2
The Status of Coffee Wilt Disease in Africa

We are losing a coffee culture to the CWD[1]

2.1 Main Findings

Coffee wilt disease (CWD) is present in four African countries: Democratic Republic of Congo (DRC), Uganda, Tanzania and Ethiopia, and absent from the other countries surveyed (Rwanda, Côte d'Ivoire and Cameroon).

DRC

- The modern outbreak started in DRC where it was first detected in the 1970s.
- This outbreak grew to epidemic proportions in the 1980s and is now found in three provinces: North Kivu, Oriental and Equator. The disease is probably still spreading in DRC.
- Losses due to CWD in DRC are hard to assess, but declines in production have been very steep, now only about 20% of peak production in the 1980s.

Ethiopia

- CWD was first detected in Ethiopia in 1957. For many years it was a minor disease; however, it has now spread widely through the coffee zones, to the point that it is now regarded there as of similar importance to coffee berry disease (CBD).
- CWD is found in wild forest coffee, giving rise to a concern that it may weaken the genetic base of the Arabica genome in Ethiopia, where the species evolved.
- The disease is particularly prevalent in plantation coffee, which may be linked to the intensive agronomic methods employed there.
- Overall, however, Ethiopian coffee production has increased in recent years, and it seems likely that the Arabica version of the disease is somewhat less virulent than the Robusta disease, possibly due to a level of natural resistance in the heterogeneous coffee landraces.

Uganda

- The disease was first detected in Uganda in 1993; by the end of 2000 it had spread to all Robusta zones of the country.

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[1] Ugandan Agriculture State Minister, Kibirige Ssebunya, Coffee Policy Makers Workshop, Hotel Equatoria, 15 December 2006 (*The Monitor*, 18 December 2006).

Phiri N. and Baker, P.S. (2009) *Coffee Wilt in Africa Final Technical Report*. CAB International.

- Ugandan Robusta production reached a peak in 1996 and then fell steadily up to 2005, when it attained only 42% of peak production, whereas Arabica production over the same period rose by 39%. It is very likely that most or all of the fall in Robusta was due to CWD.

- Decline in Robusta production since 1996 represents a loss of farm income from coffee of US$580 million for the years 1997 through 2007. This is a conservative figure since Robusta production may otherwise have risen over this period.

Tanzania

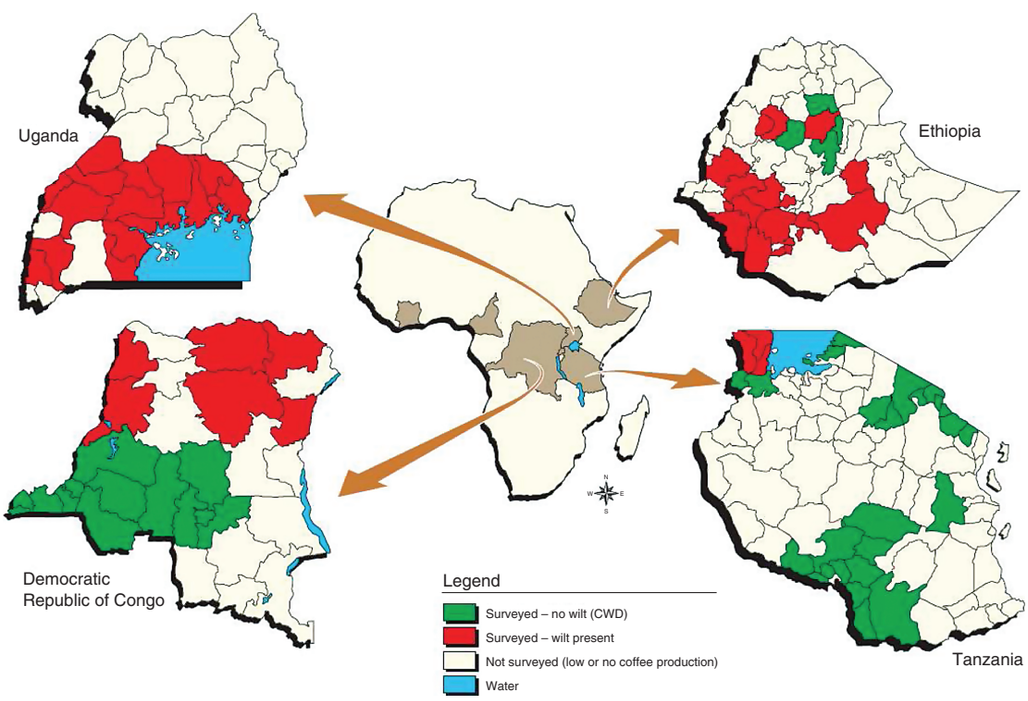
- CWD was detected in Tanzania in 1996. It is currently restricted to the north-west of the country.

- Severity of the disease is the least of the four affected countries and economic losses have been much smaller.

- Of the four countries affected, Tanzanian efforts to control the disease through eradication activities seem to have been the most cost-effective.

This chapter looks at the history, incidence and severity of the disease in each affected country (Figure 2.1), drawing on national surveys as well as surveys carried out during the Regional Coffee Wilt Programme (RCWP; see Appendix 1 for details of methodology). More details about the farms and farmers will be presented in Chapter 3.

Figure 2.1: Current coffee wilt disease (CWD) distribution in Africa.



2.2 Democratic Republic of Congo (DRC)

2.2.1 An outline of coffee wilt disease in DRC

2.2.1.1 Status of coffee in DRC

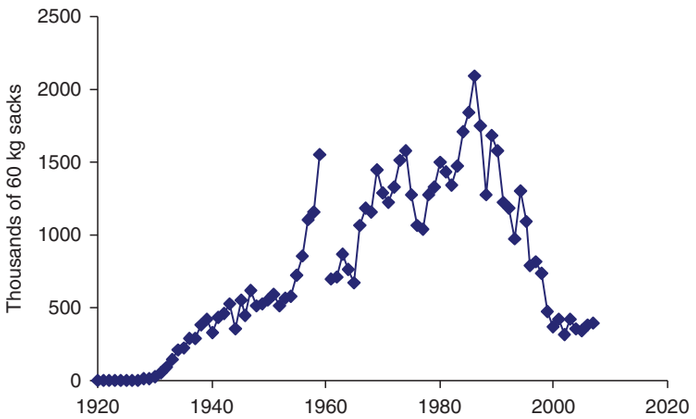
It is a key cash crop, covering about 200,000 ha of which 85% is Robusta and 15% Arabica coffee. Smallholder farmers represent about 86% of total production with an average holding of 1.3 ha for Robusta and 0.8 ha for Arabica. From a recent agricultural census (Kalonji-Mbuyi *et al.*, 2009), it has been estimated that a third of this coffee is now in a state of abandon. Indeed, coffee in DRC has been in decline since the mid-1980s with the current coffee production some 80% below its peak, down to levels not seen since the 1940s (Figure 2.2). For the 2006/2007 season production was 34,553 t with 27,007 t for Robusta and 7546 t for Arabica (Office National Du Café, 2007), giving a national average clean coffee yield of 150–200 kg/ha for Robusta and 150–300 kg/ha for Arabica. At least a part of the Robusta decline is believed to be caused by CWD but the coffee sector in DRC faces a multitude of serious difficulties including the ageing of the coffee gardens, poor management of plantations, lack of credit facilities, lack of skills and knowledge of coffee production by smallholder producers (i.e. poor extension services) as well as an inadequate road and port infrastructure.

