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Farmer field school and banana xanthomonas wilt management: A study of banana farmers in four villages in Siaya County, Kenya

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Banana xanthomonas wilt (BXW) is a primary constraint to smallholder banana production in East and Central Africa. Experiential learning through farmer field schools (FFS) can accelerate the diffusion of integrated pest management (IPM) technologies at community level, consequently rendering production systems more productive, profitable, and sustainable. This paper explores the importance of FFS in successful transfer of the four-pronged ABCC strategy (that is, Avoid disease introduction, Break male buds, Cut down diseased plants, and Clean tools) for effective BXW control in Siaya County in Kenya. About 83% FFS-participants had advanced capacity for BXW diagnosis and control it with the ABCC practices. FFS also contributed to the spillover of ABCC practices to non-participating households in the community. In a paradox, 7.2% FFS-participants disadopted various practices compared to 4.7% non-participants. A few households (21%) deployed the ABCC package in its entirety, whereas majority (79%) dismantled the package, and recreated more user-friendly options. Most widely used reconstituted packages were ABC (Avoid, Break male buds, and Clean tools) (69%), and BC (Break male bud and Clean tools) (74%). An explanation being that adoption decisions are sequential and ultimate choice to adopt being reached after realization of true benefits and costs of the technology. Farmers dismantled the ABCC package after discovering a lack-of-fit within the smallholder's context, defined by several farm level constraints. Dismantling the ABCC package allows farmers to create user-friendly practices, but also diminishes the prior anticipated impacts, which results in resurgence. Fine-tuning of these alternatives is necessary to ensure sustainable BXW management.

Key words: ABCC practices, banana xanthomonas wilt (BXW), farmer field school (FFS), Kenya, Siaya.

INTRODUCTION

Banana xanthomonas wilt (BXW) caused by the bacteria *Xanthomonas campestris* pv. *musacearum* is a primary constraint to smallholder banana production in the Great Lakes region of East and Central Africa (Tripathi et al., 2009). Economic losses of up to 100% mainly arise from plant death, premature ripening and rotting of marketable banana fruits (Tushemereirwe et al., 2003; Smith et al., 2008). BXW is highly transmissible and spreads very fast through vectors, infected planting materials, and cutting tools (Thwaites et al., 2000; Buregyeya et al., 2008; Shehabu et al., 2010). However, there is no natural source of resistance to the disease among cultivated banana cultivars (Eden-Green, 2004; Ssekiwoko et al., 2006).

A major challenge during the early years of the BXW epidemic was specifying a single control practice as a conclusive remedy. A first line of action was to engage local, national, and regional actors to establish communities of practice for knowledge generation (Karamura et al., 2008). Due to similarities in disease transmission and symptom expression with other banana bacterial wilts, a four-pronged strategy (ABCC) was quickly rolled-out to empower smallholders to avoid disease introduction into new areas (A), break the male buds with forked stick (B), cut down and rouge all diseased plants (C), and routinely clean contaminated tools (C) (Karamura et al., 2006; Tinzaara et al., 2009). Subsequently, through rigorous awareness creation and community-mobilization, the epidemic was finally halted in Uganda, ushering in the recovery of affected banana farms (Kubiriba et al., 2012).

Apparently, sustainable BXW management has largely remained elusive in many countries in the region, despite mass sensitization of smallholders. Numerous local challenges influence farm-level BXW control (Jogo et al., 2011; Tinzaara et al., 2013; Ochola et al., 2014). Many studies have reiterated the importance of tailoring the ABCC practices within the context of smallholders (Blomme et al., 2014; Ochola et al., 2014). Recent evidence reveals that in the absence of this, farmers dismantled the ABCC package and reconstituted its practices into more user-friendly alternatives (Ochola et al., 2014; Jogo et al., 2011). Moreover, dismantling of the ABCC package interferes with complementarities embedded within cultural practices, which subsequently results in disease resurgence on farms, where it had previously been controlled (Ochola et al., 2014). Unfortunately, traditional extension approaches rarely deliver farmer-desired information in an integrated manner that has immediate tangible benefits (Scarborough et al., 1997). There is a heightened need for multidimensional approaches that prioritize farmers' subjective preferences.

Farmer field school (FFS) is among the most popular adult education approaches worldwide (Braun and Duveskog, 2008). Although the methodology emerged in response to the adverse consequences of modern, industrial era rice farming in Asia (Kenmore, 1996), it can address more than immediate social, human health and environmental problems at community level (Pontius et al., 2002). It is synonymous to a school without walls originating from the informal setting through which experiential group learning takes place. Guided by a year-round curriculum, participants learn how to analyze their production systems, identify constraints, and evaluate possible solutions that are tailored to their highly diverse farming conditions. Consequently, the diffusion of useful innovations is accelerated at community level, which renders production systems more productive, profitable, and sustainable (Davis et al., 2010). As a result of its impressive success, several non-Governmental organizations (NGOs), government agencies, and even private industry have mainstreamed FFS into their development agenda, to encourage participatory technology development and dissemination. Over time, FFS was reshaped into a packaged course, with variations reflecting priorities and contexts of competing forces involved in knowledge production (Schut, 2006; Paredes, 2001; Borja, 2004).

