which have been identified as one of the most effective and economic pathway in increasing its adoption (Murage et al. 2012). Field days are defined as day-long events common especially in rural agricultural extension during which interested farmers are invited to a particular field or plot and specific information about the technology are demonstrated and discussed (Lionberger and Gwin 1991). An earlier study by Amudavi et al. (2009) showed that farmers' propensity to seek new agricultural knowledge motivated them to attend field days and overall they favourably rated their effectiveness in information dissemination. Farmers who attended

field days in Western Kenya were able to start and manage push-pull gardens without getting additional on-farm demonstration (Amudavi et al. 2009). In other studies by Murage et al. (2011a, 2011b, 2012), field days were found to be the most preferred disse-mination pathway and their use led to quicker and higher adoption of push-pull technol-ogy. Although the studies by Amudavi et al. (2009) and Murage et al. (2011a, 2011b, 2012) provided useful insights into the relevance of using field days in push-pull up-scaling, they are geographically limited to western Kenya where push-pull was promoted at the time. With the adaptation and expansion of push-pull technology to other areas in eastern Africa, there is likelihood of socio-cultural diversity, which would limit the generalisation of the findings by these studies in the new areas. In addition, these studies were also limited in discerning the gender-appropriateness of field days among a diverse range of socio-cul-tural and geographical settings. The current study therefore evaluated the appropriateness of field days in the greater eastern African region, while giving focus to its relevance to gender. It additionally evaluated the determinants of farmers' knowledge and understand-ing of the messages delivered during the training sessions and their willingness to adopt push-pull dis-aggregated by gender. The findings of the current study will elicit farmer's feedback and help in guiding gender-related policies.

Methods

Sampling and data collection

The study used data collected during farmers' field day training conducted in 2014 in Kenya, Uganda and Tanzania. In Kenya, the field days were held in western region specifi-cally in Rachuonyo, Homabay, Rarieda, Siaya, Busia and Butere districts. In Tanzania, they were mainly done in the lake zone region specifically in Bunda, Tarime, Sengerema and Igunga districts, whereas in Uganda, they were conducted in Eastern region specifically in Tororo, Bugiri, Busia, Iganga, Mbale and Pallisa districts. The selected sites were gen-erally those areas where icipe was promoting the push-pull technology for the control of Striga and stemborers. During these open days, participants were required to register when they entered the sites. Using the attendance list, an average of 30 farmers per field day were randomly selected and were requested to fill a semi-structured questionnaire covering different aspects of the field day training with help of trained enumerators. Out of 6 221 field day participants in the three countries, 2 615 were sampled for the purposes of the current study (in Kenya, out of 4 067 participants, 1 863 were interviewed; in Tanzania out of 137 participants 73 were interviewed; in Uganda, out of 2 017 participants, 679 were interviewed). It is worth noting that in Tanzania, the dissemination efforts for push-pull technology was still at the initial stages, hence the small sample. However, because the dissemination process is continuous, it was necessary to elicit whether the field days were appropriate to the community in Tanzania or not, hence the inclusion of the sample. The interviews were done immediately after the field demonstrations at the field day site. The main information obtained from respondents was on age, gender, education level, land size and main sources of livelihoods. The researchers also solicited information on knowledge gained by participants after attending field days by answering several questions about push-pull operations. Furthermore, participants who had not taken up push-pull were asked whether they would be willing to try it later on after the

field day training. Farmers' perceptions on the effectiveness of the push-pull technology were also evaluated.

Model specification and data analysis

All the variables in the dataset were summarized using descriptive analyses and cross-tabulations disaggregated by gender. To evaluate the appropriateness of field days on knowledge generation, farmers were asked a series of eight (8) questions regarding their understanding of push-pull operations; to which they had to respond Yes or No. The responses obtained from these questions were used to generate a "knowledge score" repre-senting how farmers understood push-pull technology after the training. This overall score was recoded as 0 = not understood, 1 = fairly understood, 2 = understood and 3 = well understood, depending on the score obtained. To evaluate the appropriateness of field days in catalysing adoption, participants who were non-push-pull farmers were also asked whether they were willing to try push-pull technology after what they learnt from the field days for which they responded Yes or No. The generated variables were used for econometric analysis to evaluate the determinants of farmers' knowledge on push-pull and the willingness to adopt.