2.2.1.2 Coffee varieties

In DRC, CWD attacks Robusta and other coffee species including Liberica: *Coffea liberica* var. *liberica*, *C. liberica* var. *dewevrii* as well as *C. abeokutae* in the Botanical Garden collections at Yangambi station (INERA). Arabica coffee is not affected.

Most of the Robusta coffee plantations in the DRC are derived from progenies of a few high-yielding elite local clones from the Yangambi Research Stations, and one introduced clone (SA 34) from Indonesia. No specific breeding programmes have been developed to improve the agronomic traits of genotypes, but coffee selection based on

Figure 2.2: Total coffee production in Democratic Republic of Congo (DRC). (From ICO data and Samper and Fernando, 2003.)



yields and morphological traits was carried on by INERA, and in the 1950s, six elite local clones (L-147, L-36, L-251, L-215, L-93 and L-48) were selected from monoclonal isolate plots (Drachoussof *et al*., 1991).

2.2.1.3 The historical outbreak

CWD was first observed in 1939 by Steyaert on *Coffea excelsa* collected in plantations located at Aba on the borders between the DRC and Sudan (Fraselle, 1950). Initially, the disease had only a minor impact. However, in 1949, an epidemic was reported on Robusta in Yangambi plantations which caused major losses (Heim and Saccas, 1950). The disease was later observed in Haut-Uélé, North Kasaï and in Katanga, and it quickly became a major epidemic. A number of measures to contain the disease were initiated including uprooting and burning of infected coffee trees on the spot. Widespread adoption of such sanitation practices and subsequent deployment of resistant varieties led to the decline of CWD from the late 1950s (Fraselle and Georgtay, 1952) to the point that the disease became virtually forgotten.

2.2.1.4 Re-emergence

In the 1970s, a farmer in the north-east DRC observed a wilt-like disease of coffee in abandoned plantations around Aketi, about 76 km from Isiro (Kalonji-Mbuyi *et al*., 2009). Later, the disease was observed on coffee plants during a survey conducted in 1974 and 1975 in a number of INERA fields at Yangambi (Kalonji-Mbuyi, 1975). An analysis of the samples collected by Kalonji recovered a strain of *Fusarium xylarioides*, the asexual form of CWD.

Throughout 1980 and 1981, reports of the Office National du Café (ONC) indicated the presence of a CWD source near the town of Isiro in Haut-Uélé region, Oriental Province. These reports indicated that the disease attacked only Robusta coffee plantations, and that both young as well as old established plantations were affected.

2.2.1.5 Outbreak

The disease then became widespread in Haut-Uélé plantations, progressively spreading to all the surrounding territories. More plantations were abandoned and smallholders became increasingly distressed as they saw their only source of income disappear. The existence of a very marked and decreasing gradient of infection moving away from the triangle formed by Isiro territories, Wamba and Mungbere in the valley of Nepoko led to the conclusion that this area was the primary source of the infection.

2.2.1.6 Surveys

Between 1985 and 1989, ONC carried out surveys at Ituri, Bas Uélé and Haut-Uélé districts which showed that the disease was widespread in the Oriental Province. According to estimates made in 1987, its incidence was 19% in these coffee areas (Katenga, 1987) but only 2 years later it had reached 30%, mainly in the district of Haut-Uélé (Kalonji-Mbuji *et al*., 1990). In Isiro, by the mid-1990s, 90% of plantations were affected, Mambasa 36%, Poko 34%, Bafwasende 28%, Opala 29% and Banalia 27%, while Yangambi station was disease-free.

From Haut-Uélé, the disease continued to spread down through a corridor of Robusta coffee that stretches from Mambasa to Irumu in the Ituri district. The disease then spread towards the North Kivu Province and was consistently observed in that area from 1995 onwards, its appearance always accompanied with considerable damage. The incidence of infection in 1995 was estimated to range from 13 to 30% of trees in plantations located in Mavivi, Mbawu and Mutwanga. Disease incidence was surveyed as 46% of plantations in Mangina, 41% at Oïcha, 38% at Muhangi and 37% at Mutwanga. However, the effects of disease remained less serious in the surrounding areas of Butembo-Muhangi and Musienene in Lubero district of Lubero, not exceeding 3% of farms infected.

In 1996, ONC invited Dr Julie Flood (CAB International) to assess the situation in eastern DRC, and she confirmed the presence of CWD (Flood, 1996). In 1997, assessments indicated that the incidence exceeded 50% in Haut-Uélé district (Kalonji-Mbuyi and Onyembe, 1996). More recently, CWD has infected plantations in the province of Equator through the district of Mongala on the border with the Oriental Province (Kalonji-Mbuji, unpublished, 2007).

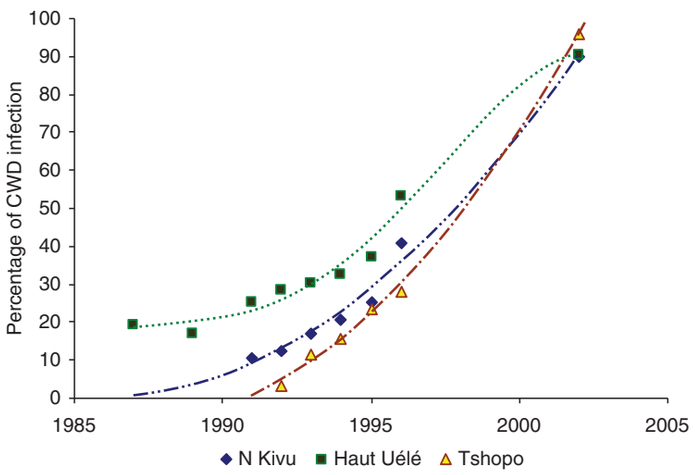
2.2.1.7 Overview of CWD in DRC

Currently, CWD is present in North Kivu, Oriental (Haut Uélé and Tshopo) and Equator provinces. The approximate spread of infection is summarized in Figure 2.3, which is a compilation of all available survey data ranging back to 1987.

Surveys suggest that the disease is absent in the provinces of Bandundu, Bas Congo, Kasaï Occidental, Kasaï Oriental and South Kivu. As we see in Chapter 4, the strain detected in DRC is identical to that of the historical outbreak, thus it seems very likely that the disease was never fully eradicated in DRC and gradually re-established itself in the 1970s before starting to spread more widely in the 1980s. It has been growing in area and significance for over 30 years and is still spreading.

It is difficult to quantify the losses due to the disease, but it is clear that CWD presents a very serious constraint to coffee production in DRC, the disease is widespread in

Figure 2.3: The spread of coffee wilt disease (CWD) infection in three provinces of DRC. (From Kalonji-Mbuyi, 2003.)



the country and has destroyed many of the coffee plantations in the major production zones of the country. It seems very likely that the disease situation in DRC is now much worse than during the historical outbreaks of the mid-20th century.

2.3 Ethiopia

Ethiopian coffee is of immense national and global significance, being the country of origin of Arabica, the country that therefore holds the great majority of the Arabica gene pool, the first country to develop a coffee culture, and the country where the largest number of smallholders depend upon it for their livelihood; coffee is directly or indirectly a source of livelihood for more than about 25 million people engaged in production, processing, trading and marketing of the crop (Girma *et al*., 2009).