FFS approach was introduced in Kenya in 1995 on a pilot basis under Food and Agricultural Organization (FAO) Special Programme on Food Production (SPFP) in collaboration with Ministry of Agriculture (MoA) and Kenya Agricultural Research Institute (KARI). To date, some of the implemented FFS projects in Kenya included: (i) integrated production and pest management (IPPM), (ii) integrated nutrient management to attain sustainable productivity increases in East African farming systems (INMASP), (iii) farmer innovation and new technology options for food production, income generation and combating desertification (PFI-FFS). A key to effective control of BXW is community mobilization. However, there is limited information on the potential of FFS in catalyzing integrated BXW management among smallholder farmers in Kenya. A superlative advantage of FFS in mobilizing community-action for BXW control was reported in Uganda (Kubiriba et al., 2012). Albeit, there is need to understand the diverse smallholder contexts that are likely to diminish the realization of similar impacts on effective BXW control in Kenya. This paper features the initial case in which the FFS approach was deployed to operationalize the transfer and adoption of ABCC practices by famers in four villages of Sidindi, Sigomere, Lunjre, and Ugunja of Siaya County. Herein, the extent to which FFS has improved the adoption of ABCC practices for BXW control was explored, and whether there are any identifiable spillover effects on non-FFS participating households.

MATERIALS AND METHODS

Source of data

Data of 120 households presented in this paper were adapted from

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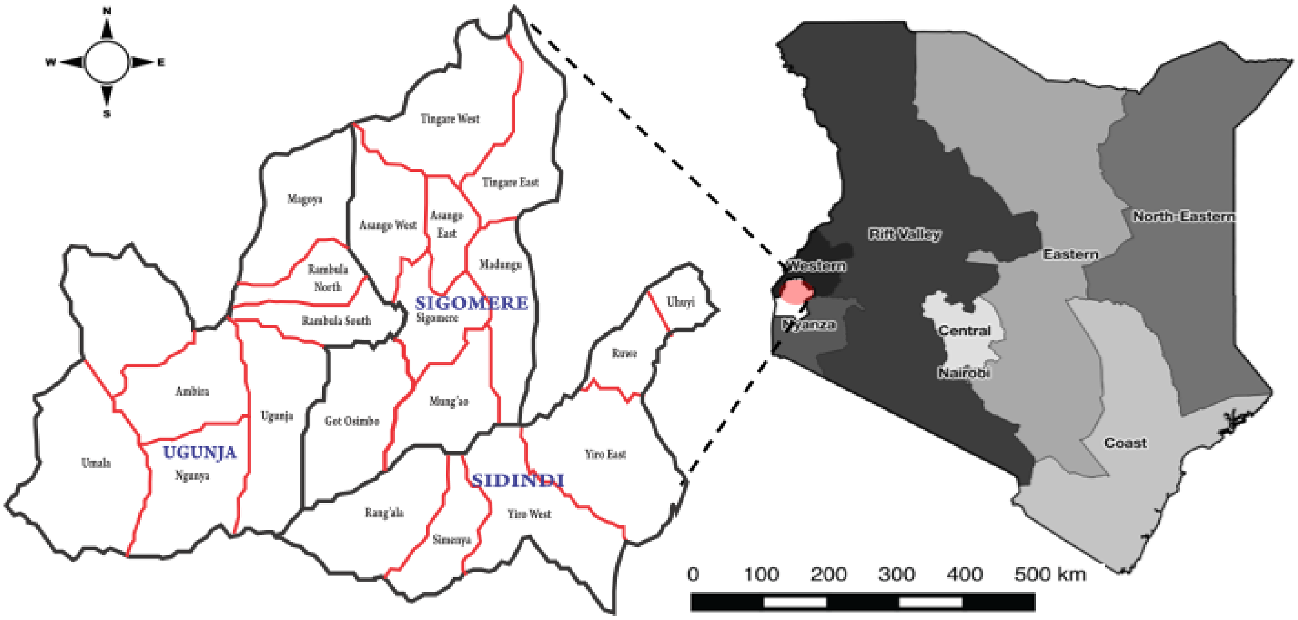

Figure 1. Map showing the surveyed areas: Sidindi, Sigomere, Lunjre and Ugunja.

the survey of small-scale banana farming households in Sidindi, Sigomere, Lunjre, and Ugunja (Ochola et al., 2014) (Figure 1). Bioversity International designed the structured questionnaire used, while the Rural Energy and Food Security Organization (REFSO) and KARI implemented the household survey. The choice of the participants was based on household head membership of FFS that aims at mitigating livelihood risks associated with BXW. In the absence of the household head, any other member of the household familiar with banana production was interviewed. FFS households (n = 38) and non-FFS households (n = 82) were further disaggregated into three categories to elucidate spillovers, that is, (a) FFS households in FFS sites (FFS-FFSS) (n = 38), (b) non-FFS households in FFS sites (NFFS-FFSS) (n = 37), and (c) non-FFS households in non-FFS sites (NFFS-NFFSS) (n = 45).

Empirical model

The empirical model discussed by Gedikoglu and McCann (2009) was adapted in this study. Accordingly, farmers' decision to disadopt an ABCC practice can be represented by the stochastic BXW prevalence framework. Disease prevalence after disadoption of a practice is compared with the prevalence from continuing to use the practice. It is assumed that the farmer disadopts the practice if the disease prevalence from abandoning the practice is greater than that of continuing to use the practice. In contrast, the farmer is most likely to retain a practice if the disease prevalence from abandoning the practice is less or equal to the disease prevalence from continuing to use the practice.