In the first scenario, the dependent variable of interest (farmers' knowledge and under-standing of push-pull during the field day training and their perception on its effective-ness) was ordinal and categorical in nature and an ordered probit model was used. An ordered probit model has been considered appropriate for analysing such categorical data in order to account for the ordinal nature of the dependent variable (Greene 2003). In the second scenario, the participants' willingness to adopt push-pull after learn-ing from a field day had a discrete dependent variable (0, 1); accordingly a logit model was considered appropriate (Greene 2003). In both models, the underlying latent variable is Y^*, which indexes the level of farmers' knowledge (for the ordered probit) and their will-ingness to adopt (for the logit) and this was modelled as a function of unknown par-ameters that are estimated in the models (β), the vector of farmer characteristics (X_i) and a stochastic error term (ε). The basic model is specified as follows (Greene 2003; Verbeek 2004):

$$Y^* = b'X_i + 1$$

For the ordered probit model, the latent variable Y^* exhibits itself in ordinal categories (coded as 0, 1, 2, 3); whereas in the logit model, Y^* is discrete in nature (0, 1)

In the case of ordered probit, the values for observed choice outcome Y_i are assumed to be related to the latent variable Y_i^* as follows:

$Y = 0 \Rightarrow$ not understood if $Y^* < \mu_o$, where $\mu = 0$

$Y = 1 \Rightarrow$ if poorly understood $0 \leq Y^* < \mu_1$

$Y = 2 \Rightarrow$ if understood $\mu_1 \leq Y^* < \mu_2$

$Y = 3 \Rightarrow$ if well understood $\mu_2 \leq Y^* < \mu_3$

where μ_i is unknown threshold parameter for outcome i that separate the adjacent bound-ary values and is estimated together with the βs. The estimated μ follows the order $\mu_0 < \mu_1 < \mu_2 < \mu_3$ (Greene 2003; Verbeek 2004). Using maximum likelihood estimates tech-nique, the values for the parameters β are estimated. To elicit causal relationship

between the explanatory variables and qualitative dependent choice outcome variable, computation of partial changes or marginal effects in the probabilities of an outcome for a given change in each dependent variable is conducted (Long 1997). Marginal effects measure the expected change in predicted probability associated with changes in the explanatory variables. The dataset was entered and managed using SPSS program. The econometric analysis was done using STATA statistical program.

Results and discussion

Field days participation by gender

Figure 1 shows the overall field day attendance by gender of the participant in each country. There was variation across countries in terms of number of participants by different gender. In Kenya and Tanzania, there were more female farmers attending field days (53.2% and 62.6%, respectively), whereas in Uganda, a higher percentage of the field day participants were men (57.4%). The results were not surprising, because observations made by World Bank (2000) indicate that women are taking over the farming sector particularly in Kenya. Indeed, Nambuya et al. (2005) noted that although women in Uganda were the main users of improved sorghum varieties, the majority of participants who turned up for the extension training were men. Dominance of men in controlling agricultural resources, including access to extension services is still being wit-nessed in some African countries (Jiggins et al. 1998), with the assumption that the infor-mation would trickle down to women in the household. This unfortunately has negatively affected women farmers' ability to maximize their productivity. There is requirement for more emphases on raising productivity of women farmers through enabling them to have equal access to efficient, effective and appropriate technology, training and information. This can be an effective engine for social change in sub-Saharan Africa (Jiggins et al. 1998). Because the role of women in African agriculture is already large and growing,

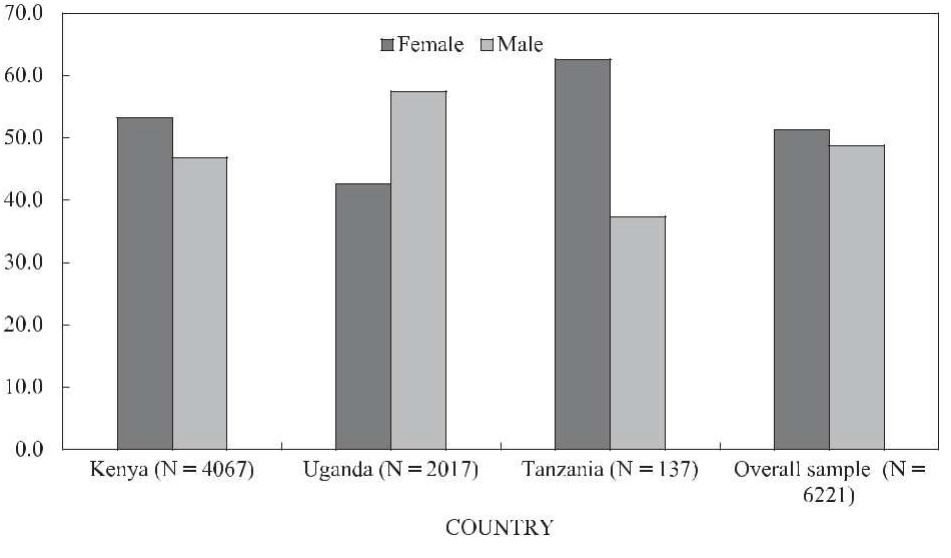

Figure 1. Field days attendance disaggregated by gender.