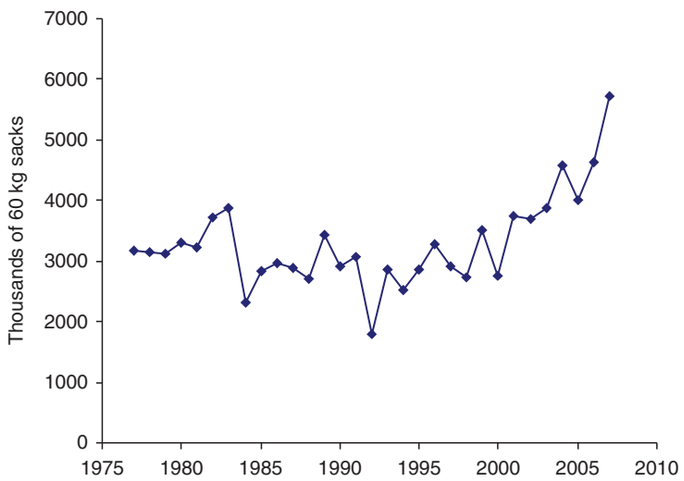
Ethiopia is the largest coffee producer in Africa, and for 2007/2008, the world's fifth largest. Coffee accounted for some 60% of Ethiopia's foreign exchange revenue in 2007/2008, when it earned more than US$525 million from exports of 170,888 t of mostly high-quality Arabica beans.[2] Substantial increases have been achieved in recent years (Figure 2.4), bucking the trend for all other African countries. More than 90% of the production is from the garden, semi-forest and forest coffee systems of small-scale farmers, while the remaining 10% comes from large-scale plantation coffee.

2.3.1 An outline of coffee wilt disease in Ethiopia

2.3.1.1 The history of CWD in Ethiopia

CWD was first observed in Ethiopia in the Keffa Province by Stewart (1957), who described a wilting of *C. arabica* and mistakenly classified it as *Fusarium oxysporum* f. sp. *coffeae*. Lejeune (1958) also noted the presence of this disease on Arabica coffee. Later, the disease was confirmed to be *Gibberella xylarioides* (Kranz and Mogk, 1973).

Figure 2.4: Total coffee production in Ethiopia since 1977. (ICO data.)



[2] Reuters, Friday, 22 May 2009.

Subsequent surveys demonstrated CWD in the major coffee-growing regions of south and south-west Ethiopia (Van der Graaff and Pieters, 1978; Merdassa, 1986; Girma, 1997; Eshetu *et al*., 2000). In Bebeka and Teppi, CWD outbreaks were noticed in plantation coffee (Girma, 1997; Eshetu *et al*., 2000).

The conclusion from these surveys is that over recent years, the prevalence and the importance of CWD has been markedly increasing throughout coffee-producing areas of the country (Girma and Hindorf, 2001; Girma *et al*., 2001; CAB International, 2003; Girma, 2004; Oduor *et al.*, 2005).

2.3.1.2 RCWP project surveys in Ethiopia

These surveys registered an overall incidence of the disease of 28% of sampled farms infested with a severity (i.e. number of trees affected) of 3%, widely dispersed through the country (Figure 2.5). There was, however, considerable variation, especially within the Gedeo Zone, home to Yirgacheffe, one of the world's most famous coffee origins, registering a CWD incidence level of 90% with a severity of 24%. The range of variation between zones can be seen in Figure 2.6. During a follow-up survey carried out 6 months after the initial survey, the rate of spread (tree-to-tree) was found to be 11.5%.

2.3.2 CWD distribution and farming system in Ethiopia

CWD incidence in Ethiopia is greatly affected by the farming system, with relatively low rates of infection in forest and semi-forest coffee and much higher rates in garden and plantation coffee. This may be due to the greater level of intervention in the latter, which gives increased opportunity for the fungus to spread, and may also be related to the greater genetic homogeneity of the coffee planted.

Ethiopian coffee farming can be classified into four systems: forest, semi-forest, garden and plantation coffee (Meyer, 1965; Paulos and Demel, 2000).

1. Forest coffee in the west and south-west is essentially coffee in its natural state where it evolved, characterized by a great diversity of both coffee and of other flora and fauna but also very low yield. The coffee trees are harvested but otherwise untended.

Figure 2.5: Distribution of coffee wilt disease (CWD) in Ethiopia.

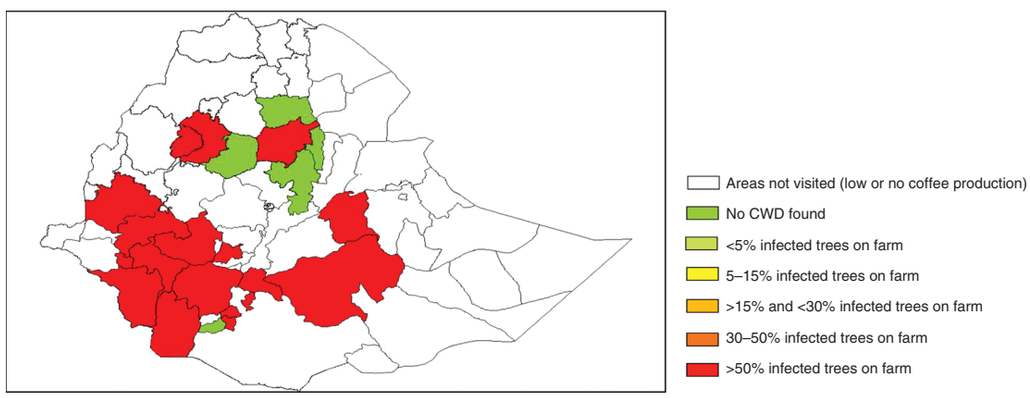
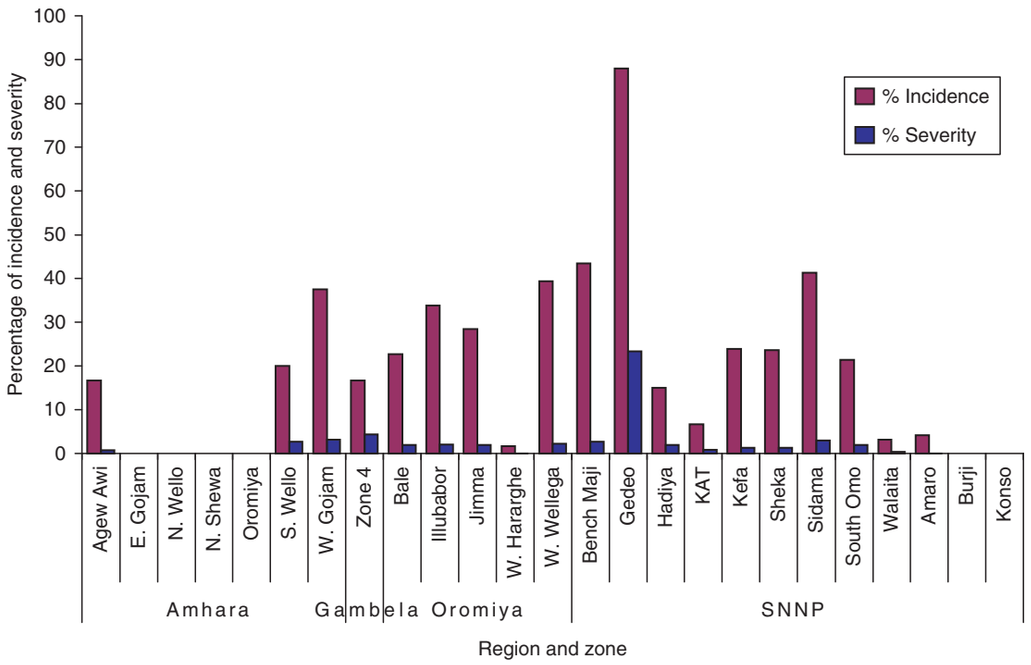


Figure 2.6: Range of incidence and severity of infection in Ethiopian coffee regions.