Disease prevalence function π (.) is assumed to be the function of years in farming (YFARM); FFSM, a dummy variable that equals to 1 if the household head belongs to an FFS; AWARE, a dummy variable that equals to 1 if the household head recognizes the threat of BXW to banana production; DIAG, a dummy variable that equals to 1 if the household head can identify BXW symptoms; ABCCP, a dummy variable that equals to 1 if the household head deployed ABCC practices prior to 2012; ABCCN, a dummy variable that equals to 1 if the household head discontinued certain ABCC practices in 2012. It is also assumed that disease prevalence has a random factor ε, which is assumed to have a normal distribution. Disease prevalence function π (.) can be represented as:

π (YFARM, FFSM, AWARE, DIAG, ABCCP, ABCCN, ε)

If πD represents the disease prevalence from disadopting a practice and πND represents the disease prevalence from retaining the practice, then the decision whether to disadopt a practice or not can be represented as:

$yi = 1$ (Farmer disadopts the practice) if $\pi D > \pi ND$

$yi = 0$ (Farmer retains the practice) if $\pi D \leq \pi ND$

For econometric analysis, the hazard function for the current study can be represented by the equation (Wooldridge, 2001):

$$\lambda(t, x) = \lim_{t \to 0} \frac{Pr[t \leq T + \Delta t \mid T \geq t, x]}{\Delta t}$$

which gives the probability that the length of time a farmer uses a practice T will be between t and t+Δt, given that it is greater or equal to t. The explanatory variables, such as YFARM, FFSM, AWARE, DIAG, ABCCP and ABCCN are included in the vector x. The estimation is done using the maximum likelihood procedure.

Data analysis

Descriptive and comparative statistics (that is, means, percentages and cross-tabulations) were used to show the differences among households. The Pearson's product moment correlation coefficient (chi-square test) was used to test for variations between FFS-FFSS, NFFS-FFSS and NFFS-NFFSS. Stepwise regression is a semi-automated process of building a model by successively adding

Table 1. Comparison of household characteristics across sites.

Characteristic		Non-FFS in non-FFS Site (N=45)	Non-FFS in FFS site (N=37)	FFS located in FFS site (N=38)	All (N=120)	P-values equality of means
Sex	Male	28	22	22	72	0.92
	Female	17	15	16	48	
Age (years)		51.8	55.0	54.7	53.8	0.46
Education (years)		9.7	8.7	9.5	9.3	0.44
Living in area (years)		35.9	40.0	40.9	38.9	0.42
Banana (years)		10.8	5.4	7.3	7.8	0.04**
Household size		5.0	7.1	6.1	6.1	0.02**
Dependence rate		1.1	2.4	1.8	1.8	0.04**
Total land acreage (ha)		1.5	1.5	1.4	1.5	0.84
Arable area (ha)		1.1	1.1	1.1	1.1	0.97
Banana area (ha)		0.13	0.21	0.20	0.18	0.29
Livestock (TLU)		2.53	4.32	3.04	3.3	0.01**

*, **,***Significance at the 10, 5 and 1% levels, respectively.

or removing variables based solely on the t-statistics of their estimated coefficients. It was used to interactively explore the adoption predictors that provide a good fit. All statistical analyses where conducted in SPSS v22 and STATA v13 for Macintosh. Graphs were developed in Microsoft Excel.

RESULTS

Comparison of household characteristics

Table 1 shows the characteristics of households from FFS and non-FFS sites, including demographic characteristics and basic assets. The mean age of the household heads were 53 years. They have between five and six members in the household. Majority had completed eight years of primary education, had over seven years growing banana on approximately 0.2 hectares and who owned 3.3 Tropical Livestock Units (TLU). Comparison of sites with FFS and without FFS revealed significant ($p<0.01$) equality of means for the years of growing banana, household size, dependence rate, and livestock ownership.

Differences in awareness and diagnostic capacity between sites

Figure 2a and 2b highlights the extent of farmer awareness of the associated risks of BXW on banana production in Ugunja Division. About 95% of the surveyed households acknowledged the disease as a major threat to their banana production. Comparison of BXW awareness between sites revealed significant ($p<0.05$) disparity in between NFFS-NFFSS (89%) and FFSS (100%) (Figure 2a). The capacity of households to diagnose the disease was highly significantly different ($p<0.01$) between sites (Figure 2b). In general, FFS-FFSS had greater (83.3%) competency to recognize multiple disease symptoms as compared to NFFS-FFSS (69.3%) and NFFS-NFFSS (37.4%). A two-fold difference between NFFS-FFSS and NFFS-NFFSS suggests that close proximity to FFS in the community exerts a significant spillover effect on the diagnostic capacity of non-participating households. Notably, about 16% NFFS-NFFSS were not fully conversant in the identification of BXW symptoms in their fields.

BXW information sources

There are many sources of agricultural information to which farmers have access to, and there are varying degrees of smallholder farmer preference how they prefer to access information in the study sites (Figure 3a and b). About 47.2% households acknowledged friends and neighbors as the primary source of information (Figure 3a). Dependence on mutual relationships for BXW information was highest (78%) among NFFS NFFSS (Figure 3b). Results show that households across all sites seldom accessed agricultural information through newspapers (NWP), radio (RAD) and television (TV) (Figure 3a and b). Although the intended beneficiaries of FFS disseminated information are the participants, there is a likelihood of spillovers to non-participants in close proximity of the FFS sites (Figure 2b). Evidence also indicates that FFS presence in the community contributes towards the strengthening of linkages with research (RES) and extension services (EXT).

