CHAPTER 1.14

Conclusions and Recommendations

*James Legg** and *Braima James***

Introduction

The first phase of the Tropical Whitefly Integrated Pest Management (TWF-IPM) Project (see Introduction to this volume) provided a unique opportunity to assess whitefly and whitefly-borne virus problems in a diverse range of cropping systems across the tropics and to obtain a broad range of diagnostic information as a basis for further concerted action. Sub-Project 4, Whiteflies as virus vectors in cassava and sweetpotato in sub-Saharan Africa, had the ambitious target of establishing collaborative research linkages among more than 15 partner institutions and implementing diagnostic surveys in nine African countries. Activities began in September 1997 and were completed in mid-1999. This chapter reviews the results obtained, considers the experiences gained in setting-up, implementing and completing the diagnostic phase of research, and discusses the implications for subsequent work on enhancing the management of whitefly-borne diseases of cassava (*Manihot esculenta* Crantz) and sweetpotato (*Ipomoea batatas* [L.] Lam.).

* International Institute of Tropical Agriculture-Eastern and Southern Africa Regional Center (IITA-ESARC), Kampala, Uganda, and Natural Resources Institute, University of Greenwich, Chatham Maritime, Kent, UK.
** IITA, Biological Control Center for Africa, Cotonou, Benin.

Increased Biological Understanding

Whitefly species and abundance

Field data collection and the examination of whitefly nymph specimens collected by project partners during surveys of cassava and sweetpotato in participating countries provided the most comprehensive information ever obtained for whiteflies on these crops in Africa. More than 2000 specimens were identified and four species were recorded. The two species that have been reported previously on cassava, *Bemisia tabaci* (Gennadius) and *B. afer* (Priesner and Hosny), were the only ones occurring widely on cassava and sweetpotato and were recorded from most locations. Two species were identified that have not been reported previously from cassava. These were the greenhouse whitefly *Trialeurodes vaporariorum* Westwood, identified from two locations in Ghana and Nigeria, and T. *ricini* (Misra) identified from a single site in the Lake Victoria zone of Tanzania. Whilst the occurrence of late instar nymphs of these two species does suggest colonization of cassava, the very low frequency of occurrence means that they are of little significance.

B. tabaci and *B. afer* both occurred on cassava and sweetpotato, although *B. afer* was relatively less frequent on sweetpotato and in Uganda was not recorded from this crop. There was an important geographical zonation in the relative abundance of the two species (Figures 1-3). Whilst *B. tabaci* predominated in countries in the equatorial belt (Ghana, Benin, Nigeria, Cameroon, Uganda and Kenya), the two species occurred at similar frequencies in Tanzania, to the south, and *B. afer* predominated in the most southerly countries, Malawi and Madagascar. The reasons for this pattern of occurrence are not clear, particularly since no single environmental factor appears to correlate consistently with the species ratio. In Malawi, however, there was a significant difference in the ratio between survey areas. In the two survey areas (1 and 2) along the shore of Lake Malawi (475-700 m altitude), similar numbers of the two species were recorded; whilst in survey area 3, the central plateau (1000-1500 m altitude), 97% of specimens identified were *B. afer* (Chapter 1.9, this volume).

The key difference between the lakeshore and plateau environments is temperature and it seems likely that the low temperatures that occur in the mid-altitude environments of southern Africa are unfavourable for *B. tabaci*. This possibility is supported by published information indicating that the development period of this species is significantly increased (Gerling et al., 1986) and fecundity significantly reduced (Azab et al., 1971) at temperatures below 15 °C. More detailed ecological studies and molecular characterization of the two species will be required to clarify these issues, particularly since the current surveys were conducted only at one time in the year and therefore may not be fully representative. It is important to highlight, however, that *B. afer* has never been shown to transmit viruses. The distinction between the two species therefore becomes important if errors are not to be made in describing relationships between adult whitefly populations and the spread of viruses causing cassava mosaic disease (CMD) or sweetpotato virus disease (SPVD).

Geographical patterns of variation in abundance of cassava whiteflies were partly confounded with the different patterns of distribution of the two species (Figures 1-3). Although survey teams were trained to differentiate the adult stages of the two species, it was not always possible for them to do so during counting. Some patterns in distribution were apparent, however. In West Africa, where *B. tabaci* was the dominant species, abundance was generally greater in the more humid rainforest and transition forest ecozones. Conversely, populations were smaller in the drier northern savannah zones. This is a pattern that has been recognized before, both in the Ecologically Sustainable Cassava Plant Protection (ESCaPP) surveys of 1993-94 (IITA, 1998) and through earlier studies of CMD epidemiology in Ivory Coast (Fauquet et al., 1987; 1988). In East Africa, two centres of whitefly abundance were recognized: the northern shoreline of Lake Victoria, in Uganda, and the northern Tanzania/southern Kenya coast. As for West Africa, these are also the areas in the region where humidity is greatest. It is notable, however, that abundance of *B. tabaci* in the “Lake Crescent” agro-ecological zone in Uganda, comprising the southern districts of Iganga, Mukono,

