# 12
# Evaluating Preventative Measures Against CWD

*…agricultural research in Africa had generally yielded few benefits for poor people because it was elitist and out-of-touch with rural realities; … too often interested only in productivity to the detriment of sustainability; 'reductionist' as opposed to 'holistic'; and top-down or supply driven, not participatory or demand-driven. While each of these assertions has been contested, the combined weight of this critique proved difficult to parry.*
(Sumberg, 2005)

## 12.1 Main Findings

- In Ethiopia, Democratic Republic of Congo (DRC), Tanzania and Uganda, on-farm participatory trials and classical research station trials were carried out using a number of possible techniques to prevent coffee wilt disease (CWD) infection.
- Through pre-initiation workshops, farmers were consulted about the treatments to be applied and some of their suggestions were incorporated into the experiments.
- The most salient result was that ways to limit the use of machetes or slashers seemed to have the most effect on lowering the incidence of CWD.
- Fungicide stem applications and herbicide sprays also showed promise in some cases, but may be too expensive for many of the poorest farmers.
- Some of the trials were inconclusive, especially the on-farm trials. This is to be expected given the large range of confounding factors that can affect the outcomes.
- The results were generally deemed important by a wide range of stakeholders, however, and similar trials should be repeated with a larger number of replicates so that accurate cost–benefit analysis can be carried out for these candidate measures, to arrive at optimal prevention strategies for a range of coffee farming systems.

## 12.2 Introduction

For each of the participating countries where CWD is present, it was proposed that the effects of various agronomic practices and control methods on CWD would be studied using a dual approach, i.e. on-farm field trials run according to farmer participatory methods and a classical scientific on-station approach.

According to the biological and socio-economic surveys (Chapters 2 and 3), a number of factors seemed to be impacting on the incidence of CWD in Ethiopia, Uganda and Tanzania. Factors which might be having an effect on CWD included the use of mulch, fertilizers and herbicides and various weeding methods.

During the Regional Coffee Wilt Programme (RCWP) workshop held at CAB International Africa, Nairobi (13–14 November 2002), it was agreed that field trials

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should be conducted from 2003 to assess the effects of agronomic practices and control methods on the incidence of coffee wilt. At this meeting, it was agreed that a farmer field school (FFS) approach should be used for on-farm trials and, additionally, that the participatory approach should also be used to come up with treatments for each country. Hence the treatments finally selected came from: (i) the results of the biological surveys; (ii) farmers' experiences; and (iii) the literature.

## 12.3 Materials and Methods

In order to agree on CWD management options and control strategies to be evaluated in trials, a workshop was held in each country, which included farmers, extensionists and scientists. Scientists from national coffee programmes and CAB International facilitated the workshops. A document outlining the trial details was circulated to all participating collaborators before the workshops were held. Pre-trial initiation workshops were held in Uganda, Tanzania and Ethiopia. Farmer representatives, extension and research staff were brought together in each of the participating countries for a period of 3 days.

The main aims of the workshops included:

1. To select the CWD treatment options to be included in the on-station and on-farm trials; and
2. To discuss the type of experiment and design and how to collect data.

Other topics were covered for training purposes, including the country status, the identification, and the current management practices of CWD, as well as farmer participatory research.

### 12.3.1 Coffee wilt disease treatment options

Treatment options which were evaluated in on-station and on-farm trials were agreed during pre-trial workshops, which included farmer representatives, extensionists and researchers. Details of treatment options which were evaluated in the participating countries can be seen in Table 12.1.

### 12.3.2 Rates and application of treatments

Details of treatment applications are as follows:

- *Mulch* – to be applied at least 30 cm from the coffee stem, a layer 10–15 cm deep.
- *Herbicide* – Roundup®, diluted at the rate of 50 ml in 5 l of water, applied twice per year with a knapsack sprayer.
- *Fungicide stem paint* – copper oxychloride (50% WP), diluted at the rate of 300 g in 1 l of water, and applied with a paint brush to the first 50 cm of the stem (starting from the base). The treatment to be applied at a frequency of once every 4 months.
- *Ash* – to be heaped around the coffee stem. One 3 l bucket full of ash to be applied per coffee bush.

