

Farmers' Knowledge of Pests and Diseases in the Coffee-Banana Agroforestry Systems of Mid-Eastern Uganda

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Abstract

Recent trends in agricultural research and development recommend incorporating farmers' knowledge and experience into the research agenda. A questionnaire was therefore administered to 10 purposively selected households per district in 7 randomly selected districts located in the coffee-banana agroforestry system of mid-eastern Uganda to determine farmers' knowledge of pests and diseases of coffee and bananas. Most of the respondents interviewed had knowledge of the pests and diseases attacking both coffee and bananas. The black coffee twig borer (BCTB) and coffee wilt disease (CWD) were the most commonly reported pests – by 46 and 72% of the respondents respectively. Farmers' knowledge of BCTB was significantly ($p=0.0391$) dependent on sex, but not age or education of the respondent. On the other hand, their knowledge of CWD was not dependent on age, sex nor educational level. For the bananas, the banana weevils and banana xanthomonas wilt (BXW) were the most commonly mentioned pests – by 21 and 84% of the respondents respectively. More than 50% of the respondents were employing cultural practices for managing BCTB, CWD, banana weevil, nematodes, black ants (kaasa) and BXW. However, more than 65% of the respondents had limited knowledge of managing the biting ants, mites, coffee leaf rust and red blister disease, caterpillars and black sigatoka. This therefore calls for more awareness campaign on all pests and diseases of both crops in the region.

Keywords: Banana-xanthomonas-wilt, banana-weevils, black-coffee-twig-borer, coffee-wilt-disease, management

1. Introduction

Coffee and banana are important crops contributing tremendously to the income and food security of smallholder farmers of Uganda (Musoli et al., 2001; van Asten et al., 2011). In Uganda, both crops are often grown together to enhance land-use efficiency, provide shade to coffee, supply mulch materials and reduce soil erosion (Bongers et al., 2012; Jassogne et al., 2013). However, productivity of both crops remains far below the attainable yields. For example, the actual clean (green) yields of Robusta coffee average at 550 Kg ha⁻¹ which is four times less than the potential yields of 2.2 t ha⁻¹ (van Asten et al., 2011). Similarly, the actual banana yields of cooking bananas on many smallholder banana farms are 5–20 Mg ha⁻¹ yr⁻¹ FW which are also far below the estimated potential yield of 100 Mg ha⁻¹ yr⁻¹ FW (Nyombi, 2010). This is due to biotic factors among others, particularly the emergence/resurgence of pests and diseases such as the black coffee twig borer and coffee wilt diseases for coffee (Adipala et al., 2001; Egonyu et al., 2009; Kagezi et al., 2015) as well as banana bacterial wilt and black Sigatoka for bananas (Kubiriba and Tushemereirwe, 2014).

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Research and extension have identified the integration of shade trees as an entry point for re-establishing the productivity of both crops (Schroth et al., 2000). However, farmers in Uganda are already growing their coffee and bananas together with trees to form an agroforestry system (Kiyingi and Gwali, 2012; Mpiira et al., 2013; Kalanzi and Nansereko, 2014; Ssebulime et al., 2017). Agroforestry practices may influence pest and disease incidence and abundance through increased top-down regulation by natural enemies and via bottom-up factors such as moderation of microclimate, soil nutrients and water content (Schroth et al., 2000; Pumarino et al., 2015). However, the coffee-banana agroforestry systems of mid-eastern Uganda are yet to be optimized for management of pests and diseases of coffee and banana in the region. In order to do this, there is a need to first understand and also put into consideration farmers' knowledge of these pests and diseases as well as their management options (Segura et al., 2004). Understanding the potentials and drawbacks of farmers' knowledge form a basis for constructive collaboration between farmers, scientists, extension and policy makers in term of priorities definition and settings (Sileshi et al., 2005; Kekeunou et al., 2006).

This study therefore aimed at determining farmers' knowledge of the pests and diseases of coffee and bananas as well as their coping mechanisms in the coffee-banana agroforestry systems of mid-eastern Uganda.