they have a key role to play in revitalizing agriculture, especially food production (Saito and Weidemann 1990).

In Table 1, the socio-economic characteristics of field day participants are listed. At least 54.1% of women had attained primary level education and 29.1% had secondary level education in the whole sample. Similarly, 41% and 40.1% of men had attained primary level and secondary level of education respectively. The percentage of farmers with no formal education was higher for women (10.2%) than for men (4.5%) implying that the illiteracy levels was higher among the women than men. Education is an instrument of enhancing people's general understanding of new concepts and this determines how quick a person can assimilate new knowledge (Saha 1994). The results of the current study clearly indicates that rural women in Africa are still left behind in terms of education levels and this is likely to affect their ability to understand complex messages that come with new innovations, particularly if such messages are packaged in a complex channel. This limitation makes women farmers even more vulnerable in development and exacerbates their inability to utilise new innovations, especially those that are knowledge intensive. In our view, the use of field days might be the most appropriate channel, because it offers simplified messages combining visual and hands-on training on the technology in question. Field days give farmers an opportunity to learn by seeing the performance of recommended practices adopted by other successful farmers, consequently offering an effective knowledge transfer mechanism to populations with low literacy rates (Rolling and Pretty 1997; Akinsorotan 2009). Farmers are able to discuss with fellow farmers and with facilitators about the new innovation being demonstrated. Indeed the results from the study by Murage et al. (2011b) indicate that less educated farmers preferred learning about push-pull from field days and Barrazas (public gatherings of people usually in the village to listen to the chief, village elders, politicians or government officials) compared with more the educated farmers who preferred print materials and radio.

The results show that 38.9% of women and 32.1% of men who attended the field days were push-pull farmers. This represents approximately a third of the sample population, implying that there were still many more new farmers attending field days to learn about the push-pull technology presenting a great potential for the program to up-scale the inno-vation intensively. The results further indicated that women were the greatest benefici-aries, because they were the majority. This corroborates earlier studies by Khan et al. (2008a), which noted that women were the main beneficiaries of push-pull technology and this was attributed to the fact that they (women) are worst hit by the Striga menace and were spending many hours weeding the crop. Most of the respondents

Table 1. Characteristics of farmers who attended field days in the three countries.

	Kenya		Tanzania		Uganda		All countries	
	Female	Male	Female	Male	Female	Male	Female	Male
Level of education (%)								
None	9.7	4.8	7.7	5.0	12.5	3.8	10.2	4.5
Primary	52.8	41.7	76.9	58.3	58.2	37.1	54.1	41.0
Secondary	30.9	40.1	7.7	25.0	22.8	42.1	29.1	40.1
Tertiary	6.6	13.4	7.7	11.7	6.5	17.0	6.6	14.4
Age of the farmer (years)	43.1	45.7	40.4	49.8	39.0	42.9	42.3	45.0
	(0.432)	(0.461)	(5.188)	(1.700)	(0.720)	(0.630)	(0.377)	(0.366)
Whether push-pull farmer (% Yes)	41.6	31.7	7.7	45.0	30.2	31.1	38.9	32.1

were between 42 years for females and 45 years for males, implying that the majority of participating farmers were middle aged. This is considered the most economically active and versatile group, which could result in a positive effect on crop production (Ogunbgile et al. 2002; Akinsorotan 2009).