2. Semi-forest is semi-domesticated coffee, derived over centuries from the wild forest coffee by the world's first coffee farmers, who thinned the forest canopy and cleared understorey vegetation. They transplanted self-sown seedlings from under mother trees, often resulting in quite high-density clumps of coffee. Weeding by slashing is done once a year around the picking season. Semi-forest coffee is estimated to contribute 35% to Ethiopia's total coffee (Paulos and Demel, 2000), even though yields are low.

3. Garden coffee is mostly in the southern and south-eastern regions, with plots usually less than 0.5 ha, intercropped with a variety of other crops. The coffee often consists of many ancient landraces. This system is more intensively managed by slashing and pruning, together with some mulching and other organic materials (Workafes and Kassu, 2000).

4. Plantation coffee is the modern intensive production of a monoculture of high-yielding disease-resistant cultivars, with all the inputs and agronomy characteristic of this way of growing coffee.

CWD was found to occur in all of these production systems (Merdassa, 1986; Girma and Hindorf, 2001; Girma, 2004):

2.3.2.1 CWD in the forest and semi-forest coffee

CWD was found in four forest coffee zones in south-west and south-east rainforests with incidences ranging between 5% at Sheko and 30% at Yayu. Arega (2006) also reported increasing occurrence of CWD in the forest areas of Harenna (Bale) and Bonga (Keffa). The mean incidence in semi-forest coffee ranged from 4% at Mettu to 16% at Gera in the south-west coffee-producing areas with severity between 19 and

25% in some parts of Yirgacheffe (Girma, 2004). A similar situation was seen in Bale, Jimma, Ilubabor and West Wellega zones (CAB International, 2003).

2.3.2.2 CWD in garden coffee

CWD is prevalent in the three major quality coffee-producing districts of the southern region, i.e. Wonago, Kochore and Yirgacheffe of Sidama and Gedeo zones, with the highest incidence in Yirgacheffe. The severity of wilting seen in Yirgacheffe varied between 27 and 44% (Girma, 2004). Disease incidence varied widely across coffee-growing areas of the Southern Nations and Nationalists and Peoples state (SNNP) region, with mean incidence (35%) and severity (5%) significantly ($p < 0.001$) higher than in other regions. It was especially high in Sidama and Gedeo zones, with an incidence rate above 90% and severity of 25%. The incidence of CWD was above 35% in garden coffee of West Gojam Zone of Amhara regional state but it was very low in Wolaita (SNNP) and West Harerghe (Oromiya) (CAB International, 2003).

2.3.2.3 CWD in plantation coffee

Incidence is severe in both plantation coffee and research centre plots. CWD is commonly encountered in the research plots at Gera and Jimma amounting to 43 and 48%, respectively (Table 2.1). On plantations in Gera, Chira and Gechi districts, respectively, mean incidence ranged respectively from 22 to 26%, 33 to 77% and 35 to 60% (Table 2.2). The overall tree loss in farmers' plantations was more than 30% and a small amount of plantation coffee had been abandoned completely. Girma *et al*. (2001) confirmed that the disease was severe in plantation coffee at Bebeka, Teppi, Gera and Jimma.

2.3.3 Overview of CWD in Ethiopia

For decades, CWD was considered as a minor problem in Ethiopia but the losses incurred due to the disease are now comparable to those caused by CBD (Girma *et al*., 2009). In

Table 2.1: Prevalence and incidence of CWD in experimental plots of Ethiopian coffee research centres.

Research centres/ stations	Number of fields (*n*)	Incidence (%)		Altitude (m)
		Range	Mean and SD[a]	
Jimma	10	19.8-82.0	48.2 ± 23.1	1750
Agaro	3	5.2-12.1	8.7 ± 3.4	1650
Gera	15	21.0-61.1	42.5 ± 18.7	2000
Mettu	3	23.3-30.9	27.1 ± 5.4	1550
Teppi	3	6.5-13.4	10.0 ± 4.9	1200
Wenago	3	5.7-14.6	9.8 ± 4.5	1850
Mean of range and means		5.2-82.0	24.4 ± 17.7	

[a]SD = standard deviation.

Table 2.2: Incidence (%) of CWD in coffee under farmers' condition in south-west Ethiopia.

Location	Field	Estimated area (ha)	Incidence (%)	
			Range	Mean
Gera	Gicho 1	1.0	11.5-35.0	24.5
	Gicho 2	1.5	8.7-38.0	21.7
	Sedi-Loya	1.0	23.9-27.1	25.5
Chira	Gure-Genji	5.2	38.0-75.0	51.5
	Chira 1	4.5	55.0-89.0	77.0
	Chira 2	1.5	14.0-42.0	32.3
Tobba	Yachi	0.3	12.1-20.8	16.5
	Kilole	0.4	14.6-23.9	19.3
	Ageyu	0.2	8.3-27.0	16.1
Gomma	Shashamene	0.5	12.7-19.4	10.8
	Echemo	0.3	12.5-15.5	13.6
	Sombo	0.2	25.8-34.2	29.2
Gechi	Camp	0.5	25.0-70.0	48.9
	Mine-kobba	5.0	15.0-55.0	35.0
	Asendabo	5.0	37.7-78.6	59.7
Yayo	Jitto	1.0	11.0-34.0	22.5
Mettu	Sor	0.5	8.0-33.3	20.4
Mean of ranges and means	(Total 17)	(Total 28.6 ha)	**8.3-89.0**	**30.9 ± 18.2**

addition, with CWD the tree dies, with a high probability that neighbouring coffee trees die too, so there is a potentially greater long-term loss to the farmer. Also, CBD can be controlled with fungicides, but this is much more difficult with CWD (Girma, 2004).

The disease has spread almost unchecked to the majority of coffee-growing areas. It is worrying that it is also present in forest coffee where it must be regarded as a threat to the genetic base of this species. On the face of it, however, the virulence of the disease is less than for the Robusta strains, since overall severity levels are lower, and despite the disease's spread, Ethiopia has managed to substantially increase national production.

Van der Graaff (1979) remarked that some spectacular failures of the modern plantation system in Ethiopia could be due to CWD, and when comparisons are made across production systems, the disease is certainly more destructive in garden and plantation coffees than in forest and semi-forest coffee systems. The reason for this could be both the greater levels of intervention (hoeing, weeding and pruning) and reduced genetic diversity of plantations.

