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Farmers' experiences in the management of pests and diseases of *Calliandra calothyrsus* in Uganda

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Abstract

Evaluation of farmers' experiences on pests and diseases is important for the development and introduction of management strategies that meet farmers' aspirations and are thus likely to be adopted by them. This paper documents farmers' knowledge, perceptions and control practices against pest and disease problems on an important agroforestry fodder shrub, *Calliandra calothyrsus*, in Uganda. A survey was conducted using a pre-tested questionnaire in three agroecological zones in the country viz.: Lake Victoria Crescent, Southern Drylands and Southern Highlands. In addition, samples of insect pests and diseased calliandra trees were collected during the survey. Farmers were aware and concerned about health problems on calliandra, but they lacked advice on pests and diseases that attacked the species. The most damaging health problem on calliandra was a dieback disease. Insect pests that may become important on calliandra, and thus require regular monitoring and control, include a scale insect, *Pulvinarisca jacksoni* (Newstead) and a termite species, *Marcrotermes subhyalinus* (Rambur). Other damaging agents reported by farmers included livestock, humans, birds and wild mammals. Of concern are also pest and disease problems, especially dieback and aphids (*Aphis fabae*), which farmers reported as common to calliandra and some crops. Farmers who attempted to control pest problems on calliandra relied on their own indigenous knowledge and experience. As agroforestry technologies are developed and promoted, there is a need to incorporate information on the diagnosis and management of pests and diseases of agroforestry components in dissemination packages.

Keywords: Agroforestry, *Calliandra*, farmer knowledge, pest management

Introduction

Calliandra calothyrsus Meissner (Mimosaceae), referred to as calliandra in this paper, is one of the most promising tree species in tropical agroforestry (Roothaert *et al.*, 1998). It is a fast growing nitrogen-fixing multipurpose tree species (MPTS) native to Central America and Mexico. In Uganda, calliandra is one of the MPTS that have been intensively evaluated under agroforestry programmes since 1989 for a variety of products and services, including fodder, fuelwood, stakes for climbing beans, soil erosion control and soil fertility improvement (Peden *et al.*, 1990; Wajja-Musukwe *et al*., 1998). The World Agroforesty Centre (ICRAF) through the Agroforestry Research Networks for Africa (AFRENA) project, jointly implemented by the Uganda Forestry Resources Research Institute (FORRI), initiated research on calliandra in Uganda. Since the mid-1990s, ICRAF and national partners have been actively involved in on-farm testing and promotion of calliandra in the southern highlands (Kabale district) and Lake Victoria crescent (Mukono and Wakiso districts) in Uganda, where initial estimates of adoption have been very encouraging, and indicate considerable scope for further expansion. In the same period, Vi Agroforestry project has spearheaded the promotion of calliandra in the southern drylands, particularly in Masaka and Rakai districts. Presently, several projects and non-governmental organisations (NGOs) are taking part in scaling up the promotion of calliandra in Uganda. Some NGOs such as Heifer Project International and Africa 2000 Network stipulate farmers to plant calliandra fodder supplementation before giving them improved dairy cows. This approach tremendously enhanced the dissemination of calliandra among beneficiaries of the dairy cows (Gerrits, 2000). However, one of the major constraints in scaling up the promotion of calliandra in Uganda pertains to lack of adequate information about farmers' knowledge, perceptions and practices in the management and utilisation of this important agroforestry species. Equally important has been the failure of some programmes to address areas where farmers' knowledge is inadequate. If scientists have to work with farmers to improve calliandra production and utilisation, they should recognise farmers' constraints and their existing technical knowledge. One of the major constraints to scaling up the adoption of agroforestry technologies is the increasing evidence of pest and disease problems, and the lack of knowledge of pest management practices in agroforestry systems (Boa and Bentley, 1998; Schroth, 2000). There has been increasing evidence of pests and diseases on calliandra