2. Materials and Methods

2.1 Description of the study area

The study was conducted in the mid-eastern (Busoga) region of Uganda which is situated immediately north of the equator at latitude 00° 45' 00" N and longitude 33° 30' 00" E. It is located at an elevation of 1,148 meters above sea level (Kobusinge, 2016). The area has a mean annual temperature of 28°C and is characterized by two rain seasons (i.e. March–June and September–December) with a mean annual precipitation of 1283 mm recorded over the last 40 years (Department of Meteorology, 2000). The soils are deep, well drained to poorly drained and contain high to moderate organic matter contents. They are weakly developed over sands, gravel and boulders and mainly consist of silt, sand and clay. Free draining nature of this soil has long moisture deficit period. pH of soil ranges from 5.0 to 7.0 (Isabirye, 2009; Buyinza and Mugagga, 2010).

2.2 Data collection

The survey was conducted in seven districts selected randomly, namely: - Jinja, Kamuli, Luuka, Buyende, Bugiri, Kaliro and Namutumba in 2014. A structured questionnaire with both open and closed-ended questions was administered to 10 purposively selected households in each district – whose households practicing coffee-banana agroforestry systems. The questionnaire elicited farmers' knowledge on pests and diseases as well as their coping mechanism in managing these biotic stresses.

2.3 Data analysis

The data were entered in Microsoft Excel spread sheet. Descriptive statistics were used to analysis the data to generate means, ranges, standard deviations and frequencies. We also used a simple logistic regression analysis to define the relationship between farmers' knowledge of pests and diseases as well as their coping mechanisms and the socio-demographic characteristics (sex, age and education). All the data analysis was done in SAS v. 9.1 for Windows (SAS Incorporation, 2008).

3.0 Results and Discussion

This section presents the results obtained in the study as well as providing the discussion on the observed results. Our study aimed at determining farmers' knowledge of (a) pests and diseases limiting production of both coffee and bananas in the coffee-banana agroforestry systems of mid-eastern Uganda and (b) their coping mechanisms for these pests and diseases.

3.1 Farmers' knowledge of pests and diseases of coffee

Results showed that the respondents interviewed in the mid-eastern coffee growing region of Uganda possessed knowledge of the insect pests infesting their coffee, mentioning four insect pests, namely, the black coffee twig borer (BCTB), biting ants, stem borers and mites (Fig. 1). Of these insect pests, the black coffee twig borer, *Xylosandrus compactus* (Eichhoff) was the most commonly mentioned insect pest of coffee – by 46% of the respondents.

Our finding emphasizes results of a countrywide biological assessment of BCTB conducted in 2016 which reported that this region had the highest BCTB infestation – with all the coffee fields, 80.9% of the coffee trees and 14.4% of the berry-bearing primary branches infested by BCTB (Kagezi et al., 2016b). Similarly, BCTB has been reported by farmers to be currently the most important insect pest infesting coffee in Uganda, particularly in Robusta coffee growing regions of Uganda (Egonyu et al., 2009; Kagezi et al., 2012, 2013, 2015, 2016a,b).

In Uganda, BCTB was first reported in 1993, in the western district of Bundibugyo (Adipala et al., 2001; Egonyu et al., 2009). Damage by this insect pest is initiated by the female beetle boring into berry-bearing primary and other young stems causing them to wilt and eventually die after a few weeks (Hara and Beardsley, 1976; Ngoan et al., 1976; Greco and Wright, 2015). Attacked twigs therefore do not produce berries, resulting into yield loss, and thus income. An estimated yield loss of 9.6% in coffee export volumes valued at US\$45.6 million could be realized annually if the pest is not managed (Kagezi et al., 2016b). Damage by this pest is easily recognized by farmers due to its characteristic entry hole made on the attacked plant part as well as its distinct symptoms of yellowing of the leaves and drying and death of attacked plant part (Smith, 2003).