**Table 12.1:** Coffee wilt disease (CWD) management and control options that were evaluated in on-station and on-farm trials.

| | Treatments | Democratic Republic of Congo(DRC) | Ethiopia | Tanzania | Uganda |
|---|---|---|---|---|---|
| | **Agronomic practices** | | | | |
| 1 | Mulching | | √ | √ | √ |
| 2 | Weeding with a hoe | √ | | √ | √ |
| 3 | Slashing and hand weeding under the coffee tree canopy | | √ | | |
| 4 | Slashing only | √ | √ | | |
| 5 | Herbicide use | √ | √ | √ | √ |
| 6 | Pruning | √ | | | |
| | **Control methods** | | | | |
| 7 | Use of ash | | √ | √ | √ |
| 8 | Copper oxychloride stem paint | √ | √ | √ | √ |
| 9 | Copper oxychloride stem spray | √ | √ | √ | √ |

- *Fungicide stem spray* – copper oxychloride (50% WP) sprayed on to the stem only, to be diluted at the rate of 40 g per 7.5 l of water and applied once a month during the rainy season, and once every 3 months during the dry season.

- *Control* – the control in Uganda and Tanzania was *hoe weeding* only, while the control in Ethiopia was *slashing*, a common practice for controlling weeds.

- *Slashing plus hand weeding* – the treatment was chosen for Ethiopia only. Slashing to be carried out to control weeds between coffee bushes. In addition, weeds close to the stem to be hand-picked to avoid wounding the stem with a slasher. Details of dates for first treatment application, number of sites and coffee type in each country are given in Table 12.2. Examples of how two treatments were applied are shown in Figure 12.1.

### 12.3.3 Trial design and replication

The treatments were evaluated according to farmer participatory methods, involving farmers and extension and research personnel for all on-farm trials. All treatments were laid out in a completely randomized block design with each farmer as a replicate for on-farm trials. All treatments were evaluated at each farm for on-farm trials. The treatments were sited on 12 farms in DRC, 11 farms in Uganda and Tanzania and 16 farms in Ethiopia.

On-station trials were carried out in Uganda, Ethiopia and DRC. There was no coffee farm large enough (near a source of CWD inoculum) to accommodate a replicated trial in Tanzania. Each site had four replicates, except one site in Uganda which had six replicates.

**Figure 12.1:** Examples of treatment application; use of ash (*above*) and copper stem spray (*below*).

The plot size for on-farm and on-station trials was 15 healthy-looking well-established coffee bushes showing no CWD symptoms. All treatment plots were randomly assigned to each replicate (or farm, in the case of on-farm trials). To facilitate the ease of treatment plot identification by farmers who were managing the trials with the support of extension and research personnel, colour coding was used. A treatment was represented by an agreed colour, therefore 15 coffee bushes in the plot for the treatment were painted or tagged with the agreed colour, such as green for mulch treatment.

The trials were exclusively on Robusta coffee in DRC, Uganda and Tanzania, and on Arabica only in Ethiopia. CWD was found to be infecting Robusta coffee only in DRC, Tanzania and Uganda. A strain of the same disease was confirmed as infecting Arabica coffee in Ethiopia only.

**Table 12.2:** Details for each country regarding dates for trial initiation, number of trials (on-station and on-farm).

| Country | Dates for trial initiation and treatment application | Number of on-station trial sites | Number of on-farm sites |
|---|---|---|---|
| Uganda | 16 June–1 July 2003 | 2 | 11 |
| Ethiopia | 3–12 August 2003 | 3 | 16 |
| Tanzania | 27 July–2 August 2003 | No on-station trials | 11 |
| Democratic Republic of Congo (DRC) | 24 August–10 September 2003 | 3 | 12 |

Due to the slow rate of infection in the treatment plots, final CWD incidence figures were used to evaluate treatment effectiveness after 3 years (during calendar years 2003–2006) of evaluation. All data were analysed with GenStat 9th edition after transforming using square root transformation.

In all the trials, NPK (23:21:0) fertilizer was applied at the rate of 250 g per tree. However, in Tanzania, farmers were growing their coffee organically, and did not want to apply inorganic fertilizer. Cattle manure was therefore applied at the rate of two 20 l containers full of decomposed cattle manure per tree every 2 years in all trial sites in Tanzania.