in the recent past. Singh-Rathore (1995) reported up to 15 species of phytophagous insects associated with calliandra from field visits to experimental sites in Burundi, Cameroon, Kenya and Rwanda. Gauhl et al. (1998) reported *Tragocephala guerini* White as a significant borer of calliandra branches in Cameroon. In Kenya, Kaudia (1990) attributed low seed production of calliandra or complete lack of seeds to the rose flower beetle, *Pachnoda ephippiata* Gerstaecker, feeding on calliandra flowers. In Uganda, a new and potentially threatening health problem has emerged on calliandra. It is characterised by die-back, wilting, poor vigour/stunted growth, leaf chlorosis, zigzagging of branches, premature flowering, and darkening and hardening of the branches, leading to the death of substantial parts of the tree. *Fusarium oxysporum* Schlecht., *F. solani* (Mart.) Sacc. and a *Phomopsis* species have been consistently isolated from infected calliandra samples, and could be responsible for the symptoms (Simons, unpublished report). An unidentified mealy bug and a brown scale (*Saisettia* species), which are capable of causing significant damage on young calliandra seedlings, have also been reported on calliandra in Uganda (Simons, unpublished report).

The wide range of pests and diseases reported on calliandra raise concerns of health risks as adoption of the species continues to expand. There has, however, been no published study on farmers' experiences and innovations in the management of pest and disease problems on calliandra. Such information is important in designing management strategies that meet farmers' aspirations and are thus likely to be adopted by them (Nyeko et al., 2002a). This paper documents farmers' awareness, perceptions and management practices against pests and diseases of calliandra in Uganda.

Materials and methods

Study area

This study was conducted in three ecological zones namely, Lake Victoria Crescent, Southern Drylands and Southern Highlands (Table 1) where farmers had substantial experience with calliandra. Lake Victoria Crescent (LVC) is characterised by intensive small-holder production of subsistence and cash crops, with land holdings ranging from 0.1 - 4.5 ha (NARO, 1995). Crops commonly grown in mixed cropping pattern include cassava (*Manihot esculenta* Crantz), sweet potatoes (*Ipomoea batatas* L.), maize (*Zea mays* L.), groundnuts (*Arachis hypogaea* L.), beans (*Phaseolus vulgaris* L.) and indigenous vegetables. Food crops are grown either at the edges or under canopies of bananas (*Musa* species), coffee (*Coffea arabica* L.) and other scattered trees. Isolated fruit trees such as avocado (*Persea americana*), jack fruit (*Artocarpus heterophyllus*) and mangoes (*mangifera indica*) are common within banana-coffee fields.

Southern Drylands (SDL) is characterised by short grassland where extensive grazing prevails. The communal rangelands are characterised by scattered *Acacia* species that provide shade for animals. The bimodal rains however, allow crop growth throughout the year. The agroforestry systems are mainly the extensive silvopastoral type where scattered *Acacia* trees and barrier hedges are common features in this zone. In Southern Highlands (SHL), the agricultural system is mainly based on production of annual crops, with land holdings ranging 1-3 ha. Farm size in Kabale district ranges from 0.3 - 2.4 ha with 28.3% of households having less than 1 ha (Aluma et. al., unpublished report). Commonly cultivated crops are Irish potatoes (*Solanum tuberosum* L.), peas (*Cajanus cajan* L. Huth), beans, sorghum (*Sorghum bicolour* (L.) Moench), maize and vegetables. Perennial crops include bananas, cassava, coffee and fruit trees. The main livestock kept in the three ecological zones (LVC, SDL and SHL) include cattle, goats and poultry. Cattle are kept basically for milk, meat, manure and occasionally income. Other livestock such as goats, sheep, pigs and poultry are mainly kept for sale and home consumption.

Research design and procedure

A total of 30 farmers who had grown calliandra for at least two years were selected from each of the three zones. Farmers were randomly selected from lists of agroforestry farmers in the zones, which were obtained from ICRAF (for LVC and SHL) and Vi agroforestry project (for SDL). The selected farmers were interviewed between November 2002 and February 2003 using a pre-tested semi-structured questionnaire. Respondents were interviewed in their local languages (Luganda or Rukiga), but their responses were carefully translated and recorded in English. To achieve this, research assistants from ICRAF and Vi agroforestry project, who were conversant with calliandra farmers and were fluent in both English and the local language in their respective zones, were recruited and trained to translate the questions to the farmers, and farmers' responses to the principal researcher.

