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Scoping Study on the Damages Inflicted by Fruit Flies on West Africa's Fruit Production and Action Plan for a Coordinated Regional Response

FINAL REPORT

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TABLE OF CONTENTS

ANNEXES

GLOSSARY

ACA now FICA	Agence de Commercialization Agricole, Guinée.
ADEx	Association de Developpement des Exportations, Bénin.
ADRAO / WARDA	Centre du riz pour l'Afrique West African Rice Development Association, Bénin.
AFFI	African Fruit Fly Initiative
AGRI-MAT Ltd.	Agricultural Materials Ltd, Ghana.
ANADER	Agence Nationale d'Appui au Développement Rural, Côte d'Ivoire.
APEK	Association pour la promotion économique de Kindia, Guinée.
APHIS	Animal and Plant Health Inspection Service / Service de l'Inspection de la Sante des Animaux er des Plantes Services Internationaux www.aphis.usda.gov, Sénégal.
APIPAC	Association des Professionnels de l'Irrigation et des Activités Connexes, Burkina Faso.
APROMAB	Association des Producteurs de Mangues du Burkina, Burkina Faso.
ARPPIS	Africa Regional Postgraduate Program in Insect Science, Ghana.
ASEPEX	Agence Sénégalaise pour Exportations, Sénégal.
BCEPA	Bureau Central d'etudes et de planification agricola, Guinée.
BNARI	Biotechnology & Nuclear Agriculture Research Institute, Ghana.
CAFEX	Centre d'Appui aux formalites d'Exportation , Guinée.
CDH, ISRA	Centre de Développement d'Horticulture, Sénégal.
CERE	Centre d'Etudes et de Recherche en Environnement, Guinée.
CFC	Common Fund for Commodities
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
CMAOC	Conférence des Ministres de l'Agriculture de l'Afrique de l'Ouest et du Centre, Guinée.
CNRA	Centre National de Recherches Agronomiques, Côte d'Ivoire.
CRAB	Centre de Recherche Agronomique de Bordo, Guinée.
CRAF	Centre de recherche agronomique de Foulaya, Guinée.
CRAK	Centre de recherche agronomique de Kankan, Guinée.
DAGRI	Direction de l'Agriculture Service Protection des Végétaux et Contrôle Phytosanitaire, Bénin.
DGPV	Direction Générale des Productions Végétales, Burkina Faso
DHORT	Direction de L'Horticulture, Sénégal
DICAF	Direction du Conseil Agricole et de la Formation Opérationelle, Bénin.
DLCP	Division Législation et Contrôle Phytosanitaire, Mali.
DNA	Direction National de l'Agriculture, Guinée.
DNCC	Direction Nationale du Commerce et de la Concurrence, Mali.
DPQ	Department of Plant Quarantine, Gambia.
DPV	Direction de la Protection des Végétaux, Sénégal.
DPV	Division Protection des Végétaux (will become Service de PV in future), Guinée.
DPVC	Direction de la Protection des Végétaux et du Conditionnement, B. Faso.
DPVQ	Direction de la Protection des Végétaux et de la Qualité, Côte d'Ivoire.
EMQAP	Export Marketing & Quality Awareness Project, Ghana.
EPA	Environmental Protection Agency, Ghana.
FICA	Agricultural Marketing and Investment Foundation, Guinée.
FIRCA	Fonds Interprofessionel pour la Recherche et le Conseil Agricoles, Côte d'Ivoire.
FRUITEQ	Commerce Equitable, Burkina Faso.
GAEC	Ghana Atomic Energy Commission, Ghana.

GHE	Gambia Horticultural Enterprises, Gambia.
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit GmbH
HEII	Horticultural Exports Industry Initiative, Ghana
IER	Institut d'Economie Rurale, Mali.
IFAN, Dakar	Institut Fondamentale d'Afrique Noire, Sénégal.
IITA -Bénin	International Institute of Tropical Agriculture, Bénin.
INERA	Institut de l'Environnement et des Recherches Agricoles, Burkina Faso.
INERAB	Institut National des Recherches Agronomique du Bénin, Bénin.
IRAG	Institut de Recherche Agronomique, Guinée.
IRG SAGIC	Programme Croissance Economique www.irgltd.com, Sénégal.
ISRA	Institut Scientifique de Recherche Agronomique, Sénégal.
MAEP/CNCA	Ministère de L'Agriculture de l'Elevage et de Pêche, Comite National de Controle Alimentaire, Bénin.
MAHRH	Ministère de l'Agriculture de l'Hydraulique et des Ressources Halieutiques, Burkina Faso.
MOFA	Ministry of Food and Agriculture, Ghana.
NARI	National Agricultural Research Institute, Gambia.
OCAB	Organisateur Centrale des Producteurs – Exportateurs d'Ananas et de Bananes, Côte d'Ivoire.
OPV	Office de Protection des Végétaux, Mali.
OPV	Office de Protection des Végétaux, Mali.
PADL/CLK	Project d'Appui au Développement Local des Provinces de la Comoé, de la Léraba et du Kénédougou, Burkina Faso.
PAFASP	Programme d'Appui aux Filières Agro-Sylvo-Pastorales, Burkina Faso.
PAIMAF	Projet d'Appui Institutionnel a la Modernisation de l'Agriculture Familiale, Bénin.
PAMPEAG	Papaya and Mango Producers and Exporters Association of Ghana.
PCDA	Programme Compétitivité Diversification Agricole, Mali.
PDA GTZ	Programme Développement de l'Agriculture Deutsche Gesellschaft fur Technische Zusammenarbeit GmbH, Burkina Faso.
PDMAS	Programme de developpement des marches agricoles du Senegal www.pdmas.org, Sénégal.
SAGIC	Senegal Programme Croissance Economique www.irgltd.com, Sénégal.
SAPHYTO	Société africaine de produits phytosanitaires et d'insecticides, Burkina Faso.
SEDEP	Service de développement et de promotion des exportations des produits de bases, Guinée.
SEPAS	Sénégalaise D'exportation de produits agricoles et Services, Sénégal.
SGTF	Société de Gestion du Termina Fruitier, Burkina Faso.
SGTF	Société de Gestion du Termina Fruitier, Burkina Faso.
SNV	Service Néerlandais des Volontaires, Burkina Faso.
SOBFEL	Société Burkinabè des Fruits et Légumes, Burkina Faso.
TIPCEE	Trade and Investment Program for a Competitive Economy, Ghana.
UFMB	Union Fruitière et Maraîchère du Burkina, Burkina Faso.
UNIVERS	Union Nationale Interprofessionelle pour la valorisation de l'Entreprise Rurale au Senegal, Sénégal.
USAID	United States Agency for International Development
USDA	United States Department of Agriculture.
UT	Université de Thiès - UFR SADR (ex ENSA) Thiès, Sénégal.
WARDA / ADRAO	West African Rice Development Association / Association pour le Développement Rizière en Afrique de l'Ouest, Centre du riz pour l'Afrique, Bénin.