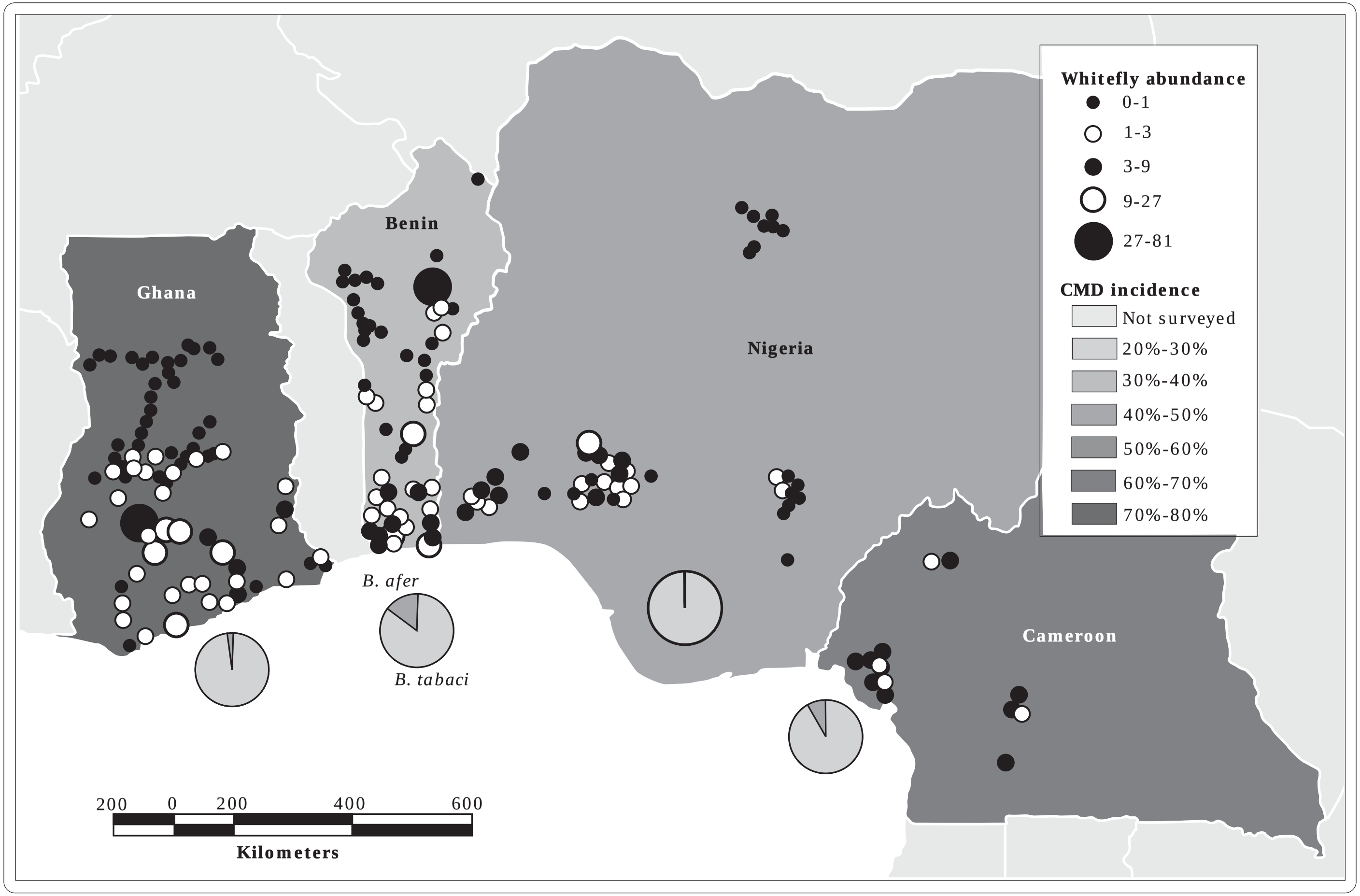

Figure 1. Whitefly abundance, cassava mosaic disease (CMD) incidence and *Bemisia tabaci*/*B. afer* ratio for Sub-Project 4 countries in West Africa.