The trials were initiated in the different participating countries from 16 June to 10 September 2003. Details of number of trial sites and dates for trial initiation are presented in Table 12.2.

### 12.3.4 Open days at trial sites

Open days were held at several representative on-farm trial sites in order to introduce the CWD management technologies that were being evaluated and to stimulate the interest of many farmers, intermediary organizations and policy makers, as well as to create an environment in which informal contacts and learning could take place. The open days at trial sites combined demonstrations, comparisons and discussions on introduced techniques. Each open day was hosted by a participating farmer (the one managing the trial) and was attended by neighbouring farmers, non-governmental organizations (NGOs), local leaders and government officials. Invited media (national and local) covered the day's event in most cases. The national project coordinator, the field extension officer, the participating farmer and the local leaders decided on the essential details of the open day that included, among other things, technologies which were shown, division of work and responsibilities and the exhibition and distribution of dissemination materials (posters, leaflets and booklets, mostly in local languages).

All open days were publicized well in advance in each country in order to have a large audience. The publicizing included signboards displayed at the study plot. All the visitors were taken around the study plot, ensuring that they saw the important points of the demonstrations. The participating farmer explained the new technologies that were being evaluated.

After a tour of the study plot, the project coordinator and the extension officer facilitated a discussion with the participants (farmers and other visitors) about the technologies

**Table 12.3:** Coffee wilt disease (CWD) management options (treatments) which were chosen and were validated in farmer field schools (FFSs).

| Country | Management options chosen and validated in FFSs |
|---|---|
| Tanzania | Ash and fungicide stem paint |
| Uganda | Mulch and fungicide stem spray |
| Ethiopia | Mulch, fungicide stem spray, slashing plus hand weeding |
| Democratic Republic of Congo (DRC) | Fungicide stem spray and the use of herbicide |

which were being evaluated and demonstrated. Open days were held at the representative trial sites; however, individual visits by farmers, government officials, NGOs and politicians also took place at the different on-farm trial sites. More details on open days in terms of figures of those who visited are provided in Chapter 14.

### 12.3.5 Workshops to discuss on-farm trial results

Workshops were held in all countries where on-farm trials were taking place. The objective was to present results of the trials to all stakeholders (farmers, extensionists and researchers) so that they select the promising CWD management options which were included in the FFS for validation in improved plots of the FFS. The details of FFSs are discussed in Chapter 14. The criteria for choosing the CWD management options included its efficacy to manage CWD (as shown by the lowest CWD incidence after 3 years of testing), ease of application and the cost for acquiring the management option. Based on the aforementioned, the following treatments and management options were chosen in each country and included in FFSs (Table 12.3).

## 12.4 Results

### 12.4.1 On-station trials

In Uganda, the overall disease incidence over the 3-year period was 25.3%, with the fungicide stem spray displaying the lowest CWD incidence (10%), half the rate of the control treatment (Figure 12.2). In DRC, however, fungicide stem paint recorded lower CWD incidence (10.6%) (Figure 12.3).

Results for Ethiopia (Figure 12.4) showed that mulching, fungicide stem spraying, slashing plus hand weeding and the use of herbicide had much lower (0, 1.7, 1.7 and 3.3%, respectively) CWD incidence over the 3-year period. All the four treatments were associated with reduced coffee tree wounding. The common weed control practice is slashing which had the highest CWD incidence (13.3%, Figure 12.5). The large effect of slashing in Ethiopia may be related to the use of machetes rather than hoes in Uganda and Tanzania. Hoes are generally blunter, and are used in a downward motion rather than crossways like a machete and hence spore transmission by hoe could be lower.