1 BACKGROUND TO THE SCOPING STUDY

Damage caused by fruit flies has been recognised as a quarantine problem on fruit destined for the European market for many years. The growing importance of the fruit export industry in Africa has attracted increasing levels of damage by indigenous fruit flies and research institutions concerned with tropical crop pests (IITA, ICIPE, CIRAD) have sought to assess and manage the problem. The first research programme in this field was the African Fruit Fly Initiative (AFFI) based at ICIPE which began in 1998[1]. However, the discovery of a new and invasive exotic fruit fly species (*Bactrocera invadens*) from South Asia, first in East Africa and subsequently across West Africa since 2003, has led to increased interception of mangos arriving in the EC and to higher levels of loss in the producing countries.

The lack of precise information on these losses and the best means to combat the problem has led to the intervention of multi-lateral and bilateral donors (USAID, World Bank), and increased efforts by industry organizations (COLEACP) to equip producers to control the damage. Initiatives have included the recent teleconference for West African countries organised by the World Bank, a newsletter (produced by COLEACP) financed by the French government and some small advisory and research projects and a guideline (published by CTA) financed under the COLEACP PIP Project by the European Commission. National Research institutions have also been involved in studying the problem, especially in Senegal, Ivory Coast and Ghana.

However the slender resources of national agricultural and research institutions have not permitted an adequate level of research input or the elaboration and deployment of effective control strategies across the region. There is a perceived need for a common regional approach and strategy to deal with an economic problem which requires large scale monitoring and control of fruit flies using best practice approaches across all the member countries of ECOWAS/CEDEAO and beyond. The current Scoping Study has been developed at the request of the ECOWAS/CEDEAO member countries through the financial participation of the Environment and Rural Development Unit of the Directorate-General for Development of the European Commission, with coordination by the Delegation of the European Commission in Nigeria, situated in Abuja, which is also the seat of the Secretariat of ECOWAS/CEDEAO.

[1] Lux SA, Zenz N, Kimani S. 1998. The African fruit fly initiative: development, testing and dissemination of technologies for the control of fruit flies. ICIPE Annual Scientific Report 1998- 1999 7: 78-80.

2 TERMS OF REFERENCE FOR THE SCOPING STUDY

The TOR for the Scoping Study were provided in the form of a 13-page document (**Annex 1**)[2] summarizing the background and rationale for the study and the current situation of serious losses to fruit production across West Africa caused by fruit flies (Section I). The overall and specific objectives of the Study were largely described in Sections II and III of the TOR, together with detailed requirements for the national situation documents and the rationale for and content of the regional Action Plan. All these different elements were dispersed throughout the TOR document. They have therefore been brought together here and summarised in terms of the objectives, outputs/results and activities of the Scoping Study.

2.1 Objectives

The Objectives, outputs and activities of the study can be summarised as follows:

Overall Objective: "to protect West Africa's edible horticultural production and export sectors that contribute to the balanced diet of millions of consumers at local and regional levels and provide a livelihood for a large number of smallholder producers in rural areas"[3].

Specific Objective: "to improve the plant health situation in West Africa through the mitigation of the fruit-fly inflicted damages that compromise the availability and quality of fruits and vegetables produce for both local markets and export sales, especially in the mango sub-sector."[4]

2.2 Result areas of the Scoping Study

To address these objectives the Scoping Study has the following four Outputs or Results:

Result 1. Review of existing literature on the fruit fly problem. This will include review of incidence of fruit fly species in West Africa[5] and their technical / economic incidence in fruit production, drawing from numerous published studies and articles and unpublished reports funded by donors[6]. In addition, the existing post-harvest technologies will be reviewed in order to make informed recommendations as to the technologies best suited to the West African context[7].

Result 2. Detailed synopses of the national situations and responses to the fruit fly problem in the visited countries (Senegal, Gambia, Guinea, Mali, Burkina Faso, Benin, Cote d'Ivoire, Ghana), at all stages of the value chain, assessing the economic impact of the plague[8] and outlining the involvement of the state and the private sector and the nature of any public-private cooperation and donor involvement in these responses.

Result 3. National level recommendations and action plans and assessment of their feasibility. At each of the above stages following a logical orchard to market chain, make recommendations[9] for improvement bearing in mind the need to address

[2] Terms of Reference for a Scoping Study on the Damages Inflicted by Fruit Flies on West Africa's Fruit Production and Action Plan for a Coordinated Regional Response. (Version 2). 13 pp.
[3] TOR, Section II, paragraph 2.
[4] TOR, Section II, paragraph 3.
[5] TOR, Section II, subsection 1
[6] TOR, Section III, subsection 1.
[7] TOR, Annex 1, subsection 2.
[8] TOR, Section I, paragraph 6.
[9] This paragraph was included under Result 1 of the TOR (Section III, subsection 2), but as a recommendation logically belongs here.

control of all fruitfly pest species at a national level. Recommendations should take account of cost/benefit, sustainability, environmental protection, regional cooperation, capacity development and training needs.

Result 4. Regional level recommendations and Action Plan, with an assessment of its feasibility, including the development of a logical framework with appropriate indicators and activities covering short medium and long-term time scales.

2.3 Activities of the Scoping Study

The following activities were prescribed to deliver these outputs:

Result 1. Literature Review

A desk review (by Category I and II consultants) of existing literature and unpublished reports to compile an inventory and assessment of:

Activity 1.1 Incidence of fruit fly species on the main crops of commercial value in West Africa
Activity 1.2 Extent of the damages caused to fruit production,
Activity 1.3 Available field monitoring and control strategies[10] and
Activity 1.4 Review of the post harvest technologies used throughout the region (hot water treatment, micro-waves, irradiation etc)[11].

Result 2. National Situation synopses

Activity 2.1 Preparation by the Team Leader of detailed guidelines for Category III experts to conduct national situation assessments[12].
Activity 2.2 Preparation of individual preliminary country situation assessments by Category III experts, including description of the fruit fly problem, its economic impact and national responses to it, outlining involvement of state and private sector entities and the involvement of donors. The assessments were to encompass the different stages in the value chain from orchard to export[13]
Activity 2.3 Production of National Situation Synopses[14] finalised by Category I and II experts on the basis of country visits to complete assessment of local situations, by discussions with public and private institutions and donors. These synopses will:
- Characterize the seriousness of the fruit flies infestation situation by quantifying and evaluating consequential losses incurred by fruit growers
- Describe and evaluate the existing fruit fly population monitoring/ surveillance policies and methods prevailing in the country, including relevance and efficacy of baiting technologies adopted,
- Describe and evaluate existing fruit fly population control methods prevailing in the country, including any attempts at IPM using predators and parasites, especially against *B. invadens*,
- Describe and evaluate existing research programs in the country and expected applied research outcomes (prospects for breakthrough and likely timing),

[10] Surprisingly, the TOR do not explicitly indicate the need for this. However it is clearly essential to document international best practice on monitoring and control of fruit flies as a basis for intervention in West Africa.
[11] See TOR, Annex 1, paragraph 2.
[12] See TOR, Section 3, subsection 2.
[13] See TOR, Section II, paragraph 6.
[14] See TOR, Section III, subsection 3.1.

- Evaluate the human and technical capacity of key state services[15] in performing all important functions: registration of all phytosanitary products used in the country, quarantine pests management capabilities,
- Describe and evaluate interaction / cooperation between public (relevant state services such as plant protection directorates) and private sector (growers and exporters associations),
- Describe and evaluate post-harvest technologies currently applied at fruit packing station level (pre-shipment inspection).
- Identify existing regional structures and donors' programs playing a role in the area under study that may later qualify for implementing the intended action plan[16].
- Assess marketing and trade aspects of the study, including the assessment of EU regulations and their impact in fruit exporting countries[17].