2.4 Uganda

2.4.1 History of Ugandan coffee

Robusta coffee is indigenous to Uganda and its use dates back to pre-colonial times. The first Robusta exports from Uganda, mainly from the Ssese Islands (now Kalangala district) in Lake Victoria, were in 1878 (Thomas, 1947). From this modest beginning, Robusta coffee cultivation expanded and thrived to become the major foreign exchange earner for the country for several decades. Traditional varieties of Robusta have been largely replaced by high-yielding clonal varieties in the 1990s and although the volume of coffee exports has declined in recent years, it is still the most valuable export. Coffee contributes about 20–25% of national annual foreign currency earnings from exports valued between US$84 million and US$456 million during the period from 1996 to 2005. Over 3 million Ugandans derive their livelihood directly from coffee as farmers, processors, exporters, transporters, traders, etc.

Robusta coffee is grown between 800 and 1500 m asl in the central and southern parts of the country, covering an area of about 240,000 ha with an annual rainfall in the Robusta areas ranging from 1000 to 2000 mm. About 37,000 ha of Arabica is currently grown between 1500 and 2300 m in the east, west and north-western Uganda, with annual rainfall varying between 1500 and 2000 mm asl. Arabica contributes 15–20% of coffee production by volume and 20–35% of export earnings from coffee (UCDA, 2005).

The Uganda Bureau of Statistics (UBOS) estimates that there are 1.32 million coffee farmers, about 50% of whom have less than 50 coffee trees. Over 90% of coffee farmers are smallholders with an average of 0.23 ha for Robusta and 0.36 ha for Arabica. Both crops are mostly grown with food crops such as bananas and beans. The national average coffee production is around 500 kg/ha clean coffee for both Robusta and Arabica.

2.4.2 CWD in Uganda

2.4.2.1 CWD invasion

In 1992, information was received from the coffee trader Mr John Schluter of a devastating Robusta coffee disease in the Beni and Isiro areas of DRC, who warned of its consequences if allowed to cross into Uganda.

In September 1993, wilting and death of a few Robusta coffee trees was observed in a 2.8 ha experimental plot at the Coffee Research Institute, Kituza in Mukono district of Central Uganda. Dr Georgina Hakiza, Uganda's coffee pathologist, recovered *F. xylarioides* from infected stems and roots.

2.4.2.2 CWD spread

The first report of wilt outside Mukono district was received in October 1993 from Bundibugyo district in south-western Uganda bordering the DRC. In this district, both Robusta and Arabica are cultivated but the disease was reported only on Robusta. During an initial survey, two farms in each of three sub-counties were visited and samples collected. All the fields visited had some dead plants and partially diseased trees. During this first visit, CWD was not detected, probably due to the high incidence of other fungi, and symptoms of the disease were not typical

of *F. xylarioides* as described in the literature (e.g. Coste (1992)). When bark was scraped off from stems of affected plants there was no blue-black streak characteristic of *F. xylarioides*, instead only brown to dark brown disintegrating or rotting tissues were observed. From the samples collected, the fungi recovered in the laboratory were *F. stilboides*, *F. lateritium*, *F. solani* and *F. oxysporum*, which can also cause wilting, and death of plants under stress. In addition, there was a high incidence of stem borer attacks leading to wilting and death of trees in the same fields. Subsequently, CWD was recovered when the other fungi had become less frequent (Hakiza, unpublished report, 1998).

After 1993, the incidence and severity of CWD continued to rise, causing decline in yields in all affected districts. In 1994, the disease was reported from Kanungu district in south-western Uganda and the pathogen was consistently recovered from root, stem and branch samples. Specimens from Bundibugyo district also clearly revealed presence of the pathogen. The worst affected districts were Bundibugyo, Kyenjojo, Hoima, Kabale and Kayunga, i.e. western districts, where it was estimated that 40–50% of the coffee fields were completely destroyed (CORI, 1996/7; Lukwago and Birikunzira, 1997; UCDA, 1999).

It is widely believed that CWD crossed to Jinja, Mayuge and other districts in Eastern Uganda, mostly through volunteer seedlings collected from forests in Mukono district where CWD was also rampant in forest coffee. Farmers are attracted by the low cost of these seedlings compared to good seedlings from known sources. Seedlings may appear healthy but some of them from such sources are likely be infected or contaminated with disease.

2.4.2.3 First survey

In 1996, the worsening situation prompted the Ugandan Coffee Development Authority (UCDA) to organize and fund a joint survey conducted by a multidisciplinary team from Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Coffee Research Centre (COREC) and UCDA, to establish the distribution and extent and damage caused by the disease in ten major coffee-growing districts of Uganda. It revealed the presence of the disease in ten districts: Mukono, Mubende, Mpigi, Ntungamo, Kasese, Kabarole, Rukungiri, Bundibugyo, Kiboga and Masaka.

The disease continued to spread so that by 2000 all other parts of Mukono district, Kiboga, Mpigi, Jinja, Iganga, Mayuge and Iganga were affected. Also, in 2000, reports and samples were received on Robusta coffee from the West Nile, so that by the end of 2000, all Robusta coffee districts in Uganda had been affected. In Uganda, CWD also affected *C. liberica* and *C. kapakata* in the germplasm collections at Kawanda Agricultural Research Institute (KARI). Over the period 1993–2003, CWD was estimated to have destroyed about 80,000 ha of Robusta, and caused losses of 1.2 million bags of coffee worth US$100 million (UCDA, 2004).

2.4.2.4 Detailed surveys

By 1999 it was clear that CWD was a major problem in Uganda and, from what we now know, the development of the disease in Uganda had been much faster than the others affected. In 1999, UCDA estimated that 14.5 million Robusta coffee trees (4.8% of the country's coffee stock) had been destroyed. However, these estimates were based on partial information from a 1996 survey conducted in only ten districts, with no follow-up farm visits to monitor and check the rate of disease spread.

Consequently, a more accurate assessment (including quantitative information including both biological and socio-economic data) was developed to provide a comprehensive and up-to-date status of CWD in Uganda in 2002, and again in 2004.

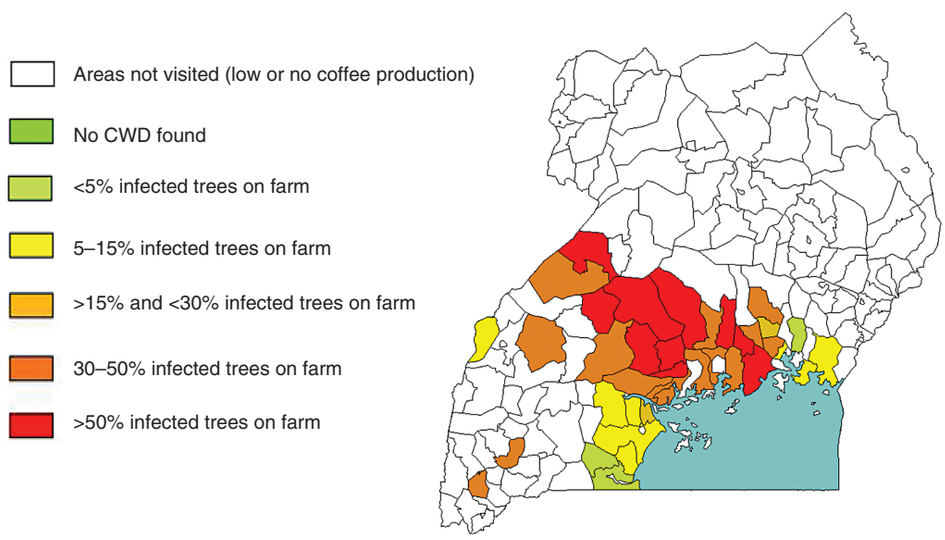
Ten districts in central Uganda (which produce 80–90% of the country's Robusta), six districts in western and five districts in the eastern part of the country were surveyed. The central zone districts included Mukono, Kayunga, Wakiso, Mpigi, Luwero, Masaka, Rakai, Sembabule, Mubende and Kiboga. The central Uganda survey included almost all coffee-producing districts except the minor producers of the Lake Victoria district of Kalangala and the marginal rainfall district of Nakasongola. In the west, the districts surveyed included Hoima, Bundibugyo, Kibale, Kyenjojo, Bushenyi and Rukungiri. In the east, Mukono district, Kiboga, Mpigi, Jinja, Iganga, Mayuge and Iganga were surveyed.