Icipe's push-pull programme used diverse channels of creating awareness on field day training. One of the methods used to reach the farmers was by means of mobile phones. The study therefore sought to understand the ownership of mobile phones and how this could additionally be used to improve communication. The result shows that in the overall sample, 78.3% of the women and 76.3% of men who participated in the field days had mobile phones (Figure 2). The mobile phone revolution has been a unique development in agriculture sector, presenting an opportunity for growth by lowering information costs, reducing transport costs and providing a platform to deliver services and innovations. For example, farmers who owned mobile phones in Bangladesh acknowledged that their use had made it easy to overcome barriers of time and location and improved agricultural pro-ductivity (Islam 2011). In another study by Nyamba and Mlozi (2012), farmers in Tanzania asserted that mobile phones conferred diverse advantages as a communication link in iso-lated circumstances, because of its distinct feature of mobility. In addition, it helped them (farmers) to easily obtain agricultural information, such as market opportunities, better prices, input supply, management practices and weather. It could be deduced that mobile phones exhibit an easy way to mobilise farmers for training and this has positive implications in reducing advertisement costs, such as for field days. Besides, ownership of mobile phones has also made it easy for farmers to access information and is seen as a move to revolutionize agriculture. In Kenya, 84.5% of women and 83.1% of men owned mobile phones, whereas in Uganda, ownership of mobile phones was lowest with 54.7% of women and 60% of men owning mobile telephones and in Tanzania, 61.5% of women and 90% of men owned the mobile telephones. Additional research on this would elicit information on how different gender utilised mobile phones particularly for agricultural purposes.

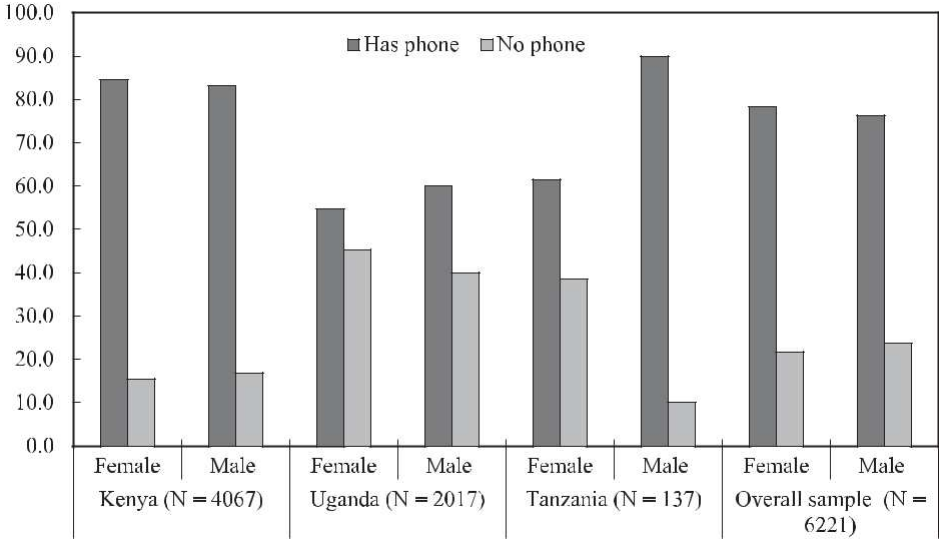

Figure 2. Percentage of field day participants with mobile phones disaggregated by gender.

Farmers' perception on Striga and stemborer constraints

Most of the participants in the three countries perceived Striga as a major problem and this was rated almost in equal measure by both men and women (Table 2). Overall, 98.9% of women and 98.3% of men responded to having Striga as a major problem. Indeed, all the respondents in Uganda and Tanzania (100%) stated that Striga was a major problem, as opposed to Kenya where 98.6% of women and 97.5% of men stated that Striga was a major problem. The majority of the respondents rated the infestation of Striga as very severe (46.6% of women and 45.5% of men). Similarly, stemborer infestation was said to be a problem by 83.8% of women and 84.6% of men, with the majority rating its severity as moderate (30.2% of women and 31.9% of men). The difference in the rating between men and women was significant at 10%. Earlier studies by Khan et al. (2008a) and Amudavi et al. (2009) described the severity of stemborers and Striga weed in most major districts as the main motivation in adoption of push-pull.

Perception and knowledge of push-pull technology benefits

Push-pull was rated as very effective by 86.3% of the female participants and 80.5% of the male participants in the overall sample and the difference was significant at 5% (Table 3). In Kenya, 94% of female and 89.4% of male participants rated the technology as very effective, followed by Uganda where 58.2% of females and 62.2% of males rated push-pull as very effective and Tanzania where the majority of the female participants (61.5%) rated the technology as moderately effective and 75% of the male participants rated it as very effective. This variation may be attributable to gender differences, which influences how women and men perceive certain attributes of the technology in view of their socioeconomic circumstances. In Kenya, there were more women involved in cereal farming activities especially in the sampled areas. These women suffered the most, as a result of Striga and stemborer infestations. However, the conventional methods used for controlling are ineffective and tedious, for example, hoeing by hand. The advent of push-pull technology was a reprieve for most women farmers, owing to reduced labour requirement, especially after the push-pull crops establishes. It is for this reason that women in Kenya are likely to view push-pull as more effective compared with men. Furthermore, men who managed gardens could gain access other methods,

Table 2. Farmers' perception of Striga and stemborers in their fields.