Result 3. National level proposals and action plans

Activity 3.1 Country visits by Category I and II experts to 8 countries to cross-check and extend information gathered by Category III experts for preparation of National Synopses (Activity 2.4) and more especially to understand the extent of existing planning for management of the frit fly problem as a basis for preparing detailed proposals for national (Activity 3.2 and regional level (Activities 4.1 and 4.2) action plans[18].

Activity 3.2 Preparation of detailed proposals for national level action plans[19], by Category I and II experts, on the basis of their country visits, through discussions with public and private institutions and donors and based on national situation synopses (Result 2) and the literature review (Result 1). At each stage of the value chain recommend improvements[20], including field control and post harvest disinfestation. Action plans should take account of the following criteria:

- noting any environmental or health impacts and their mitigation (with reference to known and internationally accepted norms)
- recognising the ideal goal of country-wide control and the necessity of monitoring and fighting all species of fruit flies affecting a given crop at the same time[21]
- distinguishing those initiatives best handled at either national level (e.g. best practice/experience sharing[22]) from those best handled regionally (see below)
- applying Cost/benefit analysis to the proposed improvements
- ensuring sustainability of the proposed measures (by implementation through public/private partnership)
- If need for strengthening and capacity building within state services, indicate budget implication and possible donors intervention

[15] Plant Protection Directorates (In French-speaking countries, Direction de la Protection des Végétaux, DPV), inspection services, existence of (and compliance with) pesticides registration procedures, links with the Comité Sahéliene des pesticides
[16] See TOR, Section III, subsection 2.
[17] See TOR, Section IV, subsection 2.
[18] See TOR, Section III, subsection 3.1.
[19] It must be well understood that after such a short period of study by local and international consultants, interacting only with those officials who happened to be available at the time of the mission, the team can only make proposals and not produce detailed blueprints for national action, which are in any case the prerogative of the sovereign national governments concerned.
[20] See TOR, Sectiomn III, subsection 3.1, subclause 8.
[21] See Annex 1, paragraph 1 of TOR.
[22] See TOR, section III, subsection 3.2.1.

- Identifying possible environmental and health impacts and their mitigation (referring to known internationally accepted norms such as the FAO code of conduct etc.)
- Proposing ways of accelerating the existing research through increased regional (ICIPE) or international cooperation (estimating costs involved)[23]
- Developing financial proposals to help train additional personnel for increased geographical coverage (training of trainers) through the use of materials and training modules that may already have been developed by applied research institutions (e.g. IITA).

Result 4. Regional Action Plan design and feasibility study

Activity 4.1 Formulation of a regional action plan with justification of a regional response, feasibility study and specific proposals and recommendations[24]. The Action Plan should:

- be structured according to the estimated duration of proposed actions (short term, medium term and long term) before they can yield the expected result.
- Identify and recommend actions better dealt with at regional level (e.g. regional research centres, early warning system, designation of a regional monitoring centre for fruit fly infestations, consolidating data received, overall pattern of the various fruit fly species development pattern region-wide, dissemination of best practices etc.) and evaluate their feasibility.
- propose activities complementary to any existing or projected actions by international and bilateral organizations and be coordinated with the organizations implementing those actions.
- Identify support actions to ensure that individual countries less advanced in the development of their national responses can catch up with others (e.g. best practice/experience sharing).
- Incorporate feasibility study of proposed actions.

Activity 4.2 Develop a logical framework with a series of defined indicators to measure the success of the proposed activities within short, medium and long-term time frames[25]. The logical framework must propose actions which will provide results at each of the intermediate stages (short, medium and long terms).

[23] See Annex 1, paragraph 3 of TOR
[24] See TOR, Section III, subsection 3.2.1
[25] See TOR, Section III, subsection 3.2.2.

3 EXECUTION OF PROJECT ACTIVITIES AND MANAGEMENT ACTIONS (RESULT 5)

3.1 Briefing meetings in Brussels and Abuja (Activities 5.1 and 5.2)

The activities of the scoping study began with a briefing visit by the Team Leader to the EC in Brussels on 2 July 2007. The study team (with the exception of Mr L. Jobe of the Gambia) met with EC Delegation and ECOWAS/CEDEAO Secretariat officials in Abuja on 16th and 17th July and a short minute documenting the proceedings of the ECOWAS meeting was prepared by the TL and sent to the EC and the participants on 19 July 2007.

3.2 Preparation of Guidelines & Briefing for Category III experts (Activity 2.1)

As required by the TOR (Activity 2.1), detailed guidelines for the Category III country appraisal visits (**Annex 2**) were prepared by the team leader in consultation with team members during the Abuja visit and this text was sent to Dr Claire Gaudot, modified and approved by her on 23 July 2007 and then issued to the national consultants as guidance in carrying out and reporting on country situation assessments (Activities 2.2 and 2.3).

3.3 Category III experts' Information gathering country visits (Activity 2.2)

Some delays were experienced by the Category III local experts in obtaining visas and travel documents for their country studies. Further delays accrued in obtaining the country assessment reports from the local experts, which required the Category II and I experts to mobilize for their country visits in most cases before receiving these reports. Difficulties were experienced in obtaining adequate introductions to responsible authorities in the relevant countries. Most agriculture ministries had not received introductory letters from ECOWAS/CEDEAO, which had been requested by the team, announcing the mission. Notwithstanding these issues the team was able to make contact with the appropriate informants and team members were invariably met with great interest and courtesy. All Category III country visits were completed.

3.4 Category III experts' country assessment reports (Activity 2.3)

The Cat III expert country reports are appended to this report in their original languages (**Annex 3-10)**. In view of the Gambian expert's inability to undertake the Ghana visit as required, a Ghanaian fruit fly specialist Dr Maxwell Billah, a research entomologist working with the African Fruit Fly Initiative (AFFI) at ICIPE in Nairobi, was recruited at a late stage (with the approval of the EC Delegation and at no extra cost) to prepare the required country study. Unfortunately Dr Bilah was posted to Sri Lanka for an extended period and his report was only finally received in late December 2007.

3.5 Production of National Situation Synopses (Activity 2.4)

The task of finalizing the National Situation Synopses was to have been carried out by the team leader Dr Stonehouse (out of 15 days allocated for report preparation) as a desk activity after completion of his field visits. Tragically Dr Stonehouse died in Senegal on 26th September and the National Synopses have been completed by Dr Ritchie.

At the time of his death Dr Stonehouse had not started to prepare the economic assessment of fruit fly damage and possible control strategies which was to have been a key element of this study. He had however accumulated a body of information needed for economic analysis and also materials to extend and deepen the country assessments. The consultants proposed that a cost-benefit analysis of control strategies should be commissioned as a desk study from Dr Ana Carvalho (who formerly worked on fruit fly economics at Imperial College with Professor John Mumford and Dr Stonehouse). However the EC Delegation declined to include this study in the Scoping Study.