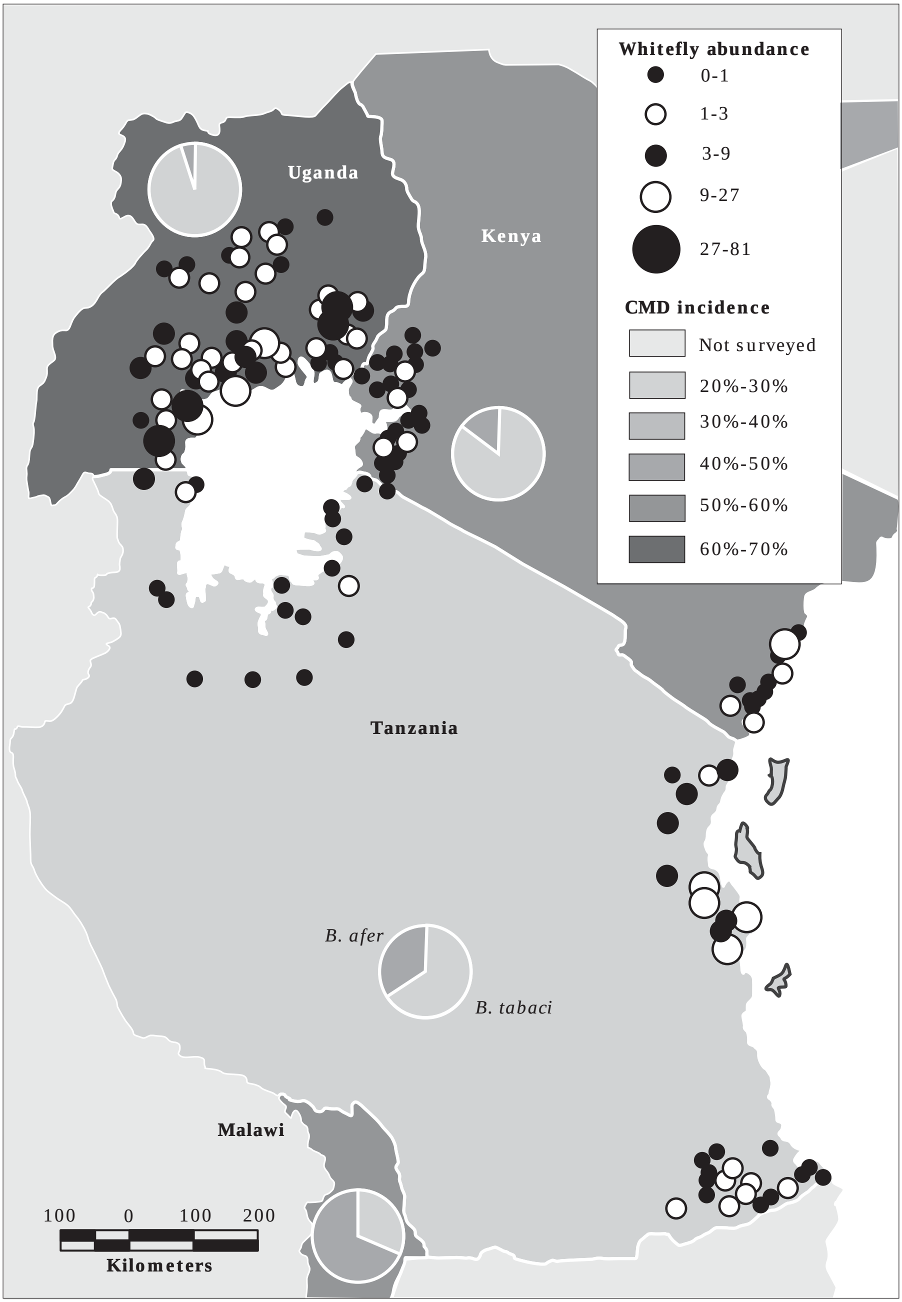

Figure 2. Whitefly abundance, cassava mosaic disease (CMD) incidence and *Bemisia tabaci*/*B. afer* ratio for Sub-Project 4 countries in East Africa.