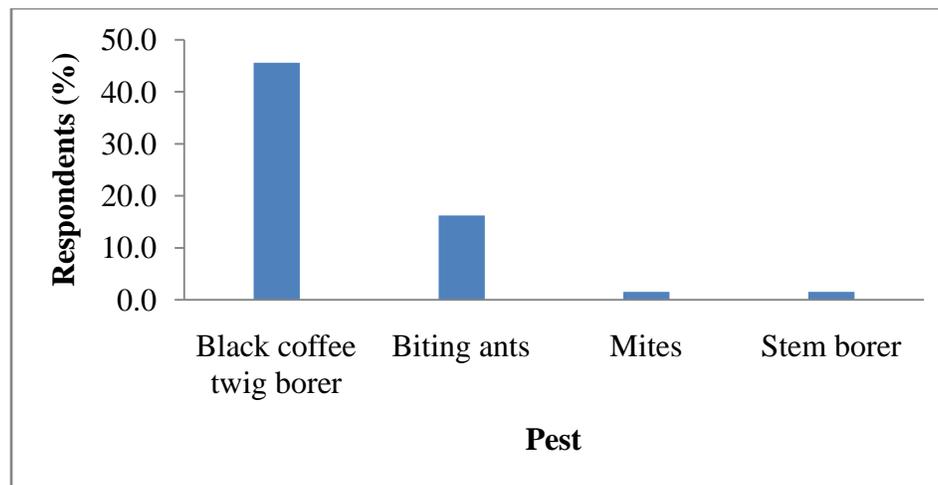


Figure 1: Respondents (%) mentioning the various insect pests of coffee in the coffee-banana agroforestry systems of mid-eastern Uganda

Similarly, farmers had knowledge of the diseases infecting their coffee, mentioning three diseases, namely, coffee wilt disease (CWD), coffee leaf rust and red blister disease (Fig. 2). The majority of the respondents (70%) mentioned CWD caused by the fungus, *Fusarium xylarioides* as the most important disease of coffee. The importance of CWD in the region is in line with a biological survey by Kagezi et al. (2016a) who reported that 76% of the sampled coffee farms in the region were infected with the disease. Our finding is in agreement with other studies which have reported CWD to be the most important disease of Robusta coffee in Uganda (Hakiza and Birikunzira, 2000; Nabeta, 2007). The devastation of Robusta coffee by CWD during the early 1990's to late 2000's led to losses of up to 45 per cent and greatly undermined government efforts to increase coffee production from 3.15 million bags in 2001/2 to 12 million bags by 2007/8 (Hakiza et al., 2009).

In contrast to some other coffee diseases, which may cause losses to the farmers for one season or loss of a few trees, CWD causes death of all infected trees, and this means that if coffee is the only source of income, all previous investments put into coffee production is completely lost (Hakiza and Birikunzira, 2000). CWD therefore threatens the livelihood of millions of small holders who depend on coffee for income. CWD is one of the major factors which are likely to escalate poverty, food insecurity and backwardness at grass root level and at national level - revenue loss from coffee will reduce domestic savings and reduce the capacity of the government to improve services to the people (Birikunzira and Hakiza, 1997; Kangire, 2014). Nevertheless, farmers are also able to easily recognize a plant infected with CWD because of its distinct symptoms of complete wilting of the plant (Rutherford, 2006).