3.6 Category I and II expert country visits (Activity 3.1)

The completion status of Category I and II expert country visits is summarized in **Table 1**. Category III expert visits have been made to all countries (Senegal, Guinea, Mali, Gambia, Burkina Faso, Cote d'Ivoire, Ghana, Benin). The Team Leader and Category I Expert, Dr John Stonehouse, was also charged with visiting all the countries of the study. However, after reaching Ghana, having visited Mali, Burkina Faso and Cote d'Ivoire, Dr Stonehouse became ill in Ghana, around the 22 September. He took medical advice and started a course of treatment for malaria while continuing his work for the Scoping Study. Still following his planned itinerary he travelled to Senegal on Sunday 23 September, but his condition worsened soon after his arrival. Tragically, despite the intervention of hotel staff and belated hospitalization, Dr Stonehouse died on 26 September in Dakar, Senegal.
As a result of Dr Stonehouse's untimely death, there was no Category I visit to Senegal, the Gambia, Guinea or Benin. However both Mr Paqui and Dr Ritchie met a wide range of informants in Senegal, Dr Ritchie had a brief meeting with the Minister of Agriculture in Guinea and he and Mr Paqui between them met with all the other key informants. In Benin (a non-exporter of mango to Europe) Dr Ritchie met with IITA and CIRAD staff and in Gambia Mr Paqui met with the main actors in the mango sector. It was therefore decided that any further visits to these countries would not be cost-effective.

Table 1. Scoping Study country visits by Category I, II, and III experts

Country	Category III Researcher	Cat. III Report status (date received)	Category II Country Visit Status (Initials of visitor)	Category I (Team Leader) (JS) Country Visit Status
Senegal	Mbaye Ndiaye	Yes (draft 15/09/07), final 04/10/07)	MR, TP,	No
Gambia	Lamin Jobe	Yes – draft (24/10/07)	TP	No
Guinea	Mbaye Ndiaye	Yes (03/10/07)	MR, TP	No
Mali	Severin Tchibozo	Yes - draft (18/08/07)	MR, TP	Yes
Burkina Faso	Remy Dabire	Yes (26/08/07)	MR, TP	Yes
Benin	Severin Tchibozo	Draft (04/10/07)	MR	No
Cote d'Ivoire	Remy Dabire	Yes – draft (26/08/07)	MR, TP	Yes
Ghana	Maxwell Billah	Yes -12/07	MR, TP	Yes
	SUMMARY	8 reports produced	8 countries visited by one or both experts	5 out of 8 countries visited

3.7 Preparation of proposals for national level action plans (Activities 3.2) and design and Logical Framework preparation for Regional Action Plan (Activities 4.1 and 4.2)

These activities were to have been completed by the Category I expert and Team Leader after receipt of reports from the Category II experts. The death of the TL while still completing field visits meant that these activities had to be completed by Dr Ritchie.

3.8 Debriefing on Scoping Study to ECOWAS/CEDEAO and reporting of preliminary findings (Activity 5.3).

The team reconvened in Abuja for meetings with EC Delegation and ECOWAS/CEDEAO Secretariat on the 13 November 2007. The purpose of the meeting was to provide a briefing on preliminary findings of the mission. This was done and a 10-page summary was provided to the EC Del. together with minutes of the discussion at the meeting, prepared by Dr Ritchie.

3.9 Debriefings in Brussels at DG Development by Category I expert after submission of draft final report (Activity 5.4).

A one-day meeting is scheduled in Brussels with DG Dev. (Dr Claire Gaudot) to discuss the project draft final report. Minor textual changes to the report will be dealt with by email.

4 REVIEW OF WEST AFRICAN FRUIT PRODUCTION AND THE FRUIT FLY PROBLEM (RESULT 1)

4.1 West African trade in fruit and vegetables to Europe

World trade in fruits and vegetables is worth about 50 billion euros annually, of which 10 billion euros (20%) is represented by European Union imports[26]. In 2005 EU imports of fresh fruit and vegetables reached 11 million tons with a value of 11 billion euros. About 8.8% of this value was contributed by imports from ACP countries. The overall relative share of imports from ACP countries has been dropping, despite increases in imports from Senegal and Ghana, probably because of internal problems (for example in Ivory Coast) and because of costs and difficulties in meeting increased EU demands for quality, food safety and traceability. The main fruit and vegetable imports from West Africa are shown in **Table 2** by country with their market share. A wider list of fruit and vegetables crops represented in trade with Europe is given in **Table 3**.

Table 2. Main West African exporters and percentage share of extra-EU15 fresh fruit and vegetable imports in 2005 (in value terms)[27].

	Damaged by fruit flies?	**Countries and their share of EU market by commodity**	**ACP Share**
Fruits			
Pineapples	No	Côte d'Ivoire (13%), Ghana (6.6%)	24.5 %
Guavas / mangoes	Yes	Côte d'Ivoire (6.5%), Senegal (1.7%), Mali (1.6%), Burkina Faso (1.3%),	13 %
Papayas	Yes	Côte d'Ivoire (4.5%), Ghana (4%)	9.5%
Vegetables			
Peas and beans	No	Senegal (4.4%)	49%
Eggplants (aubergines)	Yes	Ghana (3%)	33%
Capsicum/chillies	Yes	Ghana (6%)	20%
Sweet maize	No	Senegal (1.2%)	12%
Tomatoes	Yes	Senegal (2.5%)	2.5%

Source: Eurostat - COLEACP update, quoted in CTA Agritrade, Fruit and vegetable: Executive brief. October 2006. http://agritrade.cta.int/en/commodities/fruit_and_vegetable_sector/executive_brief

[26] ACP/EU trade in 2004/2005. COLEACP. http://www.coleacp.org/fo_internet/doc/File/Echanges_horticoles_ACP_EN.pdf

[27] Excluding root crops (Taro, cassava, yams), and fruit types (grapes, tamarind, lychee, passion fruit, avocado, oranges, grapefruit) which West African countries do not export in significant quantities.

Table. 3. Main types of fruit and vegetables exported to Europe from West Africa, and their susceptibility to fruit flies

Country	Major Fruit and vegetable crops exported to Europe												
	Mango	**Papaya**	**Banana**	**Pineapple**	**Melon**	**Eggplant**	**French beans**	**Peas with edible pods**	**Okra**	**Chili peppers**	**Sweet pepper**	**Cherry tomato**	**Other: (baby veg, asian veg;)**
Senegal 8	+				+		+	+	+	+	+	+	
Ghana 8	++	+		+++		+	+		+		+		+
Ivory Coast 4	++	+	+	+++									
Mali 4	+					+	+		+				
Burkina Faso 4	++						+		+	+			
Gambia 3							+			+	+		
Benin 2				+						+			
Guinea 1	+												
Crop subject to fruit fly damage	+++	++	-	-	+	+	-	-	+	+	+	+	-?

Sources: PIP ACP Exporters Directory; PRO€INVEST, COLEACP; other sources

4.2 Extent of fruit fly damage to fruit and vegetables (Activity 1.2)

Fruit and vegetables can be divided between those which are regularly attacked by fruitflies, and those which are not. Among the fruits, pineapples and bananas are generally not attacked and among the vegetables, peas and beans and maize are also largely unaffected. The remaining fruits and vegetables are all potentially at risk of attack (**Table 3**). Unfortunately there is little or no information relating to the economic importance of fruitfly damage to guava, papaya or citrus in West Africa. Citrus is not traded from West Africa to Europe, partly because the climate does not encourage the development of the orange colour favoured by EU consumers and partly because the EU has major producers of its own. As a result there has been much less interest in fruit fly damage to citrus, although it is important, since the issue of EU quarantine interceptions does not arise.