In order to maintain consistency, the research questions were phrased in the way they should be asked. Most survey questions were open-ended in order to avoid limiting farmers' opinions. The questions sought farmers' socio-demographic and farm enterprises, and emphasis was placed on farmers' awareness and management of pests and diseases of calliandra. Farmers were also asked to name or described pests and diseases that were common to calliandra and crops and/or other multipurpose tree species. Interviews were conducted at the farmers' home or in calliandra fields, where such fields were within 1 km from a farmer's homestead and the farmer was willing to be interviewed on site. This enabled researchers to crosscheck farmers' answers with field observations. On average, it took 1 to 2 hours to interview each farmer. After every on-farm interview session, at least 10 *calliandra* trees in the respondent's farm were examined for the incidence and severity of damaging insects and diseases. The incidence of each pest or disease was scored, at farm level, as present

Table 1: Location and characteristics of study area.

Agro-ecological zone	Study district	Mean annual rainfall (mm)	Mean annual temperature (^oC)	Altitude (masl)	Soils
Lake Victoria Crescent (LVC)	Mukono and Wakiso	1750 - 2000	12 - 29	1000 - 1200	Ferralitic clay loams
Southern Drylands (SDL)	Masaka and Rakai	under 1000	18 - 32	1300 - 1600	Ferralitic clay loams
Southern Highlands (SHL)	Kabale	1000 - 1500	10 - 23	1800 - 2800	Ferralitic red loams and sandy clays

or absent. Severity of damage by each pest or disease was scored into three scales: low (less than 25% of trees examined attacked), moderate (25-50% of trees attacked) and high (more than 50% of trees attacked). Damaging insects on the species were sampled using a beating tray or by handpicking. All insect samples were preserved under 70% ethanol in vials for later identification and reference. Identification of insect samples was done from the Natural History Museum, UK while pathogens were isolated and identified from Makerere University and Kawanda Agricultural Research Institute (KARI), Uganda.

Survey data were analysed using SPSS statistical package. Percentages, totals and means on selected variables were determined using descriptive statistics and cross-tabulation of either single or multiple responses. Farmers' ratings of variables such as farm enterprises were converted into scores, and total or mean scores determined. The incidence of each pest and disease observed was expressed as the percentage of total farms visited found having the pest or disease.

Results

Household and farm characteristics

Overall, 56% of the respondents interviewed in this study were women, but the majority (77%) of households were male-headed (Table 2). On average, there were about eight individuals per household in all the ecozones studied. The respondents comprised predominantly of two tribes, the Baganda in LVC (97%) and SDL (90%), and the Bakiga in SHL (100%). The majority of respondents in the three ecozones were middle aged (30 - 59 years old). Most farmers either purchased or inherited their farmlands. However, whereas up to 40% of the respondents owned both purchased and inherited farmlands in SHL, only 10% and 13% did so in LVC and SDL. Average farm size ranged from 1.7 ha in LVC to 2.3 ha in SDL and SHL (Table 2). Farmers' rating of their five most important farm enterprises varied between the ecological zones. Important farm enterprises mentioned by at least 60% of the respondents in the different zones included dairy cattle (83%), banana (70%) and cassava (66%) in LVC; banana (87%) and coffee (73%) in SDL; and sweet potato (100%), beans (87%), sorghum (77%) and vegetables (60%) in SHL. Sorghum, Irish potato and peas were reported as important only in SHL. Similarly, only farmers in LVC and SDL considered cassava and vanilla as important farm enterprises.

Cultivation of Calliandra calothyrsus

Methods of cultivating calliandra differed between the ecozones. Planting of nursery grown seedlings was the most commonly used method in LVC and SHL regions (Table 3), where calliandra was mainly promoted by ICRAF. In contrast, farmers in SDL who where mostly advised by Vi Agroforestry project used direct sowing method. Although up to 43% and 67% of farmers in LVC used wildings (young seedling that develop in the wild without the help of humans) in their second and third planting respectively, only 8% of respondents reported using wildings in SDL and none reported this method in SHL (Table 3). Farmers either transplant wildings in prepared sites or simply tend and leave them to grow from their germination spots. Up to 80% and 77% of farmers in SDL and SHL planted calliandra for the second time compared to only 47% of the farmers interviewed in LVC (Table 3). Similarly, more farmers planted calliandra for the third time in SDL (23%) and SHL (30%) than those in LVC (10%). A few farmers (10% in LVC and 17% in SHL) reported planting calliandra for the fourth time, and about 10% of the farmers claimed to have been planting calliandra annually for over four times.