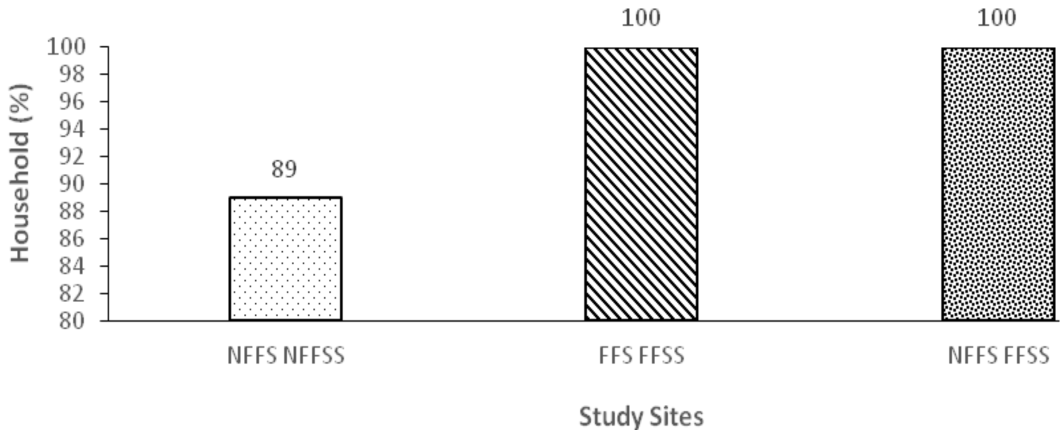

Figure 2a. Percentage of households aware of BXW across sites. NFFS-NFFSS, Non-FFS participant located in non-FFS site; FFS-FFSS, FFS participant located in FFS site; NFFS-FFSS, non-FFS participant located in FFS site.

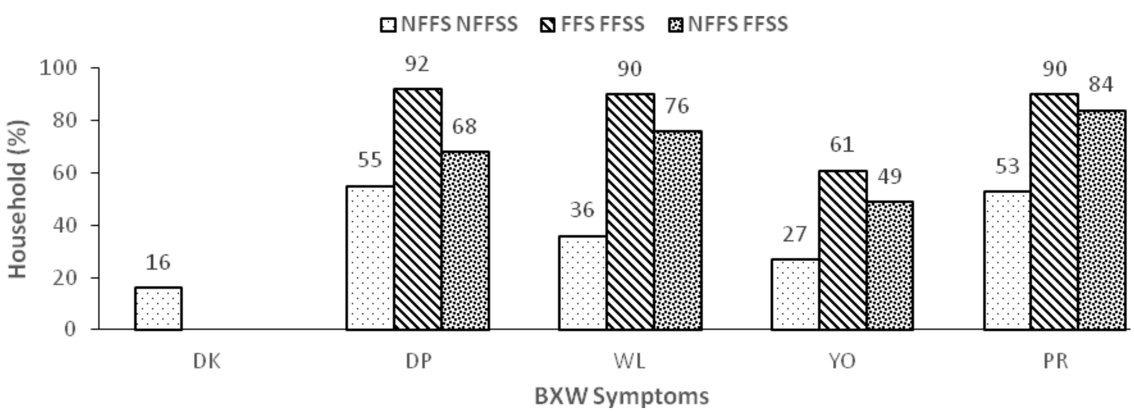

Figure 2b. Comparison of BXW diagnostic capacity across sites. DK, Do not know; DP, discoloration of pulp; WL, wilted leaves; YO, yellow ooze; PR, premature fruit ripening.

Awareness and deployment of ABCC practices

On average, 79% households located in NFFS sites lacked awareness across a wide range of practices embedded inside the ABCC package (Figure 4a). In contrast, 53% households in FFS sites were aware (that is, 62% FFS-FFSS and 42% NFFS-FFSS). FFS-FFSS households were most aware of sterilization of tools with sodium hypochlorite (SJIK) (100%), removal of male buds with forked stick (RMFS) (97%), sterilization of tools with fire (SFIR) (92%) and destroying and uprooting the entire infected mat (DAID) (89%). Likewise, in Figure 4b, the most implemented BXW control practices by FFS-FFSS were RMFS (72%) and SJIK (75%). However, significant difference between the FFS-FFSS and NFFS-FFSS were with respect to deployment of cutting diseased plants and burying (CDBG), use of clean planting materials (UCPM), and sterilization of tools with fire (SFIR) (Figure 4b). Consistent with previous research, this study also reveals that raising awareness does not necessarily result in a high level of deployment of the technology package.