2.4.2.5 Results

Survey results indicated that CWD was present in all 21 districts with 90% (range 53–100%) of farms infected (Figure 2.7). Mean severity was 44.5% (range 4–61% of trees). Nearly 100% of farms surveyed in Bushenyi, Hoima, Jinja, Kamuli, Kibale, Kiboga, Kayunga, Luwero, Mukono and Rukungiri districts had CWD. Rakai district had the highest percentage of farms without CWD. These results were based on the assumption that missing coffee trees on the farms were assumed to have been infected by CWD and destroyed by the farmers as recommended.

Only Iganga had a low mean CWD incidence (4%), with Bugiri, Rakai, Mayuge, Sembabule, Masaka and Bundibugyo having moderate incidences of CWD. Bundibugyo was where CWD was first reported, and farmers there had been advised to uproot all affected trees as soon as symptoms appeared. CWD incidence in the remaining districts was very high. Kayunga, Luwero, Kibale, Mubende, Hoima, Mukono and Kiboga were most affected with over 60% of the trees infected (sick, dead-stumped, dead-standing or uprooted due to CWD). The severity of CWD in farms was high, ranging from 3.5 in Iganga to 5.6 in Bundibugyo on a 1 to 6 scale and ranged from 1.1 in Iganga to 3.3 in Kibale. More details of infected areas can be found in Appendix 1.

Figure 2.7: Distribution of coffee wilt disease (CWD) in Uganda in 2002.



During a follow-up survey carried out 6 months after the initial one, the rate of spread (tree-to-tree) was found to be relatively high, with 8% of previously healthy farms becoming infested over this intervening period.

2.4.3 Uganda synopsis

CWD in Uganda has been particularly severe. National Robusta coffee production has fallen dramatically from 1997 to 2005, which coincides with the spread of CWD. The extent to which the decline can be attributed to CWD is not entirely clear, but when compared to the equivalent Arabica production one can see opposite trends (Figure 2.8). Even though the economic and environmental factors that affect the two species are somewhat different, it is evident that Robusta production has suffered a substantial fall that must have been due in great part to CWD. In contrast, Arabica production rose by 39% during the same period (Figure 2.8).

If we assume that CWD is entirely responsible for the decline in Robusta production (the cumulative difference between actual values and the dashed line in Figure 2.8), then we calculate, based on farm-gate prices (Figure 2.9), that farmers' income from

Figure 2.8: Total Ugandan coffee production since year 1992/93 (UCDA and UCTF data); difference between the dotted line and actual production line from year 1996/97 is the decline in Robusta production that is attributable to coffee wilt disease (CWD).

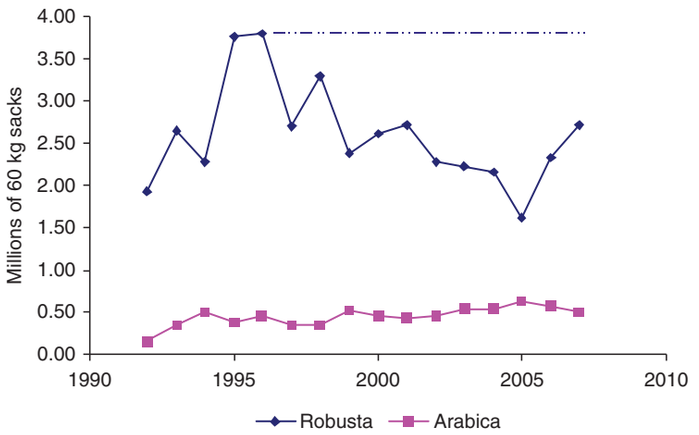


Figure 2.9: Coffee price paid to Ugandan growers. (ICO data.)

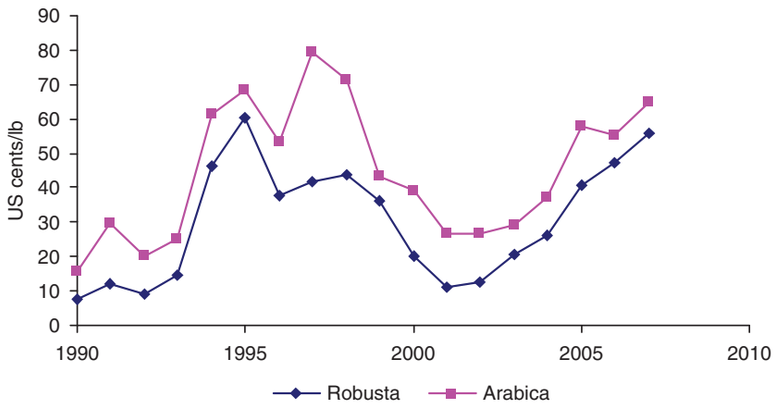
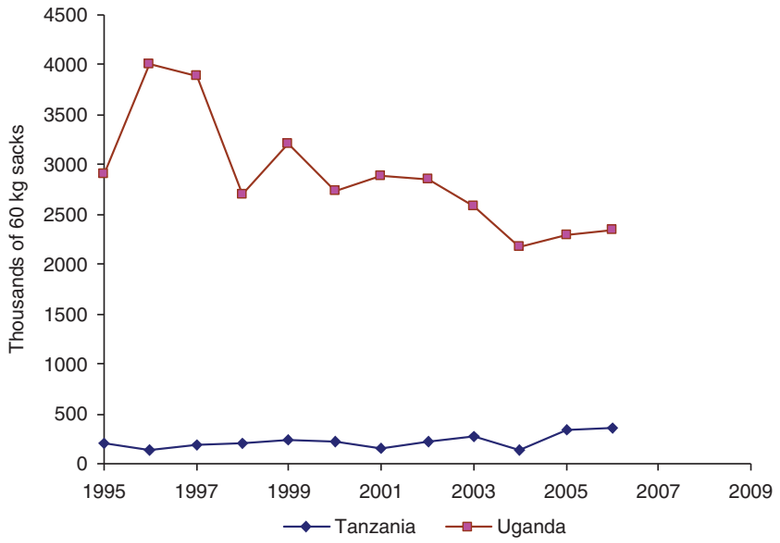


Figure 2.10: Robusta production in Uganda and Tanzania since 1995. (USDA data.)