Vegetables susceptible to fruit fly attack include melons, water melons, cucumbers, squashes and other cucurbits. Other species of fruit flies attack tomatoes, peppers, chillis and egg plant. Levels of fruit fly attack on vegetables are likely to be low at present, but losses are also entirely unreported and unquantified in West Africa, since there has been no strong economic incentive to conduct the necessary surveys. However, as part of the present Scoping Study all available records of fruit fly species affecting fruit and vegetables in West Africa have been studied and the results are summarised in Tables 5 and 6 and discussed in Section 4.5, below.

Among the fruits that are attacked by fruit flies, mango is by far the most important in both volume and value of trade, as well as in terms of the damage inflicted by fruit flies. As a result of this lack of information, this report is largely devoted to the issue of managing the very serious problems of fruit fly damage to West African mango production. The estimated severity of damage caused by fruit flies in mangos is shown by country in **Table 4**, below.

Table 4. Estimated percentage damage to mangos caused by fruit flies in West Africa.

Country	Growing Region (if specified)	Severity and seasonal timing of damage	Source of estimate
Senegal	1. Niayes, Central zone, Petit Cote 2. National Average 3. Casamance	1. 36 – 50% 2. 60% 3. >80%	1. M. Ndiaye (2007) 2. Le Soleil (2007) 3. M. Ndiaye (2007)
Guinea	In general	50-60% of harvest	Producers and researchers
Gambia	In general	Mango: 50 – 60% on improved varieties (attributed to *B invadens*); Pumpkin etc: *B. cucurbitae*: 30-100%	Jobe (2007)
Mali	In general	50% -60% of harvest	IER
Burkina	1. West Central zone 2. SW zone	1. 60% to >80% 2. 50% - 80%	Informants
Benin	1. Northern Region (Borgou & Atakora Departments) 2. Allada	1. Mango: 9% early April; 60% June 2006; 90-95% in late varieties, July 2. Gouverneur, 75% at maturity (May-June); Camerounaise, 25%	1. CIRAD/IITA 2. M. Teothim Bognon, Agrimucol de Guemey,
Ghana	In general within fruit-growing areas	Farmer level: 30-85% (mangoes) Farmer level:10-35% (papaya) National average loss: 65%	Billah (2007)
Ivory Coast	In general	Overall mean level 43% 65% in a survey of fruit	CNRA Dr Hala N'klo

Source: national situation assessments and literature.

4.3 Description of the mango market

With 32% of world mango imports, the European Union is the largest mango-importing market, followed by the United States (**Figure 1**). These two markets alone absorb over 62% of all mangos traded around the world. The European mango market grew from around 134,700 tons in 2002 to over 212,000 tons in 2007 corresponding to an increase of over 57% over the period (**Figure 2**). The Netherlands, largest importer of mangos in Europe, acts as a hub from which most mangos are distributed around Europe. EU mango imports from ACP countries have progressed markedly from 16,000 tons in 2002 to over 30,000 tons (14%) in 2006. However the gains in market share over the same period are only estimated at slightly over 2%, owing to growth in exports by competitors. In 2006, with over 84,000 tons, Brazil held around 40% of European mango market share.

Though only 14% of European mango imports originated from ACP countries, it is significant that the mango producing and exporting countries which are the subject of this scoping study (Senegal, Gambia, Guinea, Burkina Faso, Mali, Ghana and Ivory Coast) represented 52% of ACP export tonnage (**Figure 3**) and 95% of the mangos exported from Africa to Europe in 2006. During the various field visits, it appeared that the West African mango commodity chain still retained strong growth potential. However, several problems (pest and disease pressure, orchard management and maintenance) prevent it from fully expressing this potential. To this should be added the different phytosanitary risks which complicate mango exportation from West Africa to Europe.

Figure 1. Principal world mango-importing markets in 2005

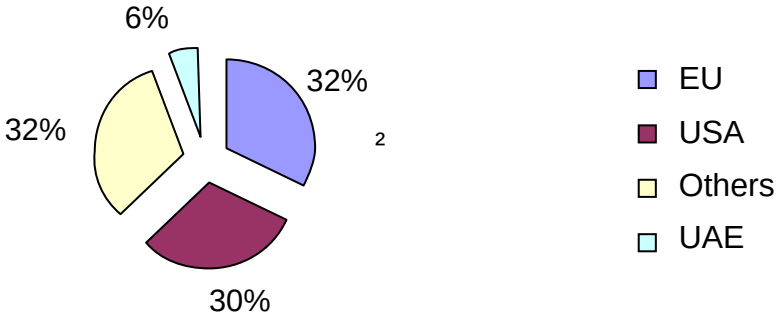
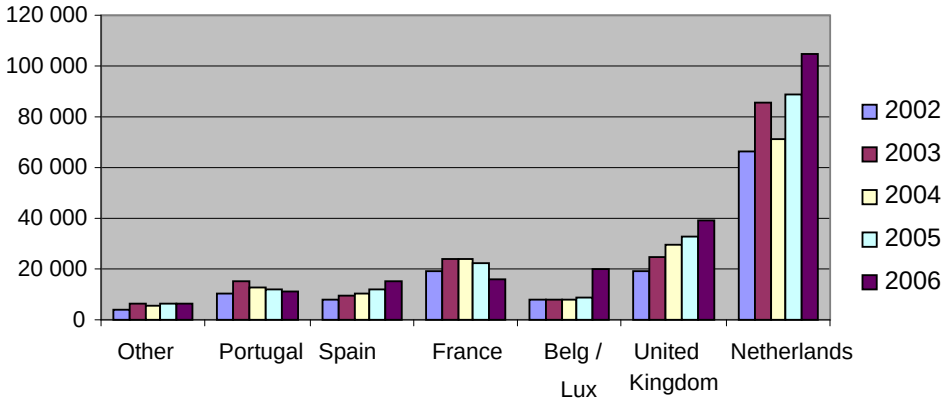
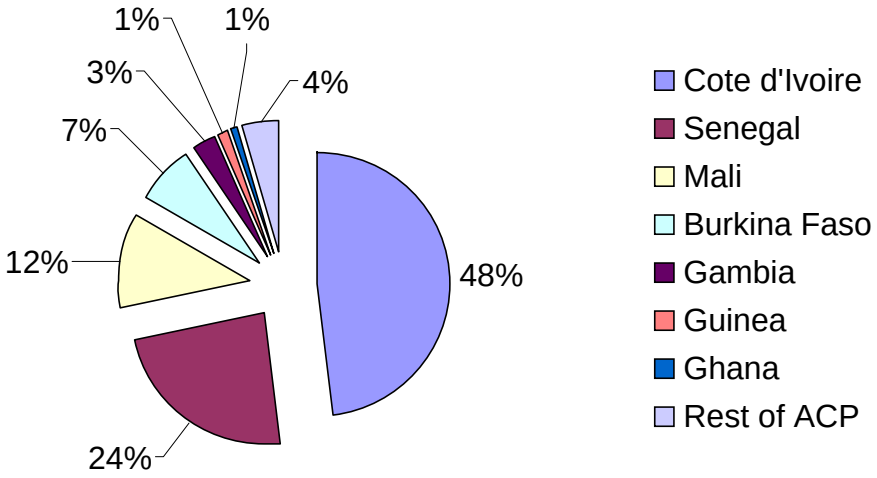


Figure 2. Development of European mango imports (2002-2006)



Source : EUROSTAT

Figure 3. West African % share of ACP country mango exports (tonnage) (2006)



Source: Scoping Study TOR

4.4 European phytosanitary requirements

4.4.1 Control of imports from non-EU countries

The basis of phytosanitary control in most countries is the IPPC (International Plant Protection Convention). Over 165 countries have signed this convention whose objective is

> "*to secure common and effective action to prevent the spread and introduction of pests of plants and plant products, and to promote appropriate measures for their control*".