During this study, average number of trees per household was highest in SDL (924 trees) followed by SHL (626 trees), and was least in LVC (362 trees). Farmers reported planting calliandra in several niches with field boundaries being the most popular niche in all the ecozones. Among the three zones, scattered planting of calliandra in cropland was most practised in LVC, but was limited only to the first and second plantings. Planting calliandra along banks of soil and water conservation ditches was most reported in SDL. Although this practice was least reported in SHL, it appears to be gaining popularity among farmers as a greater percentage of them mentioned it for their third planting (22%) compared to the first (3%) and second (4%) plantings. Only on calliandra in SHL, and rated the insect as causing low damage. In contrast, the majority of farmers rated livestock damage on calliandra as highly severe in all the zones.

Table 2: Profile of farmers

Variable	Response		
	LVC	SDL	SHL
Gender (% of respondents)			
Male respondents	40.0	43.3	50.0
Female respondents	60.0	56.7	50.0
Male headed households	76.7	90.0	93.3
Female headed households	23.3	10.0	6.7
Average family size			
Males	4.1 (1.6)	4.1 (2.7)	3.7 (1.8)
Females	3.9 (1.9)	4.1 (2.2)	4.3 (2.3)
Total	8.0 (2.7)	8.2 (4.3)	8.0 (3.2)
Ethnicity (% of respondents)			
Baganda	96.7	90.0	0.0
Bakiga	3.3	3.3	100.0
Banyarwanda	0.0	3.3	0.0
Basoga	0.0	3.3	0.0
Age (% of respondents)			
18-29 years	6.7	6.7	16.7
30-39 years	20.0	26.7	10.0
40-49 years	20.0	6.7	26.7
50-59 years	30.0	40.0	20.0
60-69 years	20.0	16.7	20.0
70+ years	3.3	3.3	6.7
Land tenure (% of respondents)			
Purchased	46.7	56.7	40.0
Inherited	43.3	30.0	16.7
Both purchased & Inherited	10.0	13.3	40.0
Church land	0.0	0.0	3.3
Farmland			
Average farm size (ha)	1.7 (1.1)	2.3 (2.0)	2.3 (2.4)
Average duration on land	28.6 (16.6)	25.5 (14.2)	24.9 (14.3)

Figures in parentheses are standard deviations.

Table 3: Methods used by farmers in their first, second third plantings of calliandra.

Method	% of respondents								
	LVC			SDL			SHL		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Direct sowing	10.3	21.4	33.3	66.7	76.9	100.0	0.0	8.3	10.1
Nursery seedlings	93.1	35.7	33.3	36.7	26.9	0.0	100.0	95.8	90.0
Wildlings	0.0	42.9	66.7	0.0	7.7	0.0	0.0	0.0	0.0
Total respondents	30	13	3	30	24	7	30	23	9

Farmers reported some variation in pest and disease severity with tree age. Damage by scales (75%), dieback (72%) and stem-boring insect (100%) was commonly reported to be most severe on mature trees between (1-5 year old). Weaverbird was reported as damaging to flowers, pods and seeds. Conversely, most farmers (63%) reported livestock, especially goats and cattle, as causing severe damage to all growth stages of calliandra. The majority of farmers who had observed termite damage (58%) reported it as most severe on less than one-year old calliandra, but up to 33% of the farmers considered coppices from over 5-year old stumps as most severely damaged by the insect.

Seasonal variability in the severity of dieback seemed less obvious to farmers as 33%, 28%, 22%, reported the disease as most severe in dry season, wet season and throughout the year respectively, and 17% of them were not sure. Similarly, equal proportion of farmers (38%) reported damage by scales as most severe in wet and dry season, 13% considered it as equally severe throughout the year while 13% were not sure. However, the majority of farmers considered damage by birds (50%), livestock (64%), stem boring insect (100%) and aphids (100%) as equally severe throughout the year. All farmers who reported damage by termites and wild animals considered these pests as most damaging in the dry season.