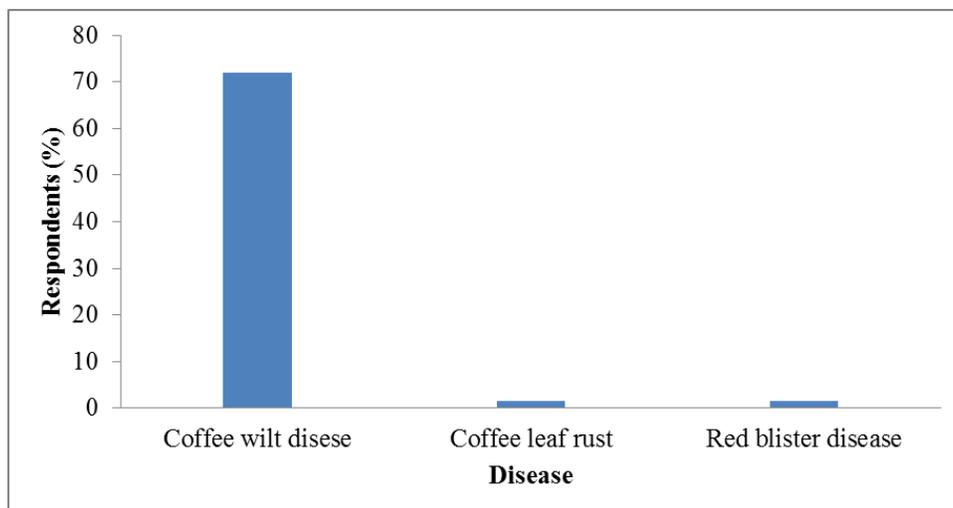


Figure 2: Respondents (%) mentioning the various diseases of coffee in the coffee-banana agroforestry systems of mid-eastern Uganda

A simple logistic regression analysis showed that farmers' knowledge of the black coffee twig borer was dependent ($P=0.0391$) on sex of the respondent but there was no significant ($p>0.05$) relationship between other variables and pests and diseases (Table 1). Males were more (71%) knowledgeable of BCTB than females. Our finding supports report conducted in Mt. Elgon, eastern Uganda which shows that men had a significantly higher mean score on coffee IPM knowledge index than women (Ochago et al., 2016). Similarly, Pouratashi and Iravani, (2012) found out that males were more familiar with alternatives for controlling pests than their female counterparts. This could in part due to the fact that males participate more in production of cash (commercial) crops such as coffee whereas, females are more involved in food crops like beans.

However, farmers knowledge of CWD was not significantly ($p\geq 0.05$) dependent on age, sex nor educational level. This implies that all farmers irrespective of the category had knowledge of CWD - emphasizing the importance farmers attach to this disease in their farms (Nabeta, 2007; Unger, 2014).

Table 1: Sex, age and educational level as determinants of farmer's knowledge of the black coffee twig borer and coffee wilt disease

Constraint	Parameter	Df	Standard Estimate	Wald Error	Chi-Square	Pr > ChiSq
<i>Black Coffee Twig Borer</i>						
	Intercept	1	-1.3344	1.3639	0.9573	0.3279
	Sex	1	1.1200	0.5428	4.2574	0.0391
	Age	1	0.00560	0.0172	0.1053	0.7456
	Education level	1	-0.2500	0.3263	0.5872	0.4435
<i>Coffee Wilt Disease</i>						
	Intercept	1	-1.7781	1.5249	1.3597	0.2436
	Sex	1	0.7319	0.5770	1.6091	0.2046
	Age	1	-0.00437	0.0188	0.0541	0.8161
	Education level	1	-0.0538	0.3457	0.0242	0.8763

3.2 Farmers' knowledge of how to manage pests and diseases of coffee

Results further showed that the respondents had knowledge of managing only BCTB and CWD on their coffee (Table 2) – with more than 50% of them mentioning that they employ cultural methods to manage both pests. Cultural options are currently the most utilized methods for managing BCTB in Uganda (Egonyu et al., 2029; Kagezi et al., 2013, 2015, 2016a.b) and elsewhere (Jones and Johnson, 1996; Smith, 2003; Burbano, 2010) as well as CWD (Hakiza and Birikunzira, 2000; Nabeta, 2007; Kangire, 2014; Unger, 2014).

Cultural methods are local and therefore readily available. However, they are labor intensive, may be uneconomical and to be effective, they require to be applied at community level in order to reduce re-infection/infestation from non-managing neighboring farmers (Egonyu et al., 2009; Kagezi et al., 2013, 2016a,b; Kangire, 2014). Though most of the respondents had knowledge of managing BCTB and CWD, 80% of them lacked knowledge of how to manage other insect pests and diseases of coffee (Table 2). This calls for investment in extension services because some of these insect pests and diseases that are currently considered as minor by the farmers can easily explode into serious outbreaks with time (Kagezi et al., 2018).