Robusta coffee has declined by a cumulative total of US$580 million over 1997 to 2007. This could well be an underestimate since without CWD Robusta production may well have risen, as it has done in neighbouring Tanzania (Figure 2.10).

2.5 Tanzania

Coffee is currently Tanzania's second most important export, accounting for 23% of the country's total foreign exchange. Tanzanian coffee has an estimated area of 265,343 ha (TCB, 2006) with historically a major predominance of Arabica over Robusta. However, this proportion seems to be changing over recent years, with Robusta production rising and Arabica falling. The latter shows major fluctuations in production that are most probably climate-induced and may be an indication of climate change occurring in Tanzania, where as temperatures rise, Robusta would tend to replace Arabica (Figure 2.11).

According to Kilambo *et al*. (2009) most smallholder farms produce about 250 kg/ha of clean coffee. The main centre for Robusta is the Kagera region, supporting about 250,000 coffee-growing families in Bukoba, Biharamulo, Karagwe, Misenyi, Muleba and Ngara districts of this north-western corner of Tanzania. About 80% of the coffee in Kagera is Robusta, where it grows well over a wide range of rainfall, from 700 to 2000 mm.

2.5.1 CWD in Tanzania

CWD was first found on Robusta coffee in the Kagera region, in the Misenyi Division of Minziro ward at Kigazi village near the Ugandan and Tanzanian border towards the end of 1996. To date CWD still remains confined to this north-west zone (Figure 2.12).

Figure 2.11: The changing relationship of Robusta (♦) and Arabica production(■) in Tanzania. (USDA data.)

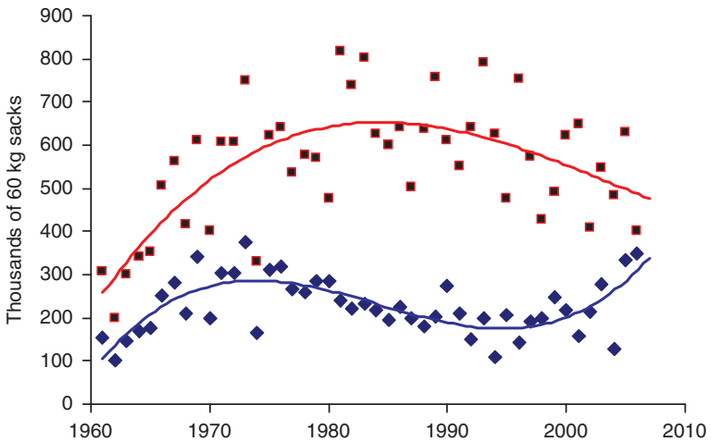
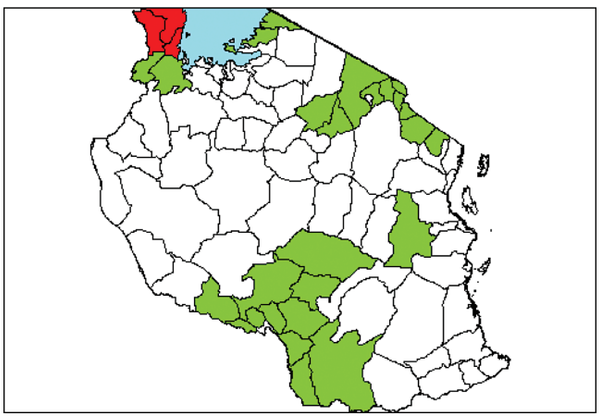


Figure 2.12: Coffee wilt disease (CWD) distribution in Tanzania, red = infected: green = not infected.



A detailed survey was carried out between September 2002 and February 2003 to determine its distribution and host range (CAB International, 2003; Kilambo *et al.*, 2004). Overall, in all the districts visited, incidence ranged from 0 (in 27 of the districts visited) to 39% in Bukoba district, and the mean severity was 1%. In the Lake Zone alone, these figures increased to 14 and 5%, respectively. Within the Lake Zone, the incidence and severity of CWD was significantly ($p < 0.05$) higher in Bukoba (39 and 16%, respectively) than in Karagwe or Muleba districts. Bugabo was the worst affected (incidence of 81% and severity of 46%).

While in 1997 CWD was detected in three wards, by 2008 the disease had spread to a total of 44 wards out of 100 in Kagera (Bukoba, Muleba, Misenyi and Karagwe). The remaining districts in Kagera region, i.e. Ngara and Biharamulo districts, are still free of the disease. The disease was observed only on Robusta coffee, even where Arabica coffee farms or trees were growing adjacent to Robusta ones. The pockets of

Robusta farms in Tarime, Mbinga, Lushoto and Morogoro districts were, however, not infected with CWD.

2.5.1.1 Losses caused by the disease

Robusta coffee is the major source of income to over 90% of households in Kagera and the disease has caused substantial losses of coffee trees in this area. Losses of trees can be equated to yield loss, which is approximately 160,000 kg of clean coffee lost due to the death of 54,133 trees from CWD. It is estimated that the disease has caused a financial loss of approximately US$316,137 over the last 10 years, including US$45,000 spent in eradication (Tables 2.3 and 2.4).

Although these figures represent a substantial loss for farmers involved, overall the severity and rate of spread in Tanzania seems to be significantly lower than in Uganda.

Table 2.3: Estimated coffee wilt disease (CWD) infected trees, yield losses and cost of uprooting. (From Tanzania Coffee Research Institute Lyamungu, Moshi.)

District	Infected coffee trees 1997-2007	Estimated yield losses from CWD infected trees[a] (kg)	Yield losses in monetary terms (US$)[b]	Cost of uprooting infected trees (US$)[c]	Total losses (US$)
Bukoba	28,155	84,465	141,057	23,369	164,426
Misenyi	17,277	51,831	86,558	14,339	100,897
Karagwe	6,279	18,837	31,458	5,212	36,670
Muleba	2,422	7,266	12,134	2,010	14,144
Total	**54,133**	**162,399**	**271,207**	**44,930**	**316,137**

[a]Estimated that mature Robusta coffee tree of 25 years old can produce 3kg of clean coffee.
[b]Estimated that the price of 1kg clean coffee = US$1.67 (October-December 2007 prices).
[c]Cost of uprooting a stump of infected Robusta tree = US$0.83.

Table 2.4: Estimated number of Robusta trees infected and uprooted from 1997 to 2007. (From Tanzania Coffee Research Institute Lyamungu, Moshi.)

District	Infected coffee trees	Uprooted coffee trees	Percentage uprooted due to CWD
Bukoba	28,155	14,079	50
Misenyi	17,277	4,566	26
Karagwe	6,279	6,279	100[a]
Muleba	2,422	2,348	97
Total	**54,133**	**27,272**	**50**

[a]CWD is still prevailing in this area.

2.5.2 Country-level CWD management practices in Tanzania

The Ministry of Agriculture, in collaboration with other sectors in the coffee industry under the coordination of Tanzania Coffee Research Institute (TaCRI), implemented strategies to minimize the effect of CWD.

2.5.2.1 Exclusion

Under provisions of the Plant Protection Act, the Ministry of Agriculture and Food Security brought in quarantine measures in 2002 to prevent movement of plant materials from neighbouring countries, and also movement of plant material, soil and farm implements from district to district and farm to farm. Because of insufficient enforcement, however, it is thought that this initiative has not been very effective.