The majority of farmers who observed calliandra pests claimed that the pests were also damaging to other tree species and/or crops (Table 5). A mealy bug species, *Planococcus kenyae* (Le Pelley), reported by one farmer in SDL to be damaging to calliandra and coffee was sampled during the survey, and was confirmed to be occurring on both crops. However, no sample of another mealybug species, *Saccharicoccus sacchari* (Cockerell), which one farmer claimed to have observed damaging sugarcane and calliandra was observed on the latter during the survey. Nearly all farmers who observed dieback on calliandra claimed to have observed similar symptoms of the disease on coffee and banana. One farmer in SDL actually uprooted calliandra that she had planted on the boundary of a banana plantation in fear that the dieback disease she observed on calliandra would spread to her banana. This indicates the need for urgent verification of farmers' perceptions on the occurrence of calliandra pests and diseases on companion crops.

Farmers' management practices

The majority of farmers who reported damage by scales (55%), termites (75%), black ants (67%) and livestock (79%) had attempted to control the pests (Table 6). However, control of dieback, which was most reported by farmers (32%), was attempted by only 38% of those who observed the pest. Of the one and two farmers who reported damage by aphids and seed boring insect respectively, none attempted controlling the pests. Farmers reported using a variety of control methods against the different pests they observed (Table 7). However, application of chemical pesticides (Ambush: permethrin, Dusban: chlorpyrifos, and Salut: dimethoate and chlorpyrifos) was mentioned only against scales and termites. Farmers rated these chemicals as highly effective against the pests, but one farmer noted that treated termite mounds are sometimes recolonised by termites. Several cultural methods including pruning, intercropping, and application of plant extracts, wood ash, and red pepper were reported against insect pests and dieback. The control methods farmers considered effective against dieback included application of decomposed cow dung around infected trees, and uprooting and burning infected trees. Farmers rated application of mixtures of (1) *Melia* leaves, goat urine, ash and red pepper or (2) mixtures of ash, *Tephrosia* leaves and marigold leaves, as highly effective against termites. The farmer who intercropped calliandra with *Melia azedarach* considered this method moderately effective against termites. Similarly, two farmers rated the application of ash on the stems of trees attacked by scales as moderately effective against the pest. However, one farmer considered this method ineffective against scales.

The majority (95%) of the respondents were not aware of the effects of different tending operations on the incidence of insect pests and dieback on calliandra. Only 4% of them claimed that weeding and regular cutting of calliandra reduce the severity of scales and dieback. Similarly, only 1% of the farmers observed that planting calliandra in banana plantation increases the severity of pod and seed damage caused by weaverbirds because the birds construct their nests on banana. Up to 100% of the respondents who observed livestock damage on calliandra reported that weeding and thinning had no effect on the incidence of livestock damage on the species. Of the 14 farmers who reported livestock damage, 92% tethered their animals and/or used zero or paddock grazing to control their damage. Neighbours with damaging livestock were either warned or reported to local councillors for court action in case of failure to comply with such warnings. Only 1% of the respondents had received some advice in relation to pest problems on calliandra. This farmer claimed to have been advised by ICRAF to remove dieback-infected trees in order to control the disease.

The farmers who did not attempt to control the pests they had observed on calliandra cited a number of reasons for their lack of control action. Up to 43% of the farmers who did not control dieback reported lack of knowledge on the causal agent of the disease. In contrast, only 6% of the 54 farmers who reported pests and/or diseases on calliandra mentioned lack of money to purchase chemical to control the different pests and/or diseases they observed. Some 10% of the 30 farmers who observed scales and dieback damage on calliandra were afraid of applying chemical pesticides against the pests in fear of contamination of the calliandra fodder that they fed to their animals. This indicates the importance of educating farmers on the side effects of pesticides when recommending them to farmers.