In Europe, more specifically, it is the EU Directive 2000/29 which determines the protection measures against the introduction into the Community of pests of plants and plant products and their spread within the Community. The Phytosanitary Regulations established by EU Directive 2000/29 aim at preventing:

> "*the introduction into the Member States from other Member States or third countries of organisms which are harmful to plants or plant products*". By harmful organism, the directive means "*any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products*".

4.4.2 Controls under Annexe V (part B) of EU Directive 2000/29

According to Annexe V (part B) of EU Directive 2000/29, only a few products imported into the European Union from non-EU countries open to contamination by quarantine pests are required to present a phytosanitary certificate the moment they reach their first point of entry into the European Union. These include mango (*Mangifera indica* L.), citrus fruit (*Citrus* spp*.)* and a few other fruit (e.g passion fruit). When a plant or plant product listed in annex V is imported, the agents in charge of plant protection in the member state where the consignment is presented must undertake a series of inspections:

- Checking the phytosanitary certificate and its compliance with IPPC principals (competence of the delivering authority, latin transcription of the plant name, country of origin, presence of official stamps etc). If one of these elements is faulty, either the importer is given a brief period of time to produce adequate documents, or the consignment is rejected. The decision depends on the perishability of the consignment. This step is referred to as document control.

- Checking compliance with the declared consignment. This entails checking if the consignment corresponds to the plants or plant products for which the certificate has been delivered (quantity, origin marked on the packaging etc). Plant protection agents refer to this step as identity control.
- The actual inspection, on the basis of a sample, in order to check whether the inspected batch contains quarantine pests. This is the phytosanitary control.

4.4.3 Controls and emergency measures made on the basis of annexes I and II of EU Directive 2000/29

These annexes concern the emergency measures that a state may take in order to protect the European Community's territory against certain quarantine pests. This is the case when there is presence:

- of pests unknown within the community and whose spreading should be prevented in all member states. This concerns for example Tephritidae (non European) listed at point 25 of chapter I of annexe I.
- of pests whose presence was not supposed to occur and whose presence could have economic consequences.

4.4.4 Reducing controls

According to EU directive 2000/29 any consignment mentioned in annexe V part B should be the object of meticulous inspection on its arrival. However, within the framework of regulation 1756/2004, a reduction in the frequency of phytosanitary controls can be planned and organised. For this to occur, the demand must concern a product which has been the object of at least 200 consignments per year on average over the last three years and that at least 600 consignments have been inspected over the same period. A product for which a proportion of over 1% of inspected consignments has been intercepted due to the presence of pests cannot be taken into consideration.

4.4.5 Measures taken following phytosanitary interceptions

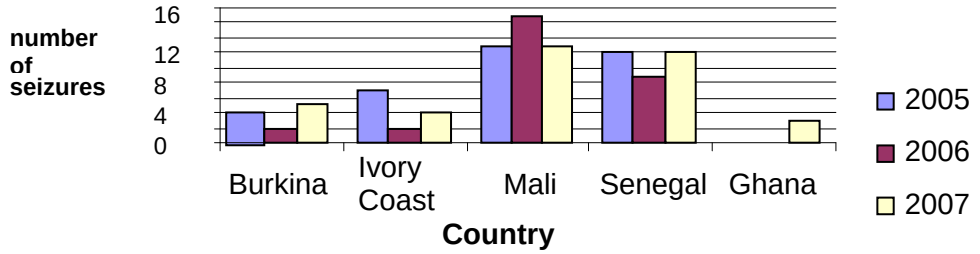
Controls made within the framework of EU directive 2000/29 are made on the basis of a sample. Sampling obeys certain rules fixed by a community *vade mecum*. It makes provision for inspections according to consignment size which may concern between 50 to 300 fruits per consignment. It appears that inspections in different importing countries may vary in their degree of rigour. The agents in charge of controls are not as numerous as they would like. If for an important consignment, 300 fruit are sampled, that does not mean that all 300 fruit are cut and opened. Also the discovery of a single fruit fly larva is enough to block all of a consignment (lot). It was confirmed to us that often, in France, the discovered insect larvae were sent to a laboratory in Montpellier to be incubated in order to determine the type of fly concerned.

An interception due to the discovery of a quarantine pest does not systematically result in the destruction of the fruit consignment. Indeed, if he so chooses, the operator has the possibility to send back the goods to their country of origin. However, on account of the perishable character of the consignments and also for obvious economical reasons (cost of transport), the batch (lot) is more often destroyed. The state which has undertaken to block the consignment then emits a notice of interception in order to inform the European Union. This leads to the consignment not receiving the authorisation for custom documents (turned back or destroyed). In the case where, following the identification of fly oviposition punctures (*piqures*), agents discover a dead larva, the consignment is not intercepted. Only living pests result in the merchandise being blocked.

4.4.6 Quarantine interceptions in France due to fruit flies

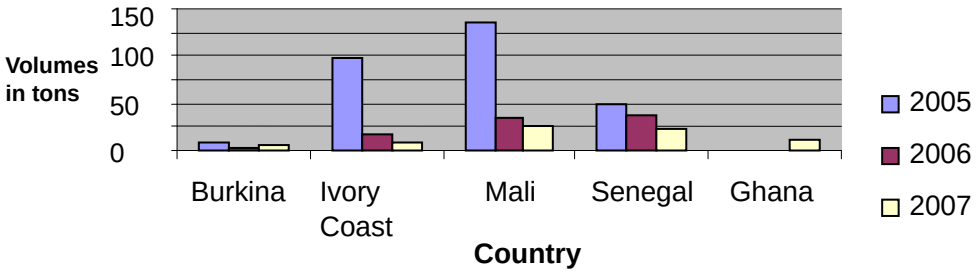
Between 2005 and 2007, 103 consignments of fruit from African exporting countries have been intercepted in France. With the exception of 3 of these (melon, passion fruit, flowers), all seizures concerned mangos. The largest volumes were intercepted in 2005, with reductions in following years (**Figure 5**), but the numbers of seizures remain high (**Figure 4**). Some countries (Mali and Senegal) appear particularly affected by these seizures. Between 2006 and 2007, the seizures and destructions linked to fruit flies increased by 23%. In 2006, seizures originating from Mali and Senegal accounted for over 85% of the intercepted consignments; in 2007, this proportion fell to 57%. From **Figures 6** and **7** it is evident that each year mango pest pressure is at its highest between June and August. It is during this period, which generally corresponds to the later stages of the export campaign, that seizures and destructions cause most harm to African mango exports.