	Kenya		Tanzania		Uganda		All countries	
	Female	Male	Female	Male	Female	Male	Female	Male
Whether Striga a problem (% Yes)	98.6	97.5	100.0	100.0	100.0	100.0	98.9	98.3
Striga severity								
Not severe	2.2	3.0	0.0	0.0	0.0	0.0	1.7	1.9
Moderately severe	18.7	21.2	7.7	25.0	28.4	29.1	20.5	23.8
Severe	32.0	26.5	61.5	25.0	26.3	34.0	31.2	28.8
Very severe	47.1	49.3	30.8	50.0	45.3	36.9	46.6	45.5
Whether stemborer is a problem (% Yes)	82.1	81.7	84.6	91.7	90.5	89.7	83.8	84.6
Level of stemborer severity								
Not severe	16.8	17.1	15.4	5.0	9.5	9.6	15.4	14.3
Moderately severe	31.9	35.1	15.4	31.7	24.1	25.1	30.2	31.9
Severe	26.3	26.0	23.1	35.0	26.3	33.3	26.2	28.6
Very severe	25.0	21.8	46.2	28.3	40.1	32.0	28.2	25.2

Table 3. Farmers' perception and knowledge of push-pull technology after attending field days.

	Kenya		Tanzania		Uganda		All countries	
	Female	Male	Female	Male	Female	Male	Female	Male
[1]Perception about effectiveness of push-pull (%)								
Not effective	1.0	2.0	0.0	1.7	2.6	8.1	1.3	3.9
Effective	5.0	8.4	61.5	23.3	39.2	29.8	12.4	15.6
Very effective	94.0	89.6	38.5	75.0	58.2	62.2	86.3	80.5
[2]Level of understanding of push-pull from the field day (%)								
Not understood	1.1	1.3	30.8	8.3	4.3	4.0	2.1	2.4
Fairly understood	2.3	1.8	7.7	8.3	5.2	6.7	2.9	3.6
Understood	17.3	13.1	7.7	21.7	39.2	46.1	21.5	23.6
Well understood	79.4	83.9	53.8	61.7	51.3	43.2	73.5	70.4
Willingness to adopt push-pull technology after the field day (% Yes)	96.5	95.4	84.6	96.7	71.1	71.4	91.3	88.1

[1]Effectiveness of push-pull measure by answering the following:
- From what you have learnt today, how effective is push pull technology in Striga control
- From what you have learnt today, how effective is push pull technology in stemborers control
- From what you have learnt today, how effective is push pull technology in improving soil fertility
- From what you have learnt today, how effective is push pull technology in providing fodder
- From what you have learnt today, how effective is push pull technology in improving cereal yields

[2]Understanding score was measure by farmers answering the following:
- During this field day have you clearly understood how Striga affects your cereals crops?
- During this field day have you clearly understood how stemborer affects your cereals crops?
- During this field day have you clearly understood how Striga and stemborers affects your cereals crops?
- During this field day have you clearly understood how to harvest desmodium seeds?
- During this field day have you clearly understood how to process desmodium seeds?
- During this field day have you clearly understood Utilisation of push-pull fodder
- During this field day have you clearly understood Silage making (fodder preservation)
- During this field day have you clearly understood Desmodium hay making (fodder preservation)

such as chemicals, because they had access to other resources, as opposed to their women counterparts.

The majority of the field day participants expressed having well understood the contents trained during these open days. There was a higher understanding among the women participants with 73.5% of them saying they "well understood", whereas 70.4% of the men said that they "well understood". The percentage of women who said that they "well understood" was higher in Uganda (51.3% vs 43.2%), as opposed to Kenya and Tanzania where the percentage of men was higher (79.4% for females vs 83.9% males in Kenya and 53.8% for females vs 61.7% for males in Tanzania). The percentage of women who did not understand was highest in Tanzania where 30.8% of females expressed having not understood the field day contents (Table 3). This can be attributed to education levels amongst the women in the three countries. In Kenya, there were more women who had attained secondary school education compared with their counterparts in Uganda and Tanzania. Among the non-push-pull farmers who attended the field days, 91.3% of the women and 88.1% of the men were willing to adopt the technology after the training (5% significance level). Willingness to adopt was highest in Kenya, followed by Tanzania.