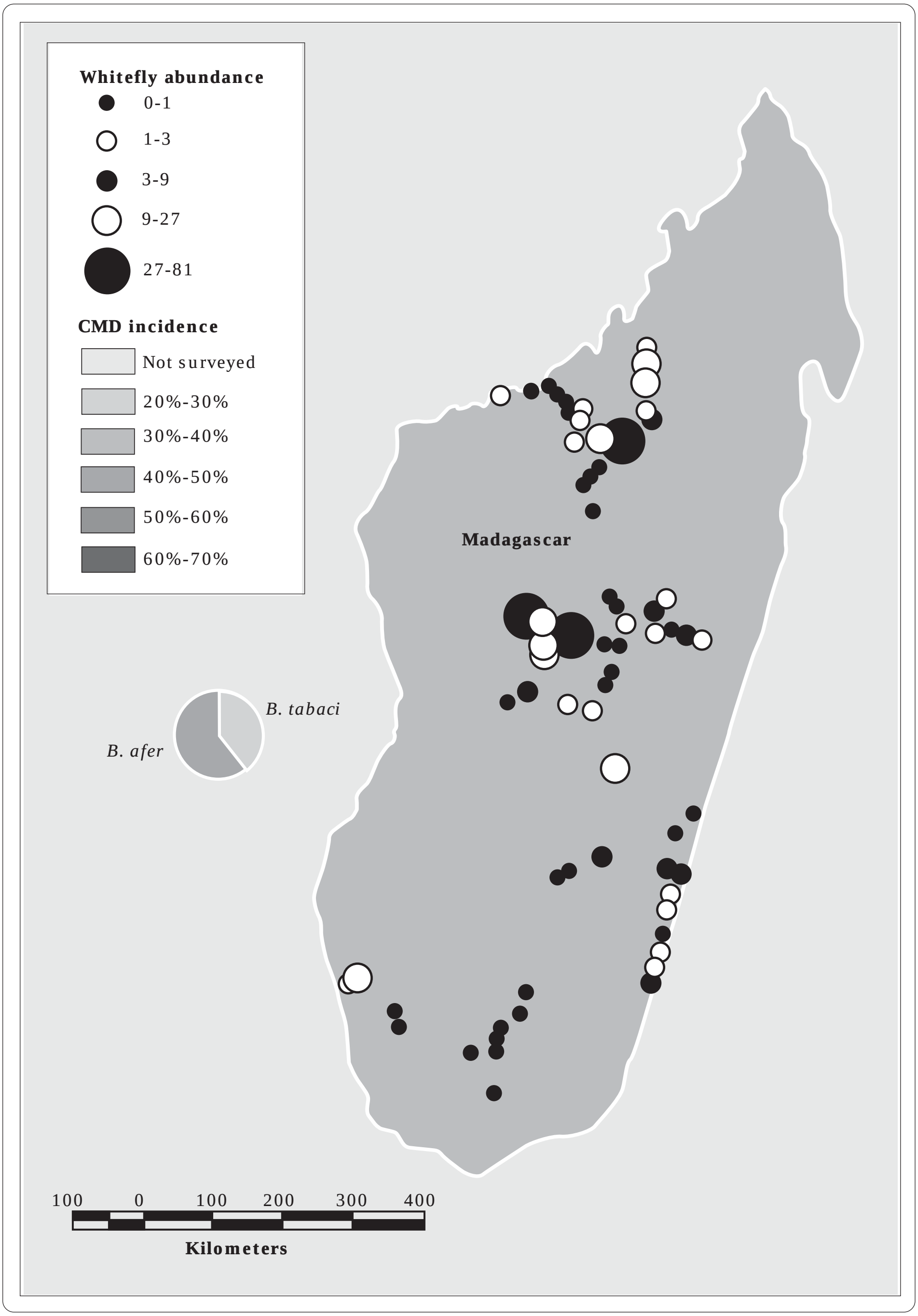

Figure 3. Whitefly abundance, cassava mosaic disease (CMD) incidence and *Bemisia tabaci*/*B. afer* ratio in Madagascar.

Mpigi, Masaka and Rakai, is recorded as having increased significantly during the second half of the 1990s (Legg, 1995; Otim-Nape et al., 1997; Legg and Ogwal, 1998). This is now thought to have resulted from a synergistic interaction with an unusually severe form of CMD, which spread through Uganda during this period (Colvin et al., 1999) and continues to spread in the East and Central African region (Legg, 1999). The interaction has occurred in all agro-ecologies in Uganda but it remains to be seen if the same will occur in the drier agro-ecologies to the south, in Tanzania. In Madagascar, there was no clear pattern of variation in abundance (Figure 3), although abundance in the southern central areas was lower than elsewhere.

Variation in abundance of sweetpotato whiteflies was much greater than for cassava whiteflies (Table 1). Very high populations were recorded around the shores of Lake Victoria, whilst whiteflies were not recorded at all from many locations in Madagascar. It is likely that seasonal effects can partly explain this degree of variation, since sweetpotato is grown for a much shorter period (typically 4-6 months) than cassava (typically 10-24 months). Thus, although cassava crops may be available throughout the year, in drier areas, sweetpotato cultivation outside the main growing season is confined to very small areas used for the maintenance of planting material. Associated with this, there is evidence showing that *B. tabaci* on sweetpotato colonize a wide range of crop plants and weed species, in contrast to *B. tabaci* on cassava, which appear to be largely restricted to cassava (Burban et al., 1992; Legg et al., 1994).