Figure 4. Numbers of mango quarantine interceptions in France (2005-2007)



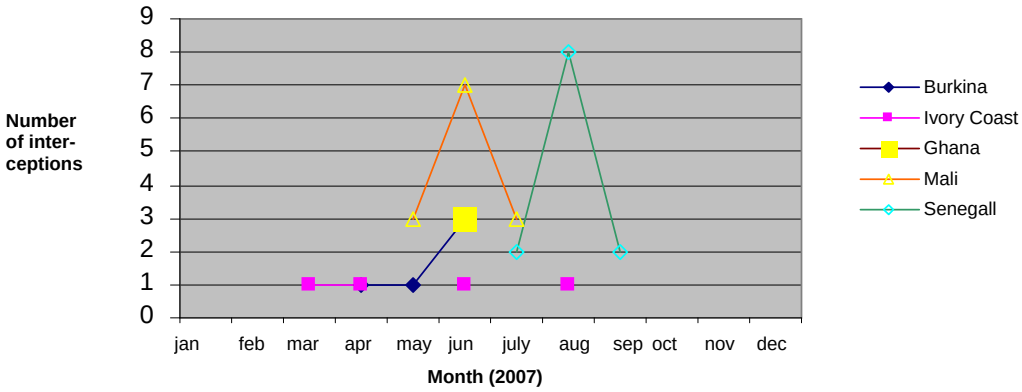
Source: French Ministry of Agriculture

Figure 5. Volumes of mango quarantine interceptions in France (2005-2007)



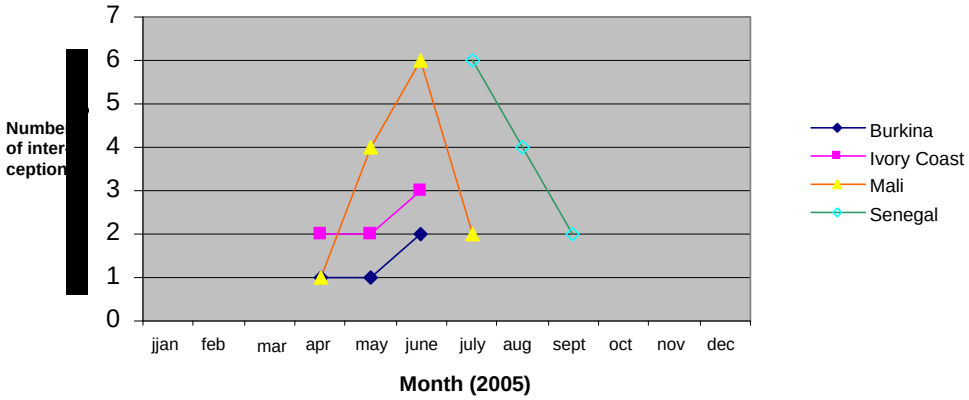
Source: French Ministry of Agriculture

Figure 6. Monthly mango interceptions in France in 2007



Source: French Ministry of Agriculture

Figure 7. Monthly mango interceptions in France in 2005



Source: French Ministry of Agriculture

4.5 Identification, hosts and distribution of Fruit flies affecting African fruit and vegetables (Activity 1.1)[28]

The fruit flies of the family Tephritidae[29] comprise about 4000 known species, grouped in about 50 genera[30], making up one of the largest families of the insect order Diptera (the two-winged flies). Of this large assemblage of species, all but a few feed on living plants. About 35% of tephritid species are specialised for fruit [31]feeding, while most of the remainder feed on flowers. The most important genera of frugivorous (fruit-feeding) Tephritidae have evolved on different continents. Thus the genus *Ceratitis* (with <4% of all tephritid species) is mainly afrotropical in origin, while the genus *Anastrepha* (5% of species) is confined to the New World tropics, and the large genus *Bactrocera* (11% of species) has its centre of origin in the Old World, principally Asia, rather than Africa.

One sub-group of *Bactrocera* (subgenus *Zeugodacus*) has species which specialise in feeding on flowers and fruits of the plant family Cucurbitaceae, which includes the melons, squashes, marrows and cucumbers. This group is common in the Old World, except in Africa where another genus, *Dacus* (with 6% of all species) occupies this same ecological niche of feeding on Cucurbitaceae, while also being present in Asia. Most frugivorous fruit flies (including most *Bactrocera* species) attack a wide range of fruit tree species but some (including some *Ceratitis* species) especially favour a narrower range of related plant species. These two genera of fruit flies, *Ceratitis* and *Bactrocera*, are by far the most important pest species in Africa. **Table 5** summarises available information on the identity, distribution, fruit hosts and male lures of 26 species of frugivorous fruit flies in West Africa. From this table it is immediately evident that mango is the most common commercial fruit host from which these species have been reared. **Table 5** includes six *Bactrocera* species, three *Dacus* and 16 species of *Ceratitis*. Among the *Ceratitis* species, all those authoritatively identified and reared from mango have been listed[32].

[28] Information in this section is largely derived from the ground-breaking work of White and Elson-Harris (1992, reprinted 1994).
[29] The fruit flies of the family Tephritidae are sometimes called the “true fruit flies” to distinguish them from the Drosophilidae, confusingly also known as fruitflies, or more correctly vinegar flies.
[30] A *genus* (plural *genera*) is a group of species which are believed to be closely related, usually with a putative common ancestor. The scientific name of a species consists of the name of the genus (with an upper case initial letter) followed by the species name (initial letter lower case).
[31] Information in this section is largely derived from the ground-breaking work of White and Elson-Harris (1992, reprinted 1994).
[32] This list has been developed using both literature (see bibliography) and also the databases for the fruitfly subtribes Ceratitidina and Dacina developed by De Meyer and White 2004 and White 2006, respectively. These

4.5.1 The Afrotropical fruit fly genus *Ceratitis*

The genus *Ceratitis* comprises more than 100 known species, of which perhaps 10% have been described as new to science within the last 5 years. *Ceratitis* includes about 20 species which occur on commercial fruit, especially mangoes and citrus. Of these about half cause economically important damage. **Figure 8** provides distribution maps of the main species of *Ceratitits* attacking fruit in Africa. These maps show that most species are restricted to tropical regions, with a few limited to West Africa. However the more serious pest species are able to live in subtropical and semi-temperate conditions (e.g. *C. cosyra*) and in areas of lower humidity (*C. capitata*).

4.5.1.1 Ceratitis capitata, the Mediterranean fruit fly

The Mediterranean fruit fly or Med Fly, *Ceratitis capitata* is a pest which has spread widely from its presumed centre of origin in East Africa (**Figure 8a)**. Broadly its range comprises every country in Africa, except for Mauritania and Western Sahara in the West and Somalia to the East, together with all the surrounding islands. Its host range comprises at least 44 families of plants and includes almost all commercial fruit crops except pineapple. A review of the hosts of *C. capitata* has been given by White and Elson-Harris (1992/4). An extensive literature has developed related to the biology and control of this species which has become also a suitable subject for studies of genetics and phylogeny in order to learn more about the invasive potential of fruit flies and how to control them. It is notable that in West Africa, *C. capitata* is usually not among the five most important species damaging mango. It is however of quarantine significance in Europe and so must be excluded from export produce.