Disadoption and dismantling of ABCC practices

Disadopters are defined as households who used an ABCC practice prior to 2012, but discontinued its use in 2012. About 12% of the households had abandoned at least two control practices that were embedded within the ABCC package (Figure 5a). In a disconcerting paradox, disadoption rates were on average greater (7.2%) in FFS households compared to 4.7% in NFFS households (Figure 5a). DAID and CLGN were the highest (31%) and least (2%) disadopted practices, respectively (Figure 5a).
It is apparent that very few (21%) households were using

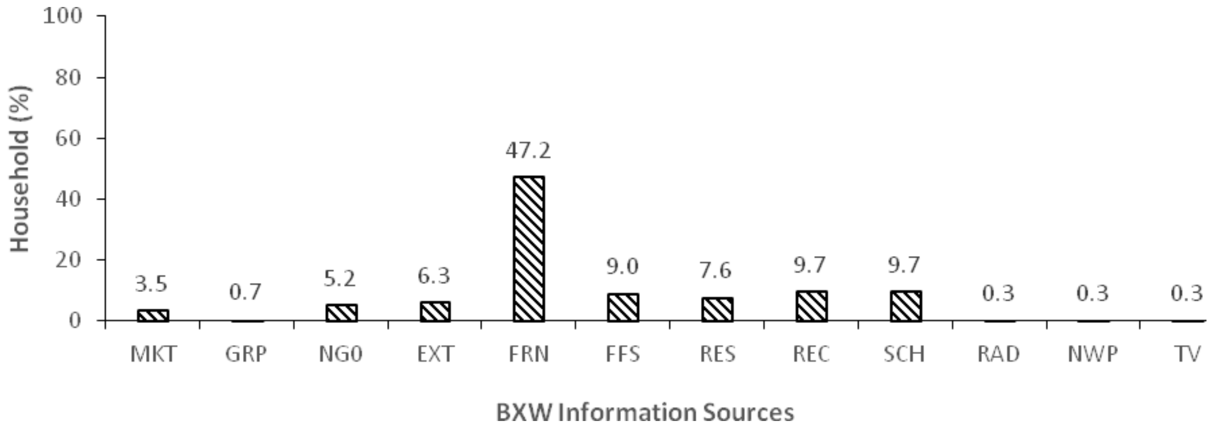

Figure 3a. Average percentage of households who rely on a particular BXW information source. MKT, Market; GRP, farmer group; NGO, non-governmental organizations; EXT, extension; FRN, friends and neighbors; FFS, farmer field school; RES, research institute; REC, religious center; SCH, school; RAD, radio; NWP, newspapers; TV, television.

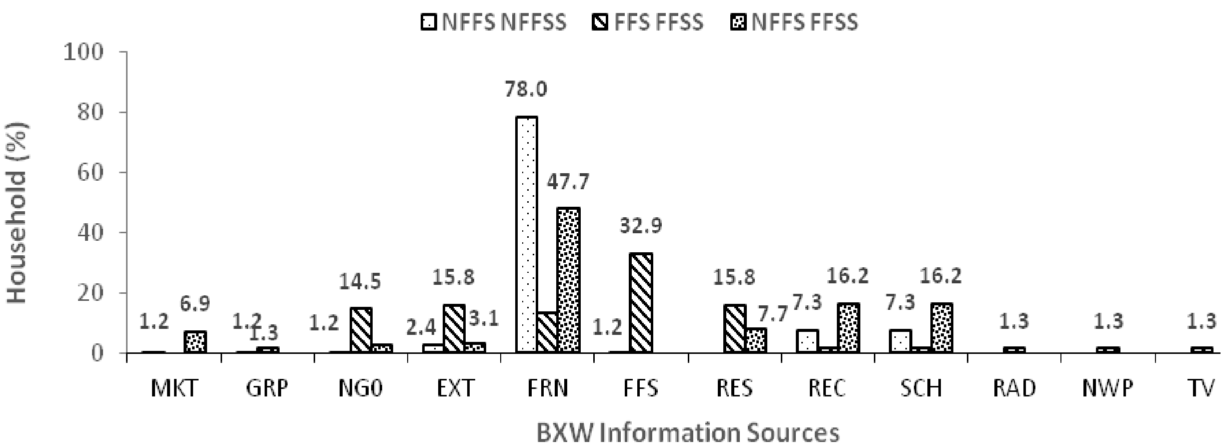

Figure 3b. Percentage household distribution according to BXW information source across study sites. MKT, Market; GRP, farmer group; NGO, non-governmental organizations; EXT, extension; FRN, friends and neighbors; FFS, farmer field school; RES, research institute; REC, religious center; SCH, school; RAD, radio; NWP, newspapers; TV, television.

the ABCC package in its entirety, whereas the majority (79%) had dismantled the ABCC package, which they later stitched together into more user-friendly combinations (Figure 5b). In general, the most widely used reconstituted packages were 69% ABC (Avoid new infection, Break male buds, and Clean tools) and 74% BC (Break male buds and Clean tools). Another important observation from Figure 4b is that majority (35%) of the households in NFFS-NFFS sites retained only the A component from the ABCC package. Data of on-farm disease prevalence confirmed that dismantling the ABCC package failed to create the enabling environment that would otherwise allow practices to complement each other. Interestingly, farmers who discarded debudding and tool sterilization risked resurgence of the disease.