**Figure 12.2:** Average incidence (%) of coffee wilt disease (CWD) for on-station trials in Uganda.

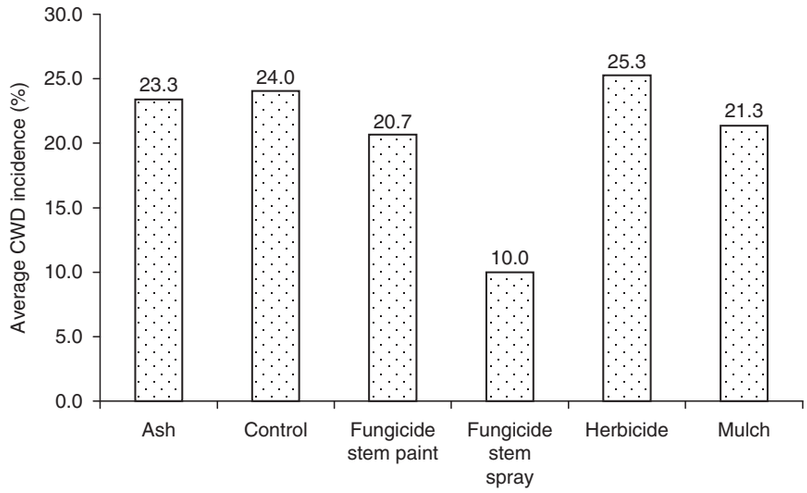
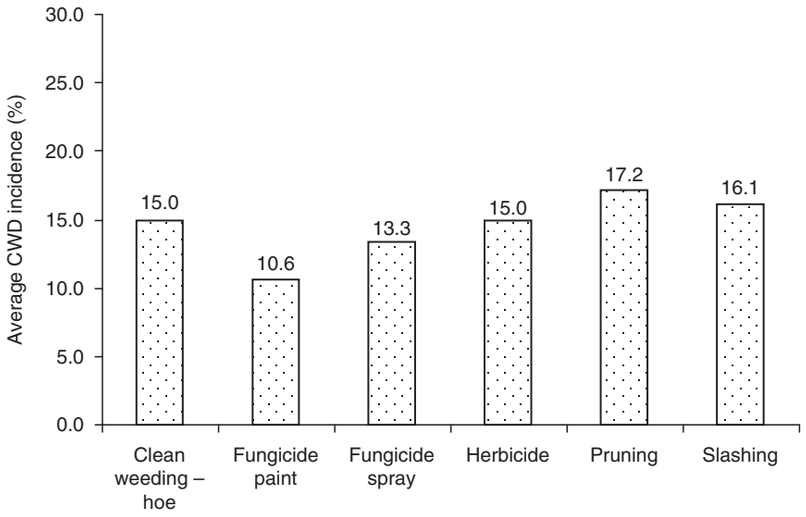



**Figure 12.3:** Average incidence (%) of coffee wilt disease (CWD) for on-station trials in Democratic Republic of Congo (DRC).




Fungicide stem paint, however, did not seem to be effective in Ethiopia. By contrast, in DRC, fungicide stem paint had the lowest CWD incidence (10.6%) compared to pruning which recorded the highest incidence (17.2%) in on-farm trial plots in DRC.

### 12.4.2 On-farm trials

The results for each country – DRC, Ethiopia, Tanzania and Uganda – were not significantly different. However, there were interesting trends in some of the countries. In Uganda, although CWD incidence was generally low (9.3% for the control), herbicide and fungicide stem paint treatments recorded the lowest incidences, 2.0 and 3.3%, respectively (Figure 12.6). In Ethiopia (Figure 12.7), all the treatments recorded lower