Whitefly-transmitted viruses in cassava

Stem samples of CMD-diseased cassava were sent from all nine principal participating countries to the John Innes Centre (JIC) for diagnostics and characterization. Chapter 1.11 (this volume) reports the results of this work. Until 1996, it was considered that two cassava mosaic begomoviruses were occurring in Africa, with largely disjunct distributions (Swanson and Harrison, 1994). *African cassava mosaic virus* (ACMV) was reported to occur in much of West, Central and southern Africa, and *East African cassava mosaic virus* (EACMV) was said to be restricted to coastal East Africa, Madagascar, Malawi and Zimbabwe. More recent diagnostic surveys have shown that EACMV is not restricted to East Africa (Offei et al., 1999; Ogbe et al., 1999), that the distributions of EACMV and ACMV overlap (Ogbe et al., 1996; 1997) and that mixed virus infections occur (Harrison et al., 1997). Results from the TWF-IPM Project (Chapter 1.11, this volume) have extended our understanding further by establishing the first record of EACMV from Benin in West Africa; identifying a novel begomovirus from cassava in Zimbabwe, which appears to be closely related to *South African cassava mosaic virus* (Rey and Thompson, 1998); and highlighting the occurrence of virus mixtures in East Africa. Dual infections are a relatively uncommon occurrence (< 10%) and it is significant that all these were recorded from the part of East Africa affected by the pandemic of unusually severe CMD (Otim-Nape et al., 1997; Legg 1999; Chapter 1.1, this volume).

Although virus diagnoses have been carried out on only a limited number of samples, a relationship is apparent between the viruses affecting cassava plants and the disease caused. In West Africa, diversity seems to be limited and symptoms of disease are generally mild to moderate (Table 1). In East and southern Africa, by contrast,

Table 1. Summary of data on the incidence of cassava mosaic disease (CMD), sweetpotato virus disease (SPVD) and abundance of *Bemisia tabaci*, from Sub-Project 4 diagnostic surveys.

Country	Survey area	Fields[a]	CMD (%)[b]	Wfinf[c] (miu)	CMD sev.[d]	Cassava WF[e]	SPVD (%)[f]	SP WF[g]
Uganda	North	20 (20)	77	48.0	3.0	1.2	5.0	1.40
	East	20 (20)	68	46.0	3.1	1.8	12.0	5.40
	South/Central	20 (20)	79	53.0	2.8	3.8	15.0	12.40
	West	20 (20)	48	55.0	2.8	9.2	10.0	3.00
Kenya	Coastal Province	17 (15)	56	36.0	2.3	2.9	0.5	0.50
	Western Province	15 (18)	85	64.0	2.9	0.3	6.0	2.30
	Nyanza Province	18 (17)	11	2.3	2.2	0.5	7.0	4.90
Madagascar	Central plateau	35 (11)	31	7.8	2.6	7.1	3.0	0.01
	Humid coast	22 (15)	71	11.0	3.5	4.3	2.0	0
	Dry coast	12 (7)	46	11.0	3.2	5.9	18.0	0.10
	Semi-humid coast	42 (6)	41	11.0	3.3	2.6	0	0
Tanzania	Lake zone plateau	20 (20)	21	1.7	2.6	0.7	11.0	40.10
	Semi-humid coast	20 (20)	12	7.1	2.7	1.2	13.0	2.80
	Humid coast	20 (20)	39	21.0	3.0	5.8	6.0	3.10
Malawi	Central lakeshore	20	62	55.0	2.8	1.5	-	-
	Northern lakeshore	9	52	34.0	2.7	1.0	-	-
	Central plateau	12	11	3.7	3.0	1.3	-	-
Ghana	Coastal savannah	10	76	44.0	2.2	11.8	-	-
	Rainforest	25	69	23.0	2.2	1.5	-	-
	Transition forest	25	74	54.0	2.5	1.0	-	-
	Guinea savannah	20	68	44.0	2.4	0.3	-	-
Benin	Transition forest	28	26	3.4	2.1	4.2	-	-
	Wet savannah	19	43	0.5	2.1	0.7	-	-
	Dry savannah	13	49	3.4	2.1	3.4	-	-
Nigeria	Rainforest	25	83	3.9	2.4	3.1	-	-
	Transition forest	25	32	2.7	2.1	2.6	-	-
	Wet savannah	20	56	0	2.4	1.0	-	-
	Dry savannah	10	45	2.4	2.2	0.3	-	-
Cameroon	South-west	26	54	21.0	2.2	4.1	-	-
	North-west	16	55	21.0	2.4	2.4	-	-
	Centre-south	28	73	5.6	2.3	3.1	-	-

a. Fields: Figures in parentheses indicate number of sweetpotato fields sampled.
b. CMD %: Total incidence of CMD, calculated as the average percentage of plants showing symptoms of virus disease from 30 plant samples recorded in each dataset (i.e., one field).
c. Wfinf (miu): Incidence of plants infected with CMD whitefly in the current season, transformed to allow for multiple infection units (Gregory, P. H. 1948. The multiple infection transformation. Ann. Appl. Biol. 35: 412-417).
d. CMD sev.: Severity of CMD symptoms, based on an arbitrary 1-5 scale, where 1 indicates low and 5 indicates high severity of symptoms.
e. Cassava WF: Mean whitefly abundance for cassava recorded as the average number of adult whiteflies counted on the five uppermost leaves of 30 plant samples recorded in each field.
f. SPVD %: Total incidence of SPVD, calculated as the average percentage of plants showing symptoms of virus disease from 30 plant samples recorded in each field.
g. SP WF: Mean whitefly abundance for sweetpotato recorded as the average number of adult whiteflies counted in ten 1-minute counts made at random in the sampled field.