Stepwise regression analysis

Unlike ordinary multiple regression, stepwise regression was useful for sifting through potential independent variables influencing household adoption of the ABCC package, and fine-tuning a model by poking variables in or out. Model 1 variables that were statistically significant are YFARM, HHSIZE, and FFSM (Table 2). In Model 2, HHSIZE and YFARM ceased to be statistically significant upon the inclusion of AWARE, DIAG, ABCCP, and ABCCN (Table 2). A positive coefficient for ABCCP suggests that much of the success in controlling BXW on smallholder farms in Western Kenya originated from multi-actor efforts prior to 2012. Moreover, the negative coefficient for FFSM suggests that household heads that

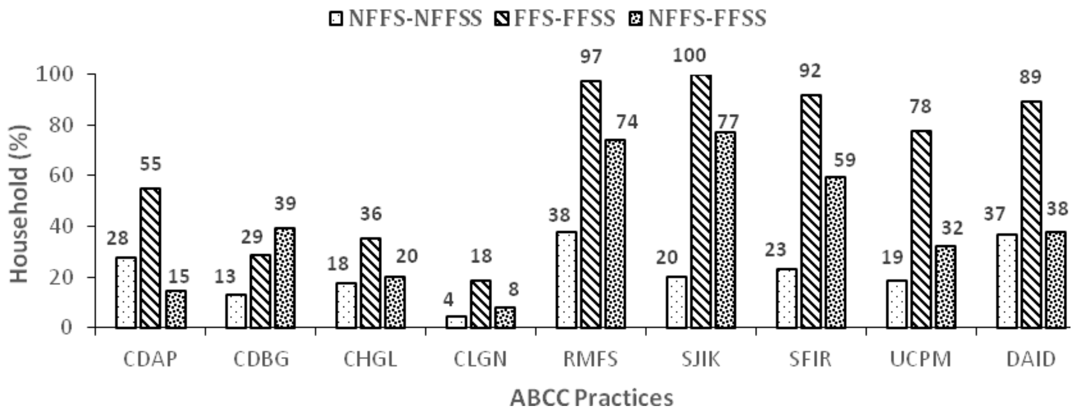

Figure 4a. Percentage household awareness of ABCC practices across sites. CDAP, Cut-down all infected plants; CDBG, cut-down all infected plants and bury in the ground; CHGL, cut-down and chop infected plants into pieces and heap on ground; CLGN, cut-down all infected plants leave on ground not heaped; RMFS, removal of male buds with forked stick; SJIK, sterilization of tools with sodium hypochlorite; SFIR, sterilization of tools with fire; UCPM, use of clean planting materials; DAID, destruction and uprooting entire mat.

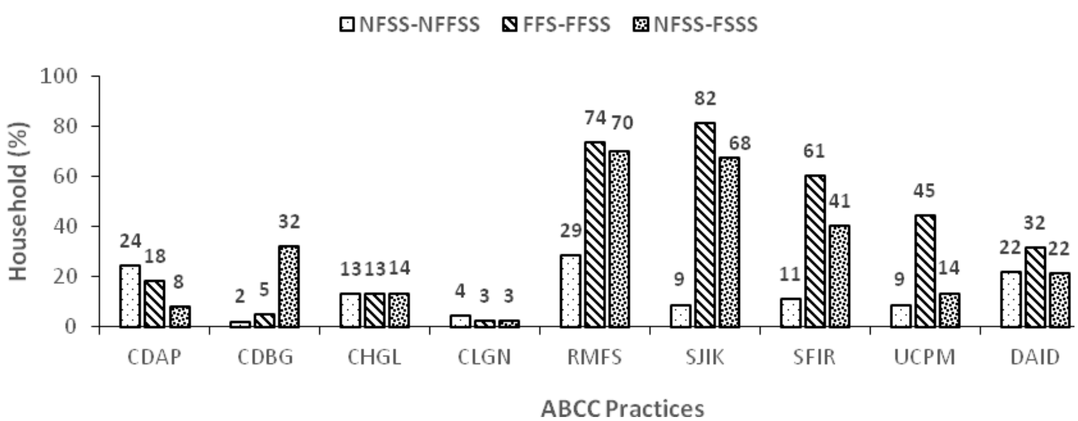

Figure 4b. Percentage household deployment of ABCC practices across sites. CDAP, Cut-down all infected plants; CDBG, cut-down all infected plants and bury in the ground; CHGL, cut-down and chop infected plants into pieces and heap on ground; CLGN, cut-down all infected plants leave on ground not heaped; RMFS, removal of male buds with forked stick; SJIK, sterilization of tools with sodium hypochlorite; SFIR, sterilization of tools with fire; UCPM, use of clean planting materials; DAID, destruction and uprooting entire mat.

are not FFS members are more likely to experience BXW on their farms.

DISCUSSION

Based on past successes in Uganda, the ABCC strategy is considered the most effective for BXW management in East and Central Africa. Besides, the FFS approach has been adopted to facilitate collective action between farmers, researchers and other stakeholders, and for scaling out the ABCC strategy to farmers as part of an effort to control BXW.