Determinants of field day participants' knowledge generation

Farmers' levels of knowledge generated by participating in field days can be influenced by their socio-economic characteristics. In the current study, gender, age, education, being

push-pull farmers, the perceptions on Striga severity were the main significant factors of knowledge level at 1% ($p = 0.000$) (Table 4). Age and gender were inversely related to the knowledge level (coefficients = −0.112 for gender and −0.003 for age). The marginal effects for the variable representing gender of the farmers were 0.005 for "not understood", 0.006 for "fairy understood" and 0.026 for "understood", compared with "well under-stood", which was dropped as the reference variable, implying that women exhibited higher level of understanding of the contents taught during field days compared with men. Traditionally, women are more involved in farming than men and this puts them on a higher platform to keenly follow the proceeding in any agricultural training as it is bound to benefit them more in their activities. In field days, the use of simplified messages benefited women farmers, particularly those with low education levels, thus restricting their understanding complex messages. Furthermore, field days give farmers an opportu-nity to share experiences with each other, which is more beneficial, especially to women, who prefer learning from their neighbours and early adopters (Rolling and Pretty 1997; Akinsorotan 2009; Murage et al. 2011b). Elsewhere, in Ethiopia, it has been shown that one of the strategies for improving productivity and market access was to encourage women farmers to participate in field days and promotional efforts (ILRI 2013).

The coefficient and marginal effect values for age shows an inverse relationship between the level of understanding and farmer's age. This means that younger farmers had a better understanding of the topics covered during the field days than the older farmers. This was not surprising, given that most of the participants were within the range of 40 to 45 years, which is relatively a young ageset. On one hand, it can be argued that modern technologies are adopted by younger farmers, because they are more likely to possess higher levels of education compared with the relatively older farmers, giving the younger farmers an edge in understanding complex messages (Murage et al. 2015). Alternatively, the young farmers are viewed to have a long planning horizon and are more commercially oriented. This would make them pay keen interest in agricultural training, because they would benefit more if they applied the knowledge gained in their future farming roles. Although older farmers are said to have authority or decision making autonomy, thus giving them advantage with respect to technology adoption (Rees et al. 2004), younger farmers have access to education and exposure making them receptive to information and subsequent change (Nkonya 1997). Njoku (1991) asserted that having formal education enhanced farmers' level of knowledge and adoption of new innovations.

The variables representing farmers with secondary education and tertiary education were positive and significant (coefficient = 0.141 for secondary education and 0.180 for ter-tiary education). The marginal effects were negative in all the three outcome levels (Table 4) compared with the base category of "well understood". Farmers with higher education expressed more understanding of the topics taught during the field days compared with those who had primary education (dropped for reference). Exposure to education increases farmers' ability to obtain process and use information relevant to the adoption of new technologies. Field day training allow farmers to learn by doing and can therefore be suitable even for farmers with low education levels. However, for knowledge-intensive technologies like push-pull, farmers with low or no education could find it challenging to understand some complex topics in a one days' training. This explains why the majority of farmers with low level of education exhibited low understanding of most of the topics taught. This corroborates the study by Nkonya (1997) who acknowledged that literate

Table 4. Factors determining the level of understanding of push-pull during field day training.

	Coefficients		Marginal effects[1]					
			Outcome 0		Outcome 1		Outcome 2	
Model variables	Coefficient	Standard error (SE)	dy/dx	Standard error (SE)	dy/dx	Standard error (SE)	dy/dx	Standard error (SE)
Gender of participants (0 = Female, 1 = Male)	–0.112***	0.053	0.005***	0.003	0.006***	0.003	0.026***	0.012
Age of the participants (years)	–0.003***	0.002	0.000***	0.000	0.000***	0.000	0.001***	0.000
[2]Participants with no education (0 = No, 1 = Yes)	0.033	0.101	−0.002	0.005	−0.002	0.005	−0.007	0.023
Participants with secondary education (0 = No, 1 = Yes)	0.141***	0.057	–0.007***	0.003	–0.008***	0.003	–0.032***	0.013
Participants with tertiary education (0 = No, 1 = Yes)	0.180***	0.087	–0.008***	0.003	–0.009***	0.004	–0.041***	0.019
Striga severity (0 = not severe, 1 = severe, 2 = very severe)	0.151***	0.030	–0.007***	0.002	–0.009***	0.002	–0.035***	0.007
Stemborer severity (0 = not severe, 1 = severe, 2 = very severe)	−0.005	0.025	0.000	0.001	0.000	0.001	0.001	0.006
Participants who are push-pull farmers (0 = No, 1 = Yes)	0.173***	0.054	–0.008***	0.003	–0.009***	0.003	–0.039***	0.012
Participants have a mobile phone (0 = No, 1 = Yes)	0.240***	0.056	–0.013***	0.004	–0.014***	0.004	–0.055***	0.013
/cut1	−1.628	0.134						
/cut2	−1.212	0.129						
/cut3	−0.172	0.126						
Number of observations	2 615							
LR Chi-square (9)	70.24							
Prob > Chi-square	0.000							
Pseudo R2	0.017							
Log-likelihood	–1 984.539							