4.5.1.2 Ceratitis rosa and *C. fasciventris*

The second most globally important African fruitfly pest has been until recently the Natal fruitfly, *Ceratitis rosa*. Widely distributed in Eastern and Southern Africa, *C rosa* apparently does not occur in West Africa and its place is instead taken by a closely related species, *Ceratitis fasciventris*, which until 2001 was regarded as a mere variant[33] of *C. rosa*. See **Figure 8f** for distribution of *C. fasciventris*. Much more is known about *C. rosa* than about *C fasciventris*, since the former species has been a serious pest in the relatively longer history of fruit production in South Africa and La Réunion. *C. rosa* has invaded Mauritius and La Réunion where it has competitively displaced both the single indigenous *Ceratitis* species, *C. catoirii*, and the earlier introduced *C. capitata*[34] This competitive superiority and its ability to survive low temperatures have given rise to the belief that *C. rosa* may ultimately prove to be a more serious quarantine threat to southern Europe than *C capitata*. The West African species, *C. fasciventris*, remains almost unstudied and most of the little that is known of its biology is derived from its eastern-most population in Kenya, where it overlaps narrowly with *C. rosa* in the western highlands. Once again however this species is not usually one of the five most important pest fruit flies in West Africa.

4.5.1.3 Ceratitis cosyra

By contrast to *C. capitata* and *C. rosa*, the biology of the remaining species of *Ceratitis* damaging fruit in West Africa is less well known. It is only in the last ten years that any information has begun to accumulate on the hosts, geographical distribution (see Maps,

databases provide biological information for specific voucher specimens which have been authoritatively identified by leading taxonomists and are available for reference, if necessary.

[33] De Meyer, M. 2001. On the identity of the Natal fruit fly *Ceratitis rosa* Karsch (Diptera, Tephritidae) Bull. Inst. Roy. Sci. nat. Belg. Entomolgie, 71: 55-62.

[34] De Meyer, 2001; Duyck et al. 2006. Importance of competition mechanisms in successive invasions by polyphagous tephritids in La Reunion.

Figure 8) and natural enemies of these species. The most important species is by general consent *C cosyra* which appears to be particularly attracted to mangos. It was formerly the most serious pest of all on mango but it has been displaced to some extent since 2003 by the adventive *Bactrocera invadens*. *B. invadens* appears to have increased damage levels substantially in mangos, especially later in the season and it is now generally recorded as the most important pest species on mango in West Africa.

4.5.1.4 Little-known Ceratitis species

The remaining seven species of *Ceratitis* definitely known to have been reared from mango are all listed in **Table 5**. They are, in no particular order, *C. quinaria*, *C. punctata*, *C. anonae*, *C. ditissima*, *C, bremii*, *C. silvestrii*, *C. flexuosa*. All are trapped in small numbers in mango orchards and are capable of doing minor damage. It should be noted that five further *Ceratitis* species (*C. flava, C. pedestris, C. penicillata, C. conexa* and *C. striatella*[35]) have either not yet, or not certainly, been reared from mango. They are included in **Table 5** because it is probable that they will eventually be found laying on mango and because they have been, and will certainly continue to be, caught by male lure and food bait traps in mango orchards. All the listed *Ceratitis* species except *C. bremii, C. striatella* and *C. flexuosa* are attracted to either terpinyl acetate or trimedlure (or both). *C. bremii* is attracted to ME and the attractants of the other two species are presently still unknown.

4.5.1.5 Trirhithrum coffeae

A single species of *Trirhithrum, T. coffeae* is a pest of coffee cherries but is not known to occur on any commercial fruit. It is listed for completeness and because it is also likely to be attracted to monitoring traps (baited with ME to attract *B. invadens*) in orchards adjacent to coffee plantations.

[35] Note that it is unclear whether *C. striatella* adults have actually been reared from Mango (Foulaya, Guinea, 1994, J-F Vayssieres).

Table 5. Economic fruit fly species associated with fruits in Africa and their male lures

Pest fruit fly species *Genus (Subgenus) species*	**Common name**	**Male lure**	**Reared from fruits**	**Present in West Africa (WA)?**
Bactrocera (Bactrocera) invadens Drew, Tsuruta & White	Invasive Fruit Fly	ME[1]	Mango [4], also guava, papaya, citrus, carambola and many other fruits[9]	2004: Benin[4], Senegal[4], Togo[4], Ghana[9]; Nigeria[9], Guinea, Mali, Burkina Faso, Cote d'Ivoire[7]. South Asian species, now suspected possibly to have been present in Mauritius in 1996[4], before detection in Kenya in 2003[9].
B. (Bactrocera) zonata Saunders	Peach Fruit Fly	ME[1]	Mango [1,4], also guava, papaya, citrus, peach[1]	**Believed not yet present in WA**, present in Mauritius by 1942, Reunion 1991, Arabia 1982, Egypt 1997, **Libya 2003[4]**
B. (Bactrocera) latifrons (Hendel)	Solanum Fruit Fly	Lati-lure[5]	Mango?[1]	**Believed not yet present in WA**, present in Tanzania
B.(Bactrocera) dorsalis (Hendel)	Oriental Fruit Fly	ME[1,4]	Mango [1,4] and many other fruits[1]	**Believed not yet present in WA**; Present in Oman since 1984[4]
B. (Gymnodacus) mesomelas (Bezzi)	-	Not reported[4], 1 female in a TML trap[4]	Guava[4, 8]	Guinea[4], Ghana[4], Mali[4], Nigeria[4], Cote d'Ivoire[4, 7]
Bactrocera (Zeugodacus) cucurbitae (Coquillett)	Melon Fruit Fly	Cue lure	Mango[1, 3], papaya[10] tomato[1], but mainly a pest of cucurbits[1]	Senegal[4], Nigeria 2003[4], Guinea 2001[4], Gambia[4], Benin 2004[4], Cote d'Ivoire 1999[4], Mali 2000[4]; Asian species.
Dacus (Didacus) vertebratus Bezzi	African melon Fly	Vert lure[1]	Mango [3] mainly pest of cucurbits[1]	Senegal, Gambia, Benin, Burkina Faso, Ghana, Liberia, Mali, Niger, Nigeria[1,3]
Dacus (Leptoxyda) langi Curran	-	Cue lure[4]	Mango [7]	Cote d'Ivoire[4, 7]
Dacus (Dacus) bivittatus	-	CL[4]	Mango? [7] papaya[1,12] mainly pest of cucurbits[1]	Benin, Gambia, Ghana, Guinea, Cote d'Ivoire, Liberia, Nigeria, Sierra Leone, Senegal, Togo[1,4]
Ceratitis (Ceratitis) capitata (Wiedemann)	Mediterranean Fruit Fly	TML, TA[1]; nu-lure[2]	Mango [2,3] guava, citrus and many other fruits[1]	Present throughout West Africa[2,3] Originating from East Africa, adventive populations on all continents (eradicated in USA), including Mediterranean Europe. Globally most damaging member of the family Tephritidae[1].

Table 5 (*continued*). Economic fruit fly species associated with fruits in Africa and their male lures