**Figure 12.4:** Average incidence (%) of coffee wilt disease (CWD) for on-station trials in Ethiopia.

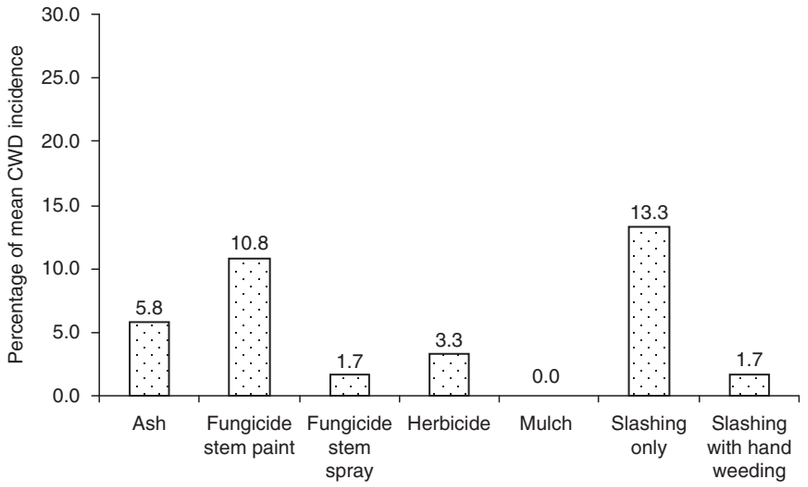



**Figure 12.5:** Wounds (arrows), originating from slashing during weed control, at the base of a coffee stem.

CWD incidence compared to the control (slashing only), which recorded 14%. The lowest incidence was 4.2%, which was recorded in the mulch treatment. Coffee wilt disease pressure was high in study plots in Tanzania as shown by the incidence in the control treatment (Figure 12.8). Fungicide stem paint recorded much lower CWD incidence (11.3%) than the rest of the treatments, especially the control, which recorded an incidence of 22.7%. In DRC, CWD incidence was generally low, and no definite trends were recorded even though fungicide stem spray and pruning recorded the lowest incidence (4%) (Figure 12.9); however, fungicide stem spray treatment resulted in lower CWD incidence than the control (hoe weeding).

**Figure 12.6:** Average incidence (%) of coffee wilt disease (CWD) for on-farm trials in Uganda.

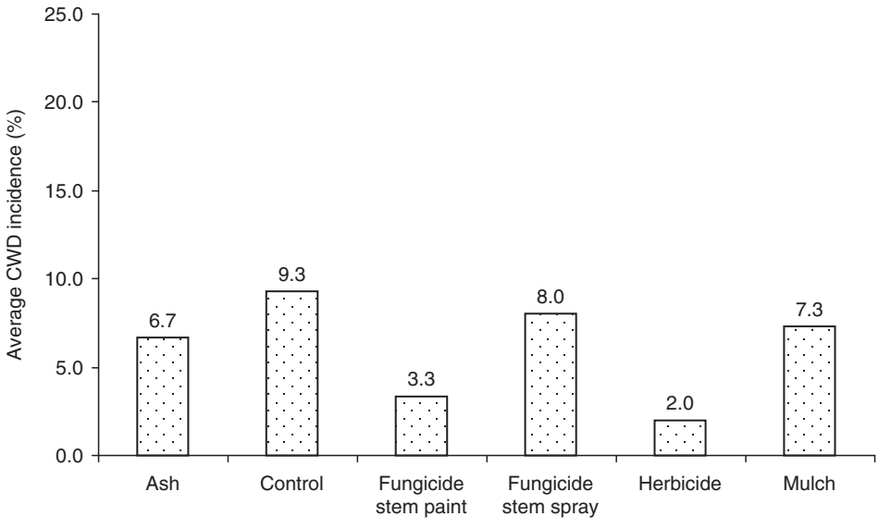
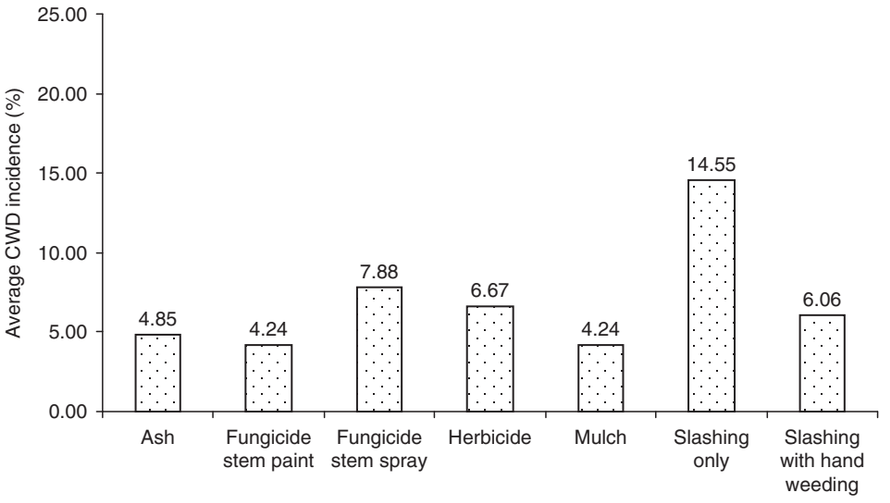



**Figure 12.7:** Average incidence (%) of coffee wilt disease (CWD) for on-farm trials in Ethiopia.




### 12.4.3 Some general observations

Use of mulch, an established agronomic practice, substantially improved the general vigour of coffee bushes in the mulched plots both on-station and on-farm, which led to farmers adopting the practice even before CWD results were discussed with them. Coffee in herbicide treatment plots also grew vigorously, especially in DRC.