[1] Outcome 3 (Well understood) used as the base category for comparison

[2] Primary level education used as reference variable

*** 1%, ** 5%, * is 10% level of significance

farmers were more likely to understand new ideas and concepts provided by extension agents and other informants, contrasted with illiterate farmers.

Farmers' perception on severity of Striga weed was also a positive determinant of level of knowledge of push-pull. The results show a coefficient of 0.151 and marginal effects −0.007 (for outcome 0), −0.009 (for outcome 1) and −0.035 (for outcome 2), implying that farmers who perceived the severity of Striga as "very severe" understood more about the topics, contrasted with those who perceived the Striga weed as less severe. It can be argued that farmers who perceived Striga as a very severe problem had a higher desire to learn more about the push-pull technology that could assist them in combatting this problem. Such farmers are likely to be keen during the training sessions, with the desire to go and implement the knowledge they acquired on their farms. In the current study, the majority of the farmers who expressed Striga to be a very severe problem were women (Table 3) and this probably explains why they had a higher level of under-standing about the technology. Indeed, Amudavi et al. (2009) acknowledged that farming constraints were among the key forces that stimulate farmer's participation in field days. A more recent study, Murage et al. (2015) observed that farmers who perceived Striga infes-tation as a serious problem on their farms were more willing to adopt climate-smart push-pull, set against those who did not perceive it as problem. This probably explains why such farmers would pay more attention and exhibit higher understanding after a day's training in a field day.

As would be expected, participants who were already push-pull farmers expressed higher knowledge of the technology after the training, compared with those who were not (coefficient = 0.173). The corresponding marginal effects were negative for the three outcome variables. This is attributed to their experience in handling the technology in their farms prior to coming to the field days. An interesting thing to note is that ownership of mobile phones was positively correlated to high level of knowledge generation (coeffi-cient = 0.240). A possible argument here could be that farmers with such exposure, either through education or their wider social contact, could be assumed to have better social capital than those without mobile phones. In our view, such farmers would be expected to be more knowledgeable and could therefore easily grasp the information offered during agricultural training.

Determinants of willingness to adopt push-pull after the field day training

The willingness to adopt by non-push-pull farmers who participated in the field day is presented in Table 5. The variables representing gender of the participant, their perception on stemborers and Striga weed severity and having mobile phones were the significant determinants of willingness to adopt. The negative coefficient (coefficient = −0.367) for gender variable implies that women farmers were more willing to adopt push-pull compared with men. Similarly, the positive coefficients (coefficient = 0.218 and 0.136, respectively) for farmers who perceived Striga and stemborers infestations as very severe indicates that these farmers were more willing to adopt push-pull after receiving training from the field day. This corroborates the results from a recent study by Murage et al. (2015) on the ex ante study on climate-smart push-pull. The scenario reflects the high desire for women to access new innovations in farming that has the potential to improve their pro-ductivity, a fact that might result into higher adoption rates by women. This is also

Table 5. Determinants of farmers' willingness to adopt push-pull technology after learning from a field day.