complexity appears greater, dual infections are more prevalent and severe disease is more widespread, although in most instances (4/5) the dual infections were in areas affected by the East African CMD pandemic (Legg, 1999). An association between virus infection and epidemiology is similarly apparent (Table 1). In East Africa, current-season whitefly-borne infection is greatest in Uganda, where the "Uganda variant" of EACMV (EACMV-Ug) was reported (Chapter 1.11, this volume) and where EACMV-Ug/ACMV mixtures were common, as reported earlier by Harrison et al. (1997); whilst in Nigeria, where only ACMV was reported, current-season whitefly-borne infection was very infrequent.

The incidence of CMD varied considerably within sub-regions. In West Africa, disease incidence ranged from 36% (Benin) to 72% (Ghana); whilst in East and southern Africa, it ranged from 21% (Tanzania) to 68% (Uganda). In all countries, the proportion of diseased plants that had arisen from planting diseased cuttings (cutting infection) was greater than that derived from current season whitefly-borne infection. Many factors influence CMD incidence, including the virus(es) infecting the plant, cultivar response to the virus(es), vector abundance and transmission efficiency, the physical environment, and cropping practices (including vector or disease management measures). Most of these factors remain poorly defined for many of the participating countries, although the surveys have provided quantitative data relating to some aspects. In this respect it would be useful to compare the epidemiology of CMD between regions, using common cultivars for reference, as proposed by Legg et al. (1997).

Whitefly-transmitted viruses in sweetpotato

Sweetpotato leaf samples with symptoms of virus disease from Uganda, Kenya, Tanzania and Zambia were analysed. Chapter 1.12 discusses in detail the results of virus diagnoses from Uganda, Kenya and Tanzania, and Kaitisha and Gibson (1999) discuss those from Zambia. The East African strain (S_{EA}) of *Sweetpotato chlorotic stunt virus* (SPCSV) occurred throughout the region and, in Uganda, Aritua et al. (Chapter 1.12, this volume) have discussed distributions for the two distinct serotypes (S_{EA1} and S_{EA2}) described by Alicai et al. (1999). The other whitefly-borne virus identified from project surveys was *Sweetpotato mild mottle virus* (SPMMV), although this was restricted to areas around the shores of Lake Victoria (Chapter 1.12, this volume). SPVD, which results from co-infection of sweetpotato plants with SPCSV and the aphid-borne *Sweetpotato feathery mottle virus* (SPFMV), occurred throughout areas sampled. The disease was most frequent in south-western Uganda, the Lake Victoria zone of Tanzania, south-eastern coastal Tanzania and the semi-arid south-western part of Madagascar. Diagnostic tests related SPVD to the co-occurrence of SPCSV and SPFMV for each of these regions (Chapter 1.12, this volume). No samples from Madagascar were tested.

Whitefly natural enemies

The agreed survey protocol for the TWF-IPM Project provided guidelines for the collection of parasitoids, predators and entomopathogens during the course of diagnostic surveys. Limitations in the methods proposed, and the short period of time available for natural enemy collection at each sampling site, meant that the collection of natural enemies was less comprehensive than had been anticipated. More intensive and targeted surveys would be required for the adequate characterization of predators and entomopathogens in particular.

Survey teams in most countries collected parasitized whitefly mummies and reared adult parasitoids from them. The parasitoids were subsequently mounted and identified by Dr. Mohammed Ali Bob of the International Center of Insect Physiology and Ecology (ICIPE). Dr. A. Polaszek of the British Museum (Natural History) verified representative specimens. Five species of parasitoid were recorded: *Encarsia sophia* (Girault and Dodd), *Encarsia lutea* (Masi), *Encarsia mineoi* Viggiani, *Encarsia* sp. (*luteola* group) and *Eretmocerus* sp. (Table 2). Only two species, *E. sophia* and *Eretmocerus* sp., were widely distributed, parasitizing whiteflies on both cassava and sweetpotato. *E. sophia* was an order of magnitude more common that *Eretmocerus* sp., although it is considered that easy recognition of the former, resulting from the black coloration of the mummy from which it emerges, may have partially biased the sampling. Whilst over 30 species of parasitoid have been described as parasitizing *B. tabaci* worldwide (Gerling, 1986), only limited information is available about *Bemisia* parasitoids in Africa, and virtually no information relating to cassava or sweetpotato (Fishpool and Burban, 1994). Whilst this component of the TWF-IPM Project's diagnostic phase had deficiencies, it is nevertheless considered that the information obtained has provided an important baseline from which to develop future studies. Key issues that will need to be more fully addressed include the variation in parasitoid diversity between regions, of which there was evidence in this study, and the role (if any) of the different parasitoid species in the population dynamics of *Bemisia* spp. and the epidemiology of CMD.