The link between tree wounding and incidence was especially evident in Ethiopia, where high CWD incidence was associated with tree wounding, especially close to the soil level, which is caused by slasher's or bushman's knives during weed management. This is worsened by close spacing of coffee bushes. Slashing is the main weed management practice in Ethiopia (Figure 12.5).

**Figure 12.8:** Average incidence (%) of coffee wilt disease (CWD) for on-farm trials in Tanzania.

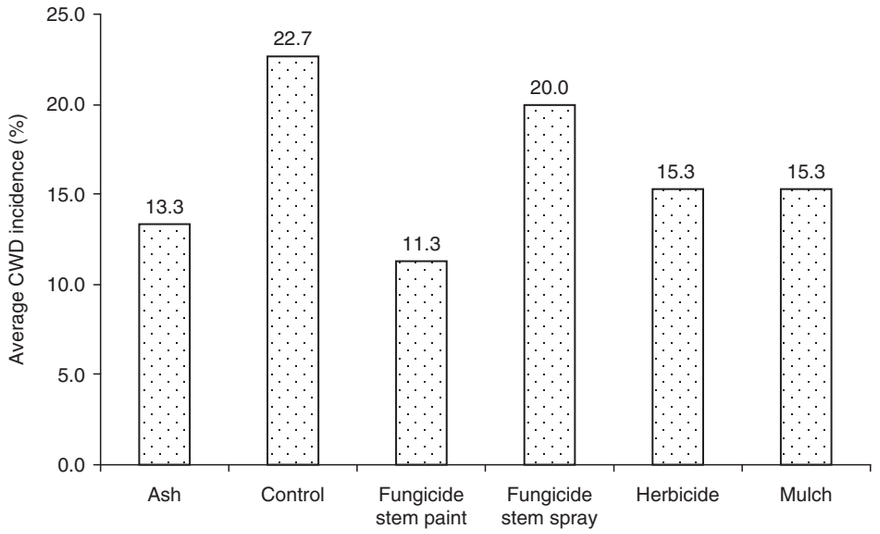
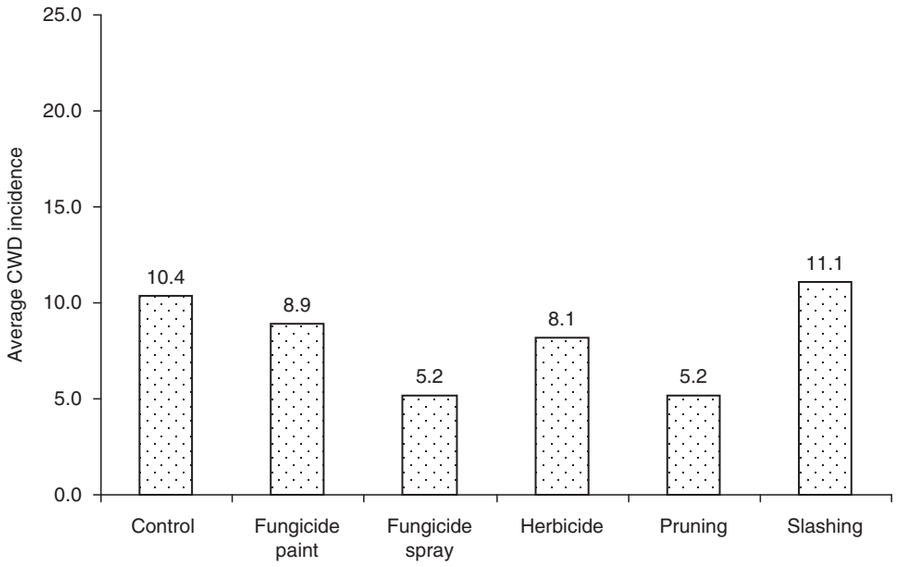



**Figure 12.9:** Average incidence (%) of coffee wilt disease (CWD) for on-farm trials in Democratic Republic of Congo (DRC).