	Coefficients		Marginal effects	
	Coefficient	Standard error (SE)	dy/dx	Standard error (SE)
Gender of participants (0 = Female, 1 = Male)	–0.367***	0.138	–0.032***	0.012
Age of the participants (years)	0.004	0.005	0.000	0.000
^{2}Participants with no education (0 = No, 1 = Yes)	0.157	0.289	0.013	0.022
Participants with secondary education (0 = No, 1 = Yes)	−0.406	0.145	−0.037	0.014
Participants with tertiary education (0 = No, 1 = Yes)	−0.230	0.216	−0.022	0.022
Striga severity (0 = not severe, 1 = severe, 2 = very severe)	0.218***	0.076	0.019***	0.007
Stemborer severity (0 = not severe, 1 = severe, 2 = very severe)	0.136***	0.064	0.012***	0.006
Participants has a mobile phone (0 = No, 1 = Yes)	0.838***	0.137	0.086***	0.016
_cons	1.101	0.313		
Number of observations	2 615			
LR chi2(8)	60.07			
Prob > chi2	0.000			
Pseudo R2	0.034			
Log likelihood	–847.195			

*** 1%, ** 5%, * is 10% level of significance

consistent with adopter perception paradigm (Adesina and Zinnah 1993), which explains that there is a significant association between farmers' perceptions of a problem or a tech-nology and their decision to adopt. Striga and stemborers are perceived as a major con-straint particularly by women in sub-Saharan Africa who bear the direct effect of inability to feed their families, because of low cereal yield. The existing cultural control measures of Striga, such as hand weeding and uprooting present a high socio-economic opportunity cost for the women who have to spend long hours in the farm uprooting the weed (Berner et al. 1995; Woomer et al. 2004). This explains why women are more likely to express a willingness to adopt new innovations faster, because they are the ones receiving the direct benefits of the technology. In fact, more women perceived Striga as either a severe (31.2%) or very severe problem (46.6%) compared with men (Table 2). This finding is consistent with that of Burton et al. (2003) and Murage et al. (2011a) who observed gender to be a strong predictor of speed of uptake of new innovations.

As in the case of knowledge accumulation above, farmers who had mobile phones were also positively linked to willingness to adopt (coefficient = 0.838). It can be argued that farmers who owned mobile phones were likely to have high self-drive to want to be compatible with adopting a new technology over time by exerting the required efforts, probably as a result of spatial influence from the neighbouring com-munity. Although literature on this is lacking in developing countries, there is increas-ing evidence on the role of neighbourhood effects in the adoption of agricultural technologies (Holloway et al. 2002; Staal et al. 2002; Bandiera and Rasul 2006; Conley and Udry 2010). Indeed, the Alliance for a Green Revolution in Africa (AGRA) has proposed use of proven ICT-enabled extension services, such as mobile phone applications to increase adoption rates for technologies. However, ICT-enabled extension services still have to be backed by locally demonstrative and interactive dis-semination strategies like field days.

Conclusion

Access to farming information via effective dissemination pathways can determine the adoption of a new innovation or not. Being male or female has a strong correlation to information access and technology adoption. Although many dissemination methods exist, the eventual usefulness of the information delivered may be determined by the socio cultural aspects of the recipients. The objective of the current study was motivated by an interest to know how men and women benefit from field day training as one method of technology dissemination, using push-pull technology as an example. The results show field days as an appropriate dissemination method for farmers particularly women who were the majority participants. It has further been shown that women in Kenya have indeed overtaken men in the farming sector and the access to information especially from field days. However, in Uganda and Tanzania, there is still male dominance in agri-cultural training, probably because of the assumption of patriarchal unitary household decision making, where information is expected to flow into the household through the male household head. Because the current study has shown a higher knowledge and understanding potential of women compared with men, then this assumption would definitely disadvantage the women farmers by not receiving information directly from the extension agents. The willingness to adopt also shows that women are likely to make quick decisions in taking up new technologies that have direct benefits to their farming constraints. This would otherwise take longer if they had to wait to receive infor-mation from the male household heads, if they had not attended agricultural training themselves. There is requirement for a paradigm shift and indeed more emphasis by any organisation planning to disseminate new innovations to deliberately offer women farmers opportunities to directly access information via their preferred methods in order to enhance their knowledge and speed up adoption. Failure to enhance gender equity in information access will lead to inability of women to realise their full economic potential and consequent independence. One assumption of technology dissemination is that the trained farmers would assist in the diffusion of the technology information to their neighbours. Knowing that men and women have very distinct networks of social contacts, with different underlying factors that shape these network linkages, it would be appropri-ate for extension agents to exploit those pathways that benefit women more. The reason is that the women's networks of sharing information are as large as those of men or in some cases substantially larger especially in poor household. The ripple effects in adoption of technologies, especially among the poor households, are likely to be greater if women are trained to a greater degree.

Conflicts of interest

The authors declare that they have no conflict of interest with the organisation that sponsored the research work.

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