2.5.2.2 Eradication

In May 2003, smallholders, cooperative unions, district and regional leaders, agricultural extension staff and ministry representatives met at Maruku Agricultural Research Institute and decided to make a CWD eradication campaign a top priority. A simple methodology was used, involving the uprooting and burning of affected trees *in situ*, with particular emphasis on early diagnosis of the disease to reduce the risk of spread to other trees and farms.

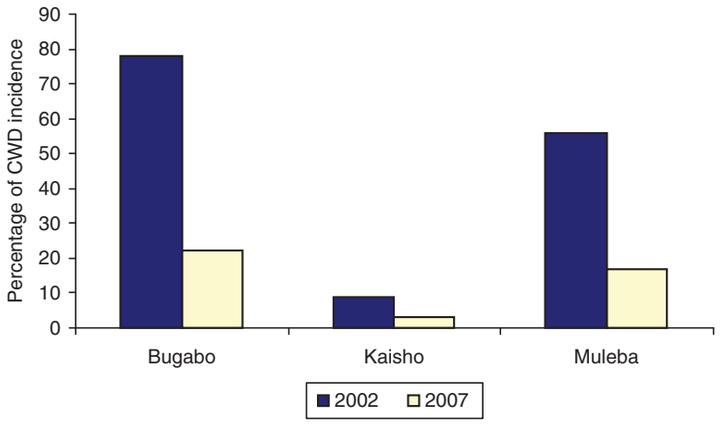
Results of the eradication campaign have been impressive with a concerted awareness and education campaign helping to get the message to farmers effectively and rapidly. Eradication of CWD-affected trees has significantly reduced the incidence of the disease (Figure 2.12). This suggests that if eradication of CWD diseased trees is done promptly for newly infected trees, it can assist in the management of the disease on farm and minimize its spread to others. Since the outbreak of CWD, a total of 27,272 diseased trees have been uprooted and destroyed.

Coffee stakeholders supported surveys, eradication and training. Funds included:

- US$8,000 for surveys from the Tanzania Coffee Board;
- US$10,000 from the Ministry of Agriculture for surveillance and eradication;
- US$6,000 from the district councils in Karagwe and Muleba for training of extension workers and eradication;
- US$70,000 from the Common Fund for Commodities (CFC) for training farmers and extension;
- US$39,000 from European Union–Collective Research Networking (EU–CORNET) contributed to carry out biological and socio-economic surveys;
- US$10,000 from TaCRI (through Système de Stabilisation des Recettes d'Exportation (STABEX) funds) for eradication programmes.

Hence, it seems that for under US$150,000 of operating costs, Tanzania has managed to contain the outbreak for a prolonged period and scale back losses to well under US$500,000. The changes in CWD incidence between 2002 and 2007 attest to the success of this campaign (Figure 2.13).

Figure 2.13: Changes in coffee wilt disease (CWD) incidence in three divisions of Kagera between 2002 and 2007.



2.6 CWD in Rwanda, Cameroon and Côte d'Ivoire

In Rwanda, only 3% of the farms visited grew Robusta coffee and CWD was not found on either Robusta or Arabica. Neither was CWD encountered in surveys of Cameroon or Côte d'Ivoire.

Currently, therefore, just four countries – Ethiopia, DRC, Uganda and Tanzania – are infected with CWD.[3]

2.7 Conclusions

At the country level, there is a wide range of different experiences with CWD (Table 2.5). It occurs on Robusta coffee in Uganda and Tanzania, and on Arabica coffee in Ethiopia, but the disease was neither found on Arabica coffee in Uganda, Tanzania or Rwanda, nor was it found on Robusta coffee in Ethiopia.

Across the countries surveyed, a total of 1728 out of the 5505 farms (31%) were found to be infested with CWD – 1280 farms with Robusta coffee (75%) and 448 farms with Arabica coffee (12%). However, the disease is far from evenly distributed throughout the sampled countries. Severity, i.e. average percentage of trees infected per farm, ranged from 0 in Rwanda to 45% in Uganda.

The highest incidence of the disease was in Uganda, where a remarkable 90% of farms had CWD, with average severity (i.e. percentage of sampled trees infected) of 45%. The disease was observed in all of the coffee-growing districts surveyed.

[3] Wrigley (1988) quotes Clowes and Hill (1981), who claimed that a berry and branch blight in Zimbabwe was due to *G. xylarioides* and that this was spread in seed from berries which may contain the CWD pathogen. However, CWD has not been confirmed in Zimbabwe and subsequent observations showed that the disease in Zimbabwe was similar to that caused by Fusarium bark disease (*Fusarium stilboides*), which was the probable source of the confusion.

Table 2.5: Status of infestation in surveyed countries as of 2007.

Country	Robusta infected	Arabica infected	Infected farms (%)	Trees infected (%)
DRC	Yes	No	27	18
Uganda	Yes	No	90	45
Tanzania	Yes	No	2.2	0.7
Ethiopia	No	Yes	28	3
Rwanda	No	No	0	0
Cameroon	No	No	0	0

In Tanzania, the disease was only found in the Kagera region, which borders Uganda, and the overall incidence and severity was much lower, at 2 and 0.7%, respectively.

Hence the surveys showed that the distribution and recent spread of CWD differs greatly between countries and raises a number of questions that are difficult to answer.

- Why did the disease resurge in DRC? And why is its incidence there lower than Uganda?
- Why has the spread and severity in Uganda been so much higher than Tanzania?
- Why has CWD spread slower in Ethiopia with, until recently, little concerted effort to control it even though it now seems widespread and serious?
- Why has the disease not resurged in West Africa? Cameroon, for example, is free of the disease despite being involved in the historical attacks during the middle of the 20th century.

The differences between countries in terms of progression of the disease are therefore striking, and candidate reasons include: different environmental conditions, different agronomic actions, different tree stock, different social effects, e.g. different rate of movement of people and plant materials. It is clear that further studies are needed to update the spread of the disease and, for instance, its prevalence in wild coffee areas.

It is worth pointing out the generally very old and degenerating plant stock found in DRC, as reported by Kalonji-Mbuyi *et al*. (2009). So the tree stock there should include varieties that were introduced to combat the problem in the 1950s and 1960s. This suggests that the disease is unlikely to have resurged there because of introduction of new susceptible varieties. As reported in Chapter 7, resistance trials do seem to show generally lower incidences of the disease than Uganda for instance.

The Arabica strain of the disease is present only in Ethiopia, and although it has been there since 1957, the incidence and severity of the disease is mostly less acute than DRC or Uganda. Van der Graff and Pieters (1978) reported that coffee lines of *C. arabica* in Ethiopia differed widely in their resistance to *F. xylarioides* and considered that these differences provided an excellent opportunity to control the disease using

resistant varieties. The authors further suggested that resistance to CWD in *C. arabica* is horizontal, i.e. broad-based, rather than vertical (complete). This could explain the relatively low severity of CWD in local coffee landraces in Ethiopia. Worryingly, however, Girma *et al*. (2009) consider that the disease, formerly of lesser importance in Ethiopia, has got much worse in recent years, to the point that they now consider it of equal status to CBD.

It is extremely worrying also that CWD is found in forest coffee, which must be considered a threat to the genetic base of Arabica, which is already under threat because of land-use change and climate change.