Results indicate that family size has a positive impact on adoption and application of ABCC practices. As a proxy of labor availability, household size influences the adoption of technology by reducing household labor constraints (Teklewold et al., 2006). However, differences in absolute and relative factor endowments often encourage farm households to engage in labor exchange with other farmers in their locality (Amsalu et al., 2013). Notably, families with many members are more likely to divert a significant portion of the labor force towards off-farm activities to earn cash income to ease the

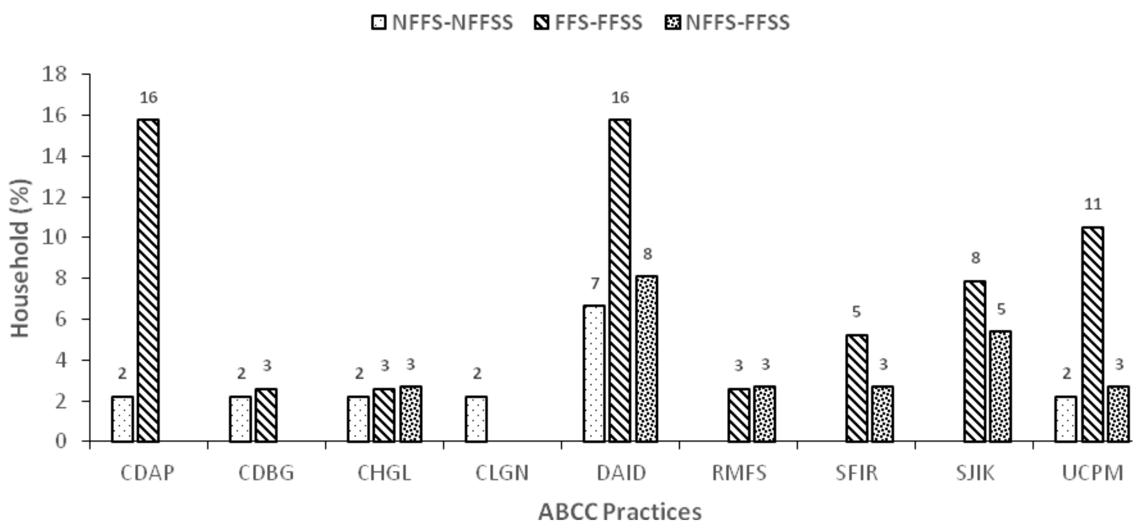

Figure 5a. Percentage household disadoption of ABCC practices. CDAP, Cut-down all infected plants; CDBG, cut-down all infected plants and bury in the ground; CHGL, cut-down and chop infected plants into pieces and heap on ground; CLGN, cut-down all infected plants leave on ground not heaped; RMFS, removal of male buds with forked stick; SJIK, sterilization of tools with sodium hypochlorite; SFIR, sterilization of tools with fire; UCPM, use of clean planting materials; DAID, destruction and uprooting entire mat.

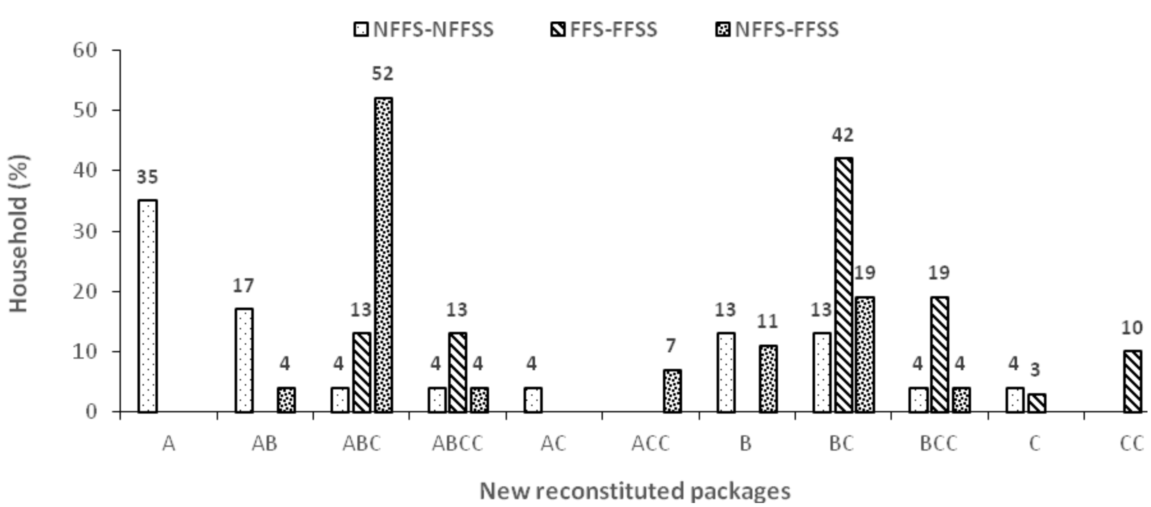

Figure 5b. Percentage of households that dismantled ABCC practices. A, Avoid new infection; AB, avoid new infection and break male buds; ABC, avoid new infection, break male buds and clean tools; ABCC, avoid new infection, break male buds, clean tools and clean planting materials; AC, avoid new infection and clean tools; ACC, avoid new infection, clean tools and clean planting materials; B, break male-buds; BC, break male buds and clean tools; BCC, break male buds, clean tools and clean planting materials; C, clean tools; CC, clean tools and clean planting materials.

consumption pressure associated with large family size (Tizale, 2007).

Farming experience is another key household characteristic that emerged to play an important role in influencing farmers' decisions to adopt components of the disseminated ABCC package. It is generally agreed that farmers' experience is very influential on adoption decision (Banerjee and Martin, 2009; Marra et al., 2001; Qaim and de Janvry, 2003; Alexander et al., 2003). Specifically, experienced farmers are believed to have generally better knowledge and information on several crop management practices (Nhemachena and Hassan, 2007). Moreover, farming experience is largely useful in the early stages of technology adoption when farmers are

Table 2. Stepwise regression to identify predictors of household adoption of the ABCC package.