Table 4: Farmers' awareness of pests and diseases of calliandra in LVC, SDL and SHL

Pest/disease	% of respondents			
	LVC (n = 30)	SDL (n = 30)	SHL (n = 30)	Total (n = 90)
Dieback	43.3	23.3	30.0	32.2
Livestock	13.3	30.0	16.7	20.0
Scales	20.0	16.7	6.7	14.4
Termites (Enkuyege, Emishwa)	26.7	10.0	3.3	13.3
Weaverbird (Ndegeya, Omushure)	0.0	10.0	10.0	6.7
Humans: thieves or vandals	3.3	6.7	10.0	6.7
Black ants (Ebisamunyu)	3.3	0.0	6.7	3.3
Seed boring larvae	0.0	6.7	0.0	2.2
Aphids	3.3	3.3	0.0	2.2
Wild animal (Ngabbi)	3.3	3.3	0.0	2.2
Stem boring insect	0.0	3.3	0.0	1.1
Mealybug (Ntonyeze)	3.3	0.0	0.0	1.1
Caterpillar (Obusanyi)	3.3	0.0	0.0	1.1
Rats (Embeba)	0.0	0.0	3.3	1.1
Moles (Efukuzi)	0.0	0.0	3.3	1.1

Words in parentheses are local (Luganda or Rukiga) names of pests.

Table 5: Farmers' perceptions on the occurrence of calliandra pests on other trees and crops

Pest	Susceptible crop and tree species
Dieback	Coffee, banana, cassava, tomato, beans, isrish potato, peas, sugarcane
Termites	Maize, groundnuts, cassava, sugarcane, coffee, *Grevillea robusta*, *Eucalyptus* species
Scales	Coffee, cassava, napier, egg plant, sugarcane,
Black ants	Avocado, green vegetables (Eswiga), beans
Aphids	Beans
Mealybug	Coffee, sugarcane, peas, *Ficus natalensis*
Caterpillars	*Sesbania sesban*
Weaver bird	Beans, maize, vanilla, banana, sorghum
Wild animal	Cassava, napier, green vegetables, Tanzanian grass
Rats	Beans, peas
Livestock	Cassava, sweet potato, jack fruit, banana, sorghum, maize, beans
Thieves	Maize

Table 6. Percentage of farmers who attempted controlling pests on calliandra.

Pest/disease	Total number of respondents who observed pest/disease	Percentage of respondents who observed pest/disease and attempted to control
Dieback	29	37.9
Livestock	14	78.6
Termites	12	75.0
Scales	11	54.5
Weaver bird	6	33.3
Black ants	3	66.7
Vandals	3	33.3
Unknown wild animal	2	50.0
Seed boring insect	2	0.0
Rats	1	100.0
Aphids	1	0.0

Researchers' on-farm assessment

Researchers visited calliandra gardens of all the interviewed farmers, except one farmer in each of LVC and SDL, and three farmers in SHL. Although researchers observed a number of pests and diseases on calliandra during this study, their incidence and severity were generally low (Table 8). Dieback was the most common health problem observed on calliandra, the majority of which occurred in LVC (50%) followed by SDL (34%) and SHL (16%). This disease was most severe in SDL where it was found causing highly severe (over 50% tree mortality) damage in 7% of the farms visited in this region. *Fusiarium oxysporum* and a *Phomopsis* species were the pathogens isolated from calliandra samples with dieback symptoms. Only one termite species, *Macrotermes subhyalinus* (Rambur) was observed damaging calliandra. Most (63%) of the damage by this species was observed in LVC and only one farm in SHL had calliandra infested by the termite. Damage by weaverbird was observed only on seed producing calliandra trees, the majority of which were in SDL. However, a bird species called '*Ekyiswa*' in Rukiga was observed causing serious damage in one nursery in SHL. The bird pecked off the shoots and cotyledons of all newly germinated/germinating calliandra in the nursery.

Discussion

Information about farmers' knowledge on health problems on calliandra is generally scant in the literature. In this study, farmers reported a number of calliandra pests including insects, mammals and birds, and dieback disease. This suggests that pest attack on the tree species was, in general, widespread in Uganda. Of the pests farmers reported, scales, dieback and livestock damage seemed common to all the zones studied. However, marked differences were observed in farmers' awareness of pest problems in the different zones, indicating patchy distribution of some pests. For example, termites were more often mentioned as a pest on calliandra in LVC and SDL than in the cooler SHL. Differences in pest awareness among farmers may also be due to variation in farmers' main objectives of cultivating calliandra. For examples, farmers growing calliandra for fodder and soil fertility may not consider weaver birds, which damage pods and seeds, as a pest major problem, yet the bird could be a serious pest to those cultivating the shrub for seed production.