### 12.4.4 The farmers' view

Some insight into the process of participatory work with farmers can be seen in Tables 12.4 and 12.5.

In the case of Gedeo farmers in southern Ethiopia (Table 12.4), when asked to rate the treatments according to their experiences, the participants tended to choose mulch, slashing plus hand weeding and ash, in that order. Similarly, mulch was ranked first,

**Table 12.4:** Mean scores and ranks given by 12 farmers and 14 extension staff in choosing different coffee wilt disease (CWD) management options – in southern Ethiopia (Gedeo).

| Treatments / Criteria | Ash | Fungicide paint | Fungicide spray | Slashing + hand weeding | Slashing (control) | Mulching | Herbicide use |
|---|---|---|---|---|---|---|---|
| Availability | 4.17 | 1.57 | 1.91 | 4.39 | 4.17 | 4.60 | 2.23 |
| Effectiveness/ efficacy | 3.74 | 3.04 | 3.52 | 4.22 | 2.39 | 4.60 | 3.86 |
| Applicability/ simplicity | 4.39 | 2.35 | 2.35 | 4.43 | 3.56 | 4.74 | 3.05 |
| Acceptability (locally) | 4.18 | 2.35 | 2.26 | 4.35 | 2.95 | 4.60 | 2.36 |
| Affordability | 4.25 | 2.60 | 2.26 | 4.22 | 3.65 | 3.69 | 2.55 |
| Overall (average score) | 4.15 | 2.38 | 2.46 | 4.32 | 3.34 | 4.45 | 2.81 |
| Treatment rank | 3 | 7 | 6 | 2 | 4 | 1 | 5 |

Score: 1 represents the least preferred practice, 5 represents the most preferred practice. Rank: 1 is the most preferred.

**Table 12.5:** Mean scores and ranks given by 17 farmers and 20 extension staff in choosing different coffee wilt disease (CWD) management options – in south-west Ethiopia (Jimma).

| Treatments / Criteria | Ash | Fungicide paint | Fungicide spray | Slashing + hand weeding | Slashing (control) | Mulching | Herbicide use |
|---|---|---|---|---|---|---|---|
| Availability | 4.60 | 1.60 | 1.60 | 4.10 | 3.60 | 3.90 | 1.80 |
| Effectiveness/ efficacy | 3.70 | 3.30 | 3.10 | 3.70 | 1.70 | 4.90 | 3.90 |
| Applicability/ simplicity | 4.20 | 2.70 | 2.40 | 4.00 | 3.50 | 4.20 | 2.90 |
| Acceptability (locally) | 4.30 | 2.90 | 2.70 | 3.90 | 2.70 | 4.20 | 3.20 |
| Affordability | 4.40 | 1.90 | 1.70 | 3.50 | 3.10 | 4.10 | 2.10 |
| Overall (mean score) | 4.24 | 2.48 | 2.30 | 3.84 | 2.92 | 4.26 | 2.78 |
| Treatment rank | 2 | 6 | 7 | 3 | 4 | 1 | 5 |

Score: 1 represents the least preferred practice and 5 represents the most preferred practice. Rank: 1 is the most preferred.

followed by ash and slashing plus hand weeding in the Jimma area (Table 12.5). In view of the promotion of the organic coffee concept and the costs of chemical inputs, it seems that the farmers tended to disfavour fungicides and herbicides.

In particular, mulch was ranked most highly with highest scores for all criteria except affordability, with participants talking of its additional advantages in terms of weed control, moisture and soil conservation, soil fertility improvement and avoiding slashing and other operations that would wound the coffee trees. However, in terms of affordability, the use of ash was more favoured than mulch at both areas. The participants decided to take the selected treatments (the first three) to FFS study sites to validate them.