Variable	Model 1	Model 2
Gender	-0.3489 (0.3022)	-0.3862 (0.3384)
Age	0.0008 (0.0129)	-0.0027 (0.0139)
Educ	0.0111 (0.0376)	-0.0074 (0.0412)
YAREA	0.0059 (0.0095)	0.0060 (0.0102)
YFARM	0.0301* (0.0155)	0.0288 (0.0175)
OCCUP	-0.0630 (0.2946)	-0.2054 (0.3355)
HHSIZE	0.1071** (0.0478)	0.0498 (0.0501)
FFSM	-1.047*** (0.2766)	-1.4837*** (0.3556)
AWARE	-	1.157 (0.7327)
DIAG	-	0.2896 (0.5245)
ABCCP	-	2.1757*** (0.7696)
ABCCN	-	-1.2294 (0.9385)
Constant	-0.4213 (0.8068)	-1.3772 (1.0783)
Log likelihood	-68.3621	-58.0459

*,**,***Significance at the 10, 5, and 1% levels, respectively.

still testing its potential benefits (Ainembabazi and Mugisha, 2014).

This study also reveals that FFS participants possess advanced capacity to accurately diagnose BXW symptoms and deploy the mutually reinforcing control practices. Notably, learning through the entire crop cycle enabled the farmers to develop confidence and expertise to make evidence-based crop management decisions. In general, by emphasizing a participant-led, multi-faceted, and iterative learning action methodology, FFS exposes farmers to diverse knowledge, experience, and skills, which enhances their decision-making capacity to solve field problems (Nederlof and Odonkor, 2006; Waddington et al., 2014). This is consistent with qualitative evidence generated by studies in Asia (Winarto, 1995; Mancini et al., 2007), Africa (Machacha, 2008; Van Der Wiele, 2004; Friis-Hansen et al., 2012), and Latin America and the Caribbean (Van Rijn, 2008; Dolly, 2009).

Existing studies reveal that long-term community empowerment through FFS may be achieved when graduates expand knowledge by helping others learn what they have already learnt (Simpson, 2002; David et al., 2006). Results particularly highlight a significant improvement in general orchard management among neighboring, non-participating farmers in the community, which actually suggests that non-participating farmers strategically benefit from knowledge spillovers. Although this finding contradicts observations by Tripp et al. (2005); it is consistent with previous studies in Kenya that showed that non-participating farmers recognized the relative advantage of FFS practices over existing practices (Najjar, 2009; Machacha, 2008; Hiller et al., 2009).

A major setback in many of the surveyed households is the disadoption of practices embedded within the BXW control package. Paradoxically, the highest disadoption rates existed among field school participants vis-à-vis non participants. A possible explanation being that adoption decisions by farmers are often sequential, made after the realization of true benefits and costs of the technology (Gedikoglu and McCann, 2009). The ultimate decision to disadopt being finally reached upon recognition that a technology does not fit within the smallholder’s context, is defined by several farm level constraints (Asiabaka, 1994). For example, about 50% of the households abandoned labor intensive BXW control practices that required the destruction, uprooting and burying entire banana mats. This corroborates with reports that farmers were more likely to abandon control practices for which the amount of effort required outweighs the anticipated benefits (Jogo et al., 2013; Ochola et al., 2014; Blomme et al., 2014). In general, adoption of labor saving technologies results in more available time for household members to increase income by seeking off-farm employment. Subsequently, the diversion of household labor to off-farm employment does not interfere with BXW management, because available extra income enables the acquisition of alternative labor options.

Farmer-led experimentation and discovery learning facilitates the integration of new knowledge into prior experiences, which results in the creation of relevant, durable and retrievable knowledge (Ndoye, 2003). As our analysis shows, farmers seldom adopted the ABCC package in its entirety. Instead they dismantled the package and reconstituted its practices into distinct user-friendly combinations that fitted within their local realities. This is consistent with Horne and Stür (2003) who observed that farmers adapt rather than adopt technology packages. In fact, discovery of the single diseased stem removal (SDSR), an effective alternative to uprooting the entire mat, was the result of experimentation with the ABCC package (Ocimati et al., 2013; Blomme et al., 2014). Apparently, the choice of cultural practice combinations that lack complementarity could result in diminished impact, and increased risk of disease upsurge and resurgence in areas where disease had been previously controlled (Ocimati et al., 2013; Ochola et al., 2014). For example, SDSR without consistent debudding with a forked stick and sterilization of cutting tools immediately after use raises the risks for inflorescence and tool-based infections (Ocimati et al., 2013; Buregyeya et al., 2008).

Conclusion

Key household characteristics identified to have a positive impact on adoption and application of ABCC practices were family size, years of farming experience and FFS participation. Particularly, FFS participation advanced the diffusion of knowledge for effective BXW management in the community. It is increasingly clear that the ABCC technology package has several limitations to operate within the local realities of the smallholder. Moreover, a wide range of user-friendly alternatives have emerged as the result of farmer innovation with the ABCC package. Although, dismantling the package permits farmers to create novel productive and sustainable practices, it unfortunately also diminishes the prior anticipated impacts, which is likely to result in disease resurgence. Therefore, fine-tuning of these alternatives is necessary to ensure sustainable disease eradication.

Conflict of Interests

The authors have not declared any conflict of interest.

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