Farmers demonstrated some good knowledge of local pest control methods, especially against termites, scales and dieback (Table 7). Various parts of plants and plant extracts are known to be either toxic or repellent to pests of crops and trees, and are widely used by small-scale farmers. For example, extracts from plants such as neem (*Azadirachta indica*), red pepper, *Tithonia* species, *Tephrosia vogelii* or wood ash, and cow dung and urine have been used to control termites in the field (Wardell, 1987; Logan et al., 1990). There has, however, been no published report on the use of such products against scales and dieback on calliandra, possibly because of the relatively new appearance of these health problems on the shrub. In this study, farmers reported application of decomposed cow dung around infected trees, and uprooting and burning infected trees to be effective against dieback. In addition, farmers rated mixtures of *Melia* leaves, goat urine, ash and red pepper or ash, *Tephrosia* and marigold leaves as highly effective against termites. Ash was reported to be moderately effective against scales. Research is necessary to verify the potential benefit of using such indigenous methods and to establish specific recommendations for their large-scale utilisation in agroforestry. In Kenya, Roothaert et al. (1998) recommended spraying scales on calliandra with a washing detergent dissolved in water, but the authors neither indicated the name of the detergent nor its required dose and frequency of application for effective control of the pest. Although some farmers reported spraying their calliandra with chemical insecticides (Ambush: permethrin, Dusban: chlorpyrifos, and Salut: dimethoate and chlorpyrifos) in this study, some of them were interestingly reluctant to do so, in fear that pesticide treated fodder could be dangerous to their animals. This indicates the importance of educating farmers on the side effects of pesticides when recommending them to farmers.

The fact that only one farmer had received some advice on calliandra pest problems is alarming. This indicates that the majority of farmers relied on their own experience in detecting and managing pest problems on calliandra rather than being advised on potential pest problems on the species prior to planting. Clearly, agricultural extension agents need to put more efforts in transferring, to farmers, pest-related information such as potential species of pest, damage symptoms, factors contributing to pest outbreaks, effects of pest infestations, and possible solutions to pest problems, in order to strengthen farmers' pest identification and management abilities. However, it should be emphasised that information programmes need not so much to stress that outbreak infestations exist, but rather, should critically assess the ecological and economic implications of outbreaks so that farmers can develop informed opinions about different pests (Nyeko et al., 2002a). For this to be effective, dissemination officers must be knowledgeable about the identity and management techniques of a given pest species or complex. As this is not often the case (Nyeko, 2001), it may be necessary for pest control programmes to commence with training of trainers to ensure that correct information is delivered to and received from farmers. This way, dissemination officers can act as liaisons between scientists, pest management specialists, and farmers while respecting each group's idiosyncrasies (Dix, 1996).

The biological survey showed a number of potential insect pests on calliandra although none had high damage incidence and severity (Table 8). However, single field visits, as conducted in this study, may not give a clear picture

Table 7. Control methods used by farmers against pests and diseases on calliandra.

Control method	Pest/disease	Responses	
		No.	%
Ash: dust infected trees with ash	Scales	3	5.4
Chemical: spray with Ambush, Dusban or Salut	Scales, dieback and termites	9	16.1
Cut affected trees and leave stumps to sprout	Scales, dieback and weaverbird	4	7.1
Spot apply manure around infected trees	Dieback	1	1.8
Spot apply cow urine + black jack + ash mixture	Termite	2	3.6
Uprooting and burning infected trees	Dieback	7	12.5
Spot apply cow urine	Termite	1	1.8
Spot apply *Melia* leaves + goat urine + ash + pepper	Termite	1	1.8
Intercropping with *Melia azedarach*	Termite	1	1.8
Destruction of termite mound	Termite	2	3.6
Spray with ash + *Tephrosia* leaves + Marigold leaves	Termite	1	1.8
Use bait: cooked potato + rat poison	Rats	1	1.8
Scarecrow in garden	Weaverbird	1	1.8
Guarding garden	Livestock and wildanimal	2	3.6
Warning to owners	Livestock	5	8.9
Reporting to local councillors	Livestock	2	3.6
Tethering, constructing strong paddock and/or zero grazing units	Livestock	13	23.2

Table 8. Researchers' rating of pest and disease damage on calliandra in farmers' fields.