## 12.5 Conclusions

Mostly, the results were not conclusive, though treatments which prevented wounding were associated with lower CWD incidences, especially in Ethiopia. It seems very likely that infection is made much easier through wounds on coffee stems – wounds are entry points for the CWD pathogen. Kranz and Mogk (1973) were the first to note that most dying and dead trees had been wounded during weeding. However, it is worth noting that wounding from pruning (interlocking branches and twigs) in DRC did not result in increased CWD incidence. This requires further investigation before concluding that the wounds at the base of the coffee stem are more important for the spread of CWD than the ones on branches.

Mulch may be suitable for preventing wounding if applied correctly because it suppresses weeds in coffee farms, thus removing the need for use of sharp implements which frequently result in the wounding of the coffee trees, particularly in Ethiopia where coffee is grown at very close spacing and slasher's or bushman's knives are commonly used for weed management. Mulch also adds nutrients to the soils in coffee gardens when it decomposes.

In Ethiopia, all infected coffee bushes were associated with wounds, especially at the base of the stem. Prevention of coffee tree wounding was also achieved when hand-picking weeds around coffee stems was added to the weed-slashing operations. This meant that the slashing process did not come close to the stem. In Ethiopia, the results clearly demonstrated that slashing without hand-picking treatment had substantially higher CWD incidence compared to when hand weed-picking was included. The demonstrated result of preventing wounding as a way of reducing CWD incidence became so popular that the so-called live mulch, i.e. a cover crop, was also included among initiatives for managing CWD. *Desmodium intotum* was used for this purpose.

Further studies are urgently needed on cover crops like *Desmodium* – in the future, because with increasingly chaotic weather, farmers will need to protect their soil from extreme rain and drought conditions. More work is needed too on intercropping and how this affects CWD transmission; in the case of pigeonpea wilt (which is caused by *Fusarium udum*, a very close relative of *F. xylarioides*), there is evidence that intercropping reduces infection (Reddy *et al*., 1990). Furthermore, there is evidence in the case of pigeonpea wilt that green manuring with *Crotolaria juncea* decreased the incidence of the disease.

In Uganda and Tanzania, where organic (dry) mulch was evaluated, the added benefit of improving coffee vigour and suppressing weeds was also an attractive option for

the two countries. However, it is worth noting that apart from Ethiopia, mulch did not seem to reduce the incidence of CWD, although use of mulch has been adopted by farmers in all countries where it was evaluated (Ethiopia, Uganda and Tanzania).

The use of herbicide was also useful in preventing wounding; however, in many cases, farmers would have to combine sparing use of herbicide with mulching due to the associate cost and environmental concerns.

Results of the use of copper oxychloride fungicide as a stem paint and spray gave somewhat conflicting results; either stem spraying or painting seemed to have an effect on reducing the CWD incidence, but not necessarily both in the same locality. Since the fungicide is a contact type, and CWD is systemic, the fungicide cannot be effective once the coffee bush is infected, so timing of application is crucial and this may have affected the results. The best use of the fungicide may be to use it for sealing pruning wounds, especially when changing the coffee cycle.

Even though the use of ash was quite popular among coffee farmers, and was proposed by them for inclusion in control options for managing CWD, it did not have a marked effect on the management of CWD.

In conclusion, the studies have demonstrated that the prevention of coffee tree wounding is the most realistic way of managing CWD in the absence of resistant varieties or among existing susceptible coffee varieties. The best approach in this case would be to use an integrated crop and pest management approach. For example to use mulch, both dry and live, hand weeding under the coffee canopy, sealing wounds formed by pruning or rejuvenation with a copper-based fungicide is the most ideal way of managing CWD. This, however, would presuppose a level of available management options for the farmer that, due to lack of funds, many would find difficult to supply, especially on a prophylactic basis.

All these strategies should be backed up by a rigorous uprooting and burning of infected coffee bushes. Insect management such as stem borers and any coffee-tree-wounding insects could also contribute to this integrated basket of management options.

The studies mentioned above need to be repeated in different localities, with combinations of treatments to see if two or more can have additive or multiplicative effects. Larger numbers of replicates are needed to reduce the large variance caused by a range of factors, including the likelihood that some trees in plots are already infected and hence incurable by the preventative measures described above. The costs to the farmer of these treatments also need to be evaluated to arrive at the most beneficial package to suggest to the farmer.