Table 2: Respondents (%) mentioning the options they employ to manage the various pests and diseases of coffee in the coffee-banana agroforestry systems of mid-eastern Uganda

Constraint	Management option		
	Cultural (%)	Chemical (%)	Nothing (%)
<i>Pest</i>			
Black coffee twig borer	50.3	1.4	46.7
Biting ants	11.1	22.1	66.7
Stem borer	0.0	0.0	100.0
Mites	0.0	0.0	100.0
<i>Disease</i>			
Coffee wilt disease	79.3	2.1	18.8
Coffee leaf rust	0.0	0.0	100.0
Red blister disease	0.0	0.0	100.0

A simple logistic regression analysis showed that farmers' knowledge of managing both BCTB and CWD was neither dependent on sex, age nor education level of respondents (Table 3). Our finding implies that all the respondents irrespective of the category had knowledge on the management options of BCTB and CWD. This emphasizes the importance respondents attach to these two pests (Egonyu et al., 2009; Kagezi et al., 2012, 2013, 2016a, b; Nabeta, 2007; Unger, 2014).

Table 3: Sex, age and education level as determinants of farmer's knowledge of managing the black coffee twig borer and coffee wilt disease

Constraint	Parameter	Df	Standard Estimate	Wald Error	Chi-Square	Pr > ChiSq
<i>Black Coffee Twig Borer</i>						
	Intercept	1	5.5333	2.4427	5.1313	0.0235
	Sex	1	-0.3751	0.8946	0.1758	0.6750
	Age	1	-0.00649	0.0239	0.0740	0.7856
	Education level	1	-0.8455	0.5900	2.0534	0.1519
<i>Coffee Wilt Disease</i>						
	Intercept	1	-4.1031	2.3669	3.0050	0.0830
	Sex	1	1.6073	0.9130	3.0993	0.0783
	Age	1	-0.00536	0.0297	0.0325	0.8570
	Education level	1	0.0681	0.4826	0.0199	0.8878

3.3 Farmers' knowledge of pests and diseases of bananas

Figure 3 below shows the pests and diseases attacking banana in the coffee-banana agroforestry systems as mentioned by respondents in the mid-eastern Uganda. Farmers mentioned four pests infesting their bananas, namely, the banana weevil, black ants (kaasa), nematodes, and caterpillars. The banana weevil, *Cosmopolites sordidus* (Germar) was the most commonly mentioned pest of bananas – by 26% of the respondents. This finding agrees with several studies in Uganda that have recognized the importance of this pest (Gold et al., 2004). The weevil has been implicated in the decline and disappearance of highland banana from traditional growing zones in East Africa (Gold et al., 1999).

The adults lay eggs at the base of the plant (Abera et al., 1997) and the larvae are the most destructive stage of the banana weevil. Damage is primarily due to destruction of the corm or rhizome tissue by the larvae, which tunnel through it as they feed (Gold et al., 2001). Tunneling interferes with root initiation and development, impedes water and nutrient uptake and eventually leads to weakening of the whole plant (Acland, 1971).