Pest	Incidence	Severity		
	(n = 85 farms)	Low	Moderate	High
Dieback	37.6	20.0	15.3	2.4
Livestock (goats, cattle and sheep)	15.3	8.2	4.7	2.4
Pulvinarisca jacksoni (scale)	12.9	10.6	2.4	0.0
Macrotermes subhyalinus (Termite)	11.8	9.4	2.4	0.0
Apidoproctus species (giant mealy bug)	3.5	3.5	0.0	0.0
Myrmicaria opaciventris (black ant)	3.5	3.5	0.0	0.0
Aphis fabae (aphid)	2.4	2.4	0.0	0.0
Planococcus kenyae (mealybug)	2.4	2.4	0.0	0.0
Weaver bird	5.9	2.4	3.5	0.0

of pest problems since pest populations generally vary markedly over time (Nyeko *et al.*, 2002b). Insect species such as *Macrotermes subhyalinus* and *Pulvinarisca jacksoni* that were found causing mortality of calliandra, albeit with low incidence, may become more important as cultivation of calliandra intensifies in Uganda. Therefore regular monitoring is required to assess the population and damage dynamics of such pest species, and also to identify new important pest species that may emerge on calliandra.

Another concern is the occurrence on calliandra of insects known to be serious pests of crops or other multipurpose tree species. Particularly noteworthy in this study is *Aphis fabae*, known to be a serious pest of some crops and trees. In southern Malawi, Sileshi *et al.* (2000) recorded *A. fabae* feeding on *Arachis hypogeae*, trees including *Cajanus cajan*, *Gliricidia sepium* and *Sesbania sesban*, and some weedy species. Populations of such pests, particularly on annual crops, may be increased by the presence of calliandra as the latter, being perennial, can provide a ready food source for the pests in periods when the crop hosts are off-season (Mchowa and Ngugi, 1994; Singh-Rathore, 1995).

A potentially devastating disease of calliandra is dieback. The primary cause of this disease was not obvious in this study due to a complex of fungal species isolated from diseased specimens. The isolation of *Fusarium oxysporum* and a *Phomopsis* species is consistent with earlier diagnosis of similar specimens from Uganda (Simons, unpublished report), suggesting that one or both of the pathogens are the primary causes of the disease. Roothaert *et al.* (1998) reported *Nectria ochroleuca* as the cause of similar dieback symptoms on calliandra, but this fungus was not isolated in the present study. Clearly, an inoculation test is urgently required to establish the cause of the dieback disease. In addition, screening trials incorporating calliandra

provenances and species from different origins are necessary to determine if genetic resistance against the disease exists in other calliandra species and/or provenances. Furthermore, farmers' perceptions on the occurrence of calliandra dieback on coffee and banana need urgent verification.

Conclusions

Although this study focused only on calliandra in Uganda, its findings have implications in scaling up agroforestry technologies in several tropical countries. It is clear from this study that farmers lack advice on pests and diseases of calliandra. Such missing links can seriously affect the credibility of not only agroforestry technologies, but also the scientists and organisations promoting the technologies in the eyes of farmers. Farmers rely on their indigenous technical knowledge (ITK) to control pest and disease problems on calliandra. Although work on ITK has shown that under certain circumstances farmers know more than scientists, we must not let this blind us to the fact that in other situations they do not have some of the vital information that would help them understand the rationale behind the development of pest and disease control measures. For example, farmers' lack of knowledge on the cause of calliandra dieback in our study indicates that their control attempts against the disease were based on trial and era, the efficacy of which requires verification. The policy implication here is that as agroforestry technologies are developed and promoted, there is a need to integrate pest diagnosis and management techniques into the scaling-up process in order to improve farmers' pest management practices.

The suite of pest and disease problems observed on calliandra in our study is a pointer to the need for systematic observations on pests and diseases in ongoing agroforestry research. In this way, pest specialists may identify pest problems that could be alleviated through agroforestry practices and develop corresponding experimentation programmes in co-operation with agroforestry scientists and farmers. For example, greater diversification of fodder shrubs, with emphasis on screening indigenous species identified by farmers, could reduce the risk of pest and disease attacks and thus improve feed quality and reliability.

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