Increased Socio-Economic Understanding

Farmers' assessment of whitefly-related problems

There was a clear relationship between farmers' assessments of CMD and SPVD and the prevalence and severity of the diseases as described from the field data collection. In Uganda, all farmers both recognized CMD and considered it a problem for their cassava production. In the countries of West Africa, on the other hand, although typically about 70% of farmers were able to recognize CMD, less than 50% considered it a problem. A smaller proportion of sweetpotato farmers recognized SPVD but, where it was recognized, most farmers

Table 2. Aphelinid parasitoids identified from diagnostic surveys of Sub-Project 4.

Country	*Encarsia sophia*	*Eretmocerus* sp.	*Encarsia* sp. (*luteola* group)	*Encarsia lutea*	*Encarsia mineoi*
Uganda	62	46	3	-	-
Kenya	13	2	-	-	-
Tanzania	62	-	1	-	-
Ghana	4	-	-	-	-
Benin	16	2	-	-	-
Nigeria	557	21	4	7	5
Cameroon	324	38	-	-	-

considered it a problem. Much smaller proportions of farmers were able to recognize whiteflies and many expressed surprise when informed of their role as disease vectors. There were significant differences between countries in this respect, however, with the extremes being Madagascar, where no farmers reported recognizing whiteflies, and Benin, where 70% recognized them.

Farmers had names for whiteflies and whitefly-transmitted diseases in all countries, but in many cases these were non-specific, translating simply as "insect" or "disease". More specific names were commonest for CMD, which was often described using anthropomorphic disease equivalents such as "leprosy". Names for SPVD were often exactly the same as those used for CMD. Where such names are in common usage, potential exists for their use, perhaps with minor modification, in training and extension programs in the future. Estimates of loss to the respective diseases were most frequently in the range of 25%-75% for cassava and 25% or less for sweetpotato, although most survey teams considered that these were likely to be overestimates, particularly in West African countries, where disease symptoms (in this case only CMD) were typically mild. Participatory yield loss studies would be helpful in many of the surveyed countries to evaluate losses scientifically and reconcile such estimates with farmer perceptions. The shortcoming of this and other responses emphasized the need to link producer interviews with the collection of more objective field data.

Managing whiteflies and whitefly-transmitted viruses

There were widely divergent responses on the use of vector and disease management measures. In Ghana and Madagascar, less than 5% of farmers reported doing anything at all to control CMD. This result was particularly anomalous for Ghana, since many farmers reported relatively high losses. Management practices were most widely reported in Uganda and Cameroon, where most farmers indicated the use of at least one practice. The most cited methods of disease management were the phytosanitary techniques of roguing, and selection of disease-free stems. This has to be set against the predominance of the use of diseased cuttings as planting material in almost all areas surveyed. Selection of disease-free planting material similarly was cited widely as a management tactic but the health status of stems was normally less important as a criterion for planting material selection than were agronomic characters.

Although it appears that farmers over-estimated their use of roguing and selection of healthy cuttings, they under-reported use of disease-resistant varieties. Use of cassava varieties recommended for resistance to CMD was most widespread in Cameroon, where 48% of farmers reported growing variety "Agric" in the knowledge that it was resistant to CMD. In Uganda, more than 15% of sweetpotato farmers were found to be growing SPVD-resistant varieties but none of these realized that this was a method of managing SPVD.

Very few farmers reported using pesticides to control whiteflies or whitefly-borne viruses. Occasionally, sweetpotato farmers reported pesticide use but this was more likely to be for the purpose of controlling other insect pests such as the sweetpotato butterfly *Acraea acerata* Hewitson. Chapter 1.13 (this volume) gives a more detailed assessment of the approaches of sweetpotato farmers to SPVD control. Few farmers reported having received any technical assistance with respect to the control of either CMD or SPVD and, as a result, most considered that the management methods being used were their own. The only exception to this was Cameroon, where 39% of farmers reported that they had received technical support relating to whiteflies and whitefly-borne diseases.