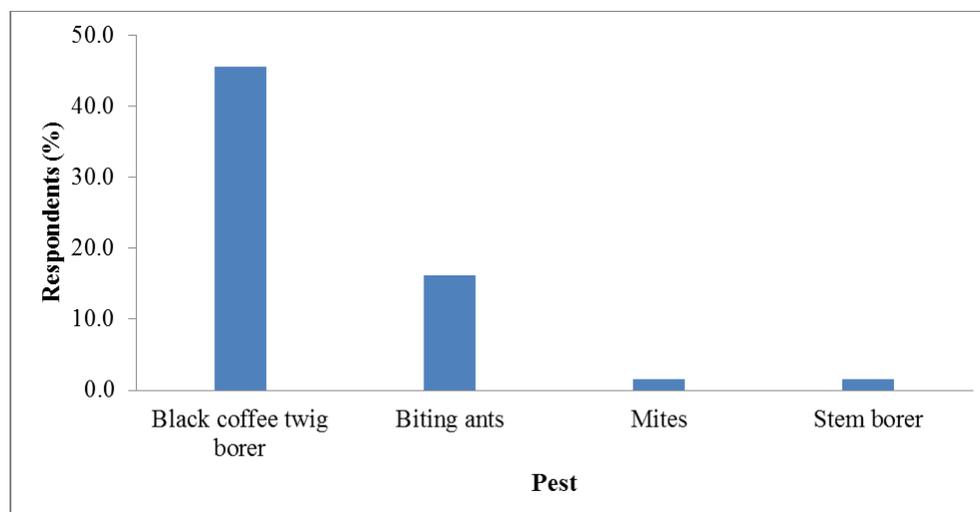


Figure 3: Respondents (%) mentioning the various pests of bananas in the coffee-banana agroforestry systems of mid-eastern Uganda

On the other hand, respondents mentioned three diseases attacking bananas in the mid-eastern coffee-banana agroforestry systems, namely, banana xanthomonas wilt (BXW), sigatoka and fusarium wilt (Fig. 4). BXW which is caused by *Xanthomonas campestris* pv. *Musacearum* was mentioned as the most important disease of bananas by most (84%) of the respondents. This result is in line with several other studies that recognize BXW as the most important disease of bananas in Uganda since its advent in 2000 (Bagamba et al., 2006; Kagezi et al., 2006; Jogo et al., 2011; Kubiriba et al., 2014). Unlike other diseases which cause gradually increasing losses over years, the impact of BXW is both extreme and rapid. The economic impact of BXW is due to death of the whole mat that would otherwise contribute to the ratoon plant production cycles (Nkuba et al., 2015). Farmers are able to easily recognize this disease due to its distinct symptoms of yellowing and wilting of leaves as well as oozing out of puss-like sap from a cut plant material (Bagamba et al., 2006; Kubiriba et al., 2014).

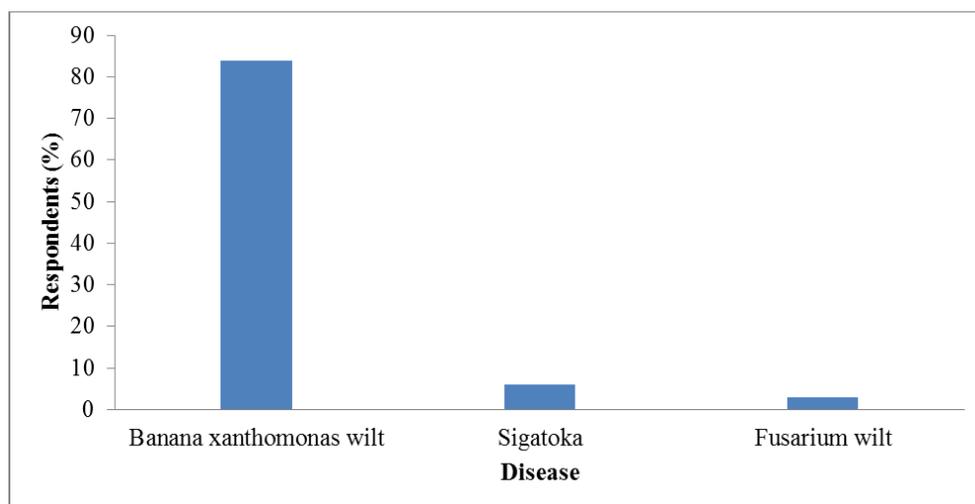


Figure 4: Respondents (%) mentioning the various diseases of bananas in the coffee-banana agroforestry systems of mid-eastern Uganda

A simple logistic regression analysis showed that farmers' knowledge of the banana weevil and BXW was neither dependent ($p > 0.05$) on sex, age nor education of the respondents (Table 4). This implies that all farmers irrespective of the category had knowledge banana weevil and BXW – emphasizing the importance farmers attach to these pests on their bananas (Okech et al., 2004, 2006; Bagamba et al., 2006).