Recommendations

The overall picture that emerges from this assessment of farmers' awareness of whiteflies and whitefly-borne diseases in cassava and sweetpotato and their approach to disease management is one of weak understanding of the nature of the problem and a correspondingly haphazard implementation of management tactics. Much of the responsibility for this lies with the research (both national and international) and extension systems. Researchers have failed to provide a well-defined and well-tested strategy for managing CMD and SPVD. Moreover, weakness in the extension systems of most of the participating countries has meant that even where management recommendations have been defined, these are not reaching the majority of farmers (as is particularly the case for the control of whitefly-borne diseases of cassava and sweetpotato in Uganda). In order to address this situation, key objectives for future work on whiteflies and whitefly-borne diseases, for both cassava and sweetpotato, should be to encourage researchers, extension agents and farmers to work together to:

(1) Define exactly where disease management is needed and where not;

(2) Develop effective, clearly defined and readily implemented vector and disease management methods (which based on current knowledge are most likely to include choosing disease-resistant varieties, selecting disease-free planting material and/or roguing of diseased plants); and

(3) Facilitate the adoption of these methods by using participatory training and all media channels available to improve the access of farmers to current knowledge.

Sub-Project 4 of the TWF-IPM Project has been successful in achieving part of the first objective. Following the completion of the diagnostic phase, there is a clearer understanding of the distribution of whitefly-borne viruses, what their impact is in terms of disease incidence and epidemiology and how farmers are responding to these diseases. The project also has been uniquely successful in obtaining comparable information of this type from nine of the major cassava-producing countries of Africa and four of the major sweetpotato-producing ones; these countries together account for more than 50% of African production of each crop. In achieving this, the project has established a network of researchers working on whiteflies and whitefly-borne disease of root crops in sub-Saharan Africa. In order to complete the first objective and to begin to address the second, the following issues, a number of which have been highlighted in the country chapters, need to be addressed.

(1) How severe are yield losses in the CMD-diseased local landraces that still dominate cassava production in Africa? Knowledge of this is particularly critical, for example, in Ghana, where farmers report high losses yet appear to make little attempt to control them. A realistic estimate of current yields and yield losses would help direct research and extension efforts more effectively.

(2) What are the conditions under which tactics for improving plant health, especially selection of disease-free cuttings and roguing of diseased plants, are most likely to be effective?

(3) Where is host plant resistance required as a foundation for sustainable management of cassava and/or sweetpotato (as compared with a strategy focusing on improving the husbandry of land races) and are particular virus/vector/environmental characteristics common to these areas?

(4) Where conditions demand the use of host plant resistance, as has been the case in Uganda during the pandemic of severe CMD, what are the constraints to the adoption of newly developed CMD-resistant varieties?

(5) Are there alternative, novel approaches to crop health management that can be used to supplement existing methods? Although both biological control and host plant resistance are regarded conventionally as being more appropriate for use against direct pests, rather than virus vectors, is there scope for their deployment?

(6) Where are successes currently being realized in CMD and/or SPVD management and how can experience from these situations be incorporated into research and extension efforts elsewhere?

The second phase of the TWF-IPM Project proposes to address key research and implementation issues such as those indicated above. In the formulation of this vitally important phase of the project, attention needs to be paid to collaborative mechanisms in addition to technical issues; the first phase, described in this volume, has provided some important lessons in this regard.

(1) The coordination structure developed during the first phase has provided an effective means by which a global-scale project can be executed. Effective interaction, facilitated by electronic communication, is vital for the efficient working of this structure.

(2) At the outset of the next phase of the project, all partners at sub-project level should participate in an introductory meeting, during which opportunities are provided for critical review of the proposed work plans and budgets, and for training in additional skills required for project implementation. This was not done during the first phase and, as a result, it was difficult to consistently train partners in national research systems and to provide all partners with an appreciation of the continental and global contexts of the project.

(3) The sub-project should budget for annual review meetings for all principal partners. If resources are limited, the number of partners should be restricted to allow full participation of each.

(4) If a large number of national research system partners are to be included, as was the case in the first phase of Sub-Project 4, the task of co-ordination and provision of research support, executed by the co-ordinating international centre, should be divided between major regions covered. In the first phase of Sub-Project 4, the International Institute of Tropical Agriculture (IITA) provided co-ordination and support through

offices in both West and East Africa. This division of responsibility was considered to be a key factor in the successful implementation of the sub-project although such a division demands an effective exchange of ideas and information between the regions.

Whiteflies continue to pose a tremendous challenge to farmers, researchers and development workers in Africa, as well as in the wider global context. However, significant successes are being realized in meeting this challenge both in terms of characterizing the problems and in developing strategies to address them in a sustainable manner. In the African context, at stake are the livelihoods of many millions of producers, who depend on cassava and sweetpotato as sources of cash income, and consumers, both rural and urban, who depend on these crops to provide affordable staple foods. It is to be hoped, therefore, that initiatives to strengthen management of whitefly-transmitted virus diseases of these two major food crops, including the second phase of the TWF-IPM Project, will be able to attract a level of support commensurate with the magnitude of the problem.

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