Table 4: Sex, age and education level as determinants of farmer's knowledge of the banana weevil and banana xanthomonas wilt (BXW)

Constraint	Parameter	Df	Standard Estimate	Wald Error	Chi-Square	Pr ChiSq	>
<i>Banana weevil</i>							
	Intercept	1	0.3598	1.6091	0.0500	0.8231	
	Sex	1	0.5753	0.6665	0.7449	0.3881	
	Age	1	-0.00576	0.0206	0.0783	0.7797	
	Education level	1	0.3540	0.4073	0.7555	0.3847	
<i>Banana Bacterial Wilt</i>							
	Intercept	1	-0.2800	1.8558	0.0228	0.8801	
	Sex	1	0.2013	0.6985	0.0831	0.7732	
	Age	1	-0.0239	0.0254	0.8846	0.3469	
	Education level	1	-0.5746	0.4591	1.5668	0.2107	

3.4 Farmers' knowledge of how to manage pests and diseases of bananas

Farmers had knowledge of the management options for banana weevils, nematodes and ants (kaasa) but not caterpillars (Table 5). More than 50% of them mentioned that they were employing cultural methods for managing the banana weevils as well as the nematodes. This is in line with studies on the banana weevils (Masanza, 2003; Okech et al., 2004, 2006) and banana xanthomonas wilt (Bagamba et al., 2006; Kubiriba and Tushemereirwe, 2014),

Table 5: Respondents (%) mentioning options they employ for managing the various pests and diseases of bananas in the coffee-banana agro forestry systems of mid-eastern Uganda

Constraint	Management options		
	Cultural (%)	Chemical (%)	Nothing (%)
Pests			
Banana weevils	57.1	0.0	42.9
Nematodes	66.7	33.3	0.0
Ants (Kaasa)	55.6	0.0	44.4
Caterpillars	0.0	0.0	100.0
Diseases			
Banana bacterial wilt	87.7	0.0	12.3
Black Sigatoka	25.0	0.0	75.0
Fusarium wilt	100.0	0.0	0.0

A simple logistic regression analysis showed that knowledge of managing the banana weevil and BXW was not dependent ($p > 0.05$) on sex, age and education level of respondents (Table 6). Our finding implies that all farmers irrespective of the category had knowledge of the main pests damaging their bananas (Okech et al., 2004, 2006; Bagamba et al., 2006).

Table 6: Sex, age and education level as determinants of farmer's knowledge of managing the banana weevil and banana xanthomonas wilt

Constraint	Parameter	Df	Standard Estimate	Wald Error	Chi-Square	Pr > ChiSq
<i>Banana weevil</i>						
	Intercept	1	-12.7822	218.0	0.0034	0.9533
	Sex	1	12.8040	218.0	0.0035	0.9532
	Age	1	-0.0155	0.0789	0.0383	0.8448
	Education level	1	0.7072	1.4761	0.2295	0.6319
<i>Banana Bacterial Wilt</i>						
	Intercept	1	-0.5539	2.0383	0.0739	0.7858
	Sex	1	-0.7581	0.9145	0.6872	0.4071
	Age	1	-0.00300	0.0266	0.0127	0.9102
	Education level	1	-0.1900	0.5322	0.1274	0.7211

4.0 Conclusion

Most of the respondents interviewed had knowledge of the pests and diseases attacking both coffee and bananas in the coffee-banana agro forestry systems of mid-eastern Uganda. They mentioned four insect pests and three diseases attacking coffee – with the black coffee twig borer (BCTB) and coffee wilt disease (CWD) being the most commonly reported. The respondents had knowledge of managing both BCTB and CWD, mostly by employing cultural methods. However, most of the respondents had limited information on managing other pests and diseases. This calls for more farmers' awareness campaigns on all the pests and diseases of both coffee and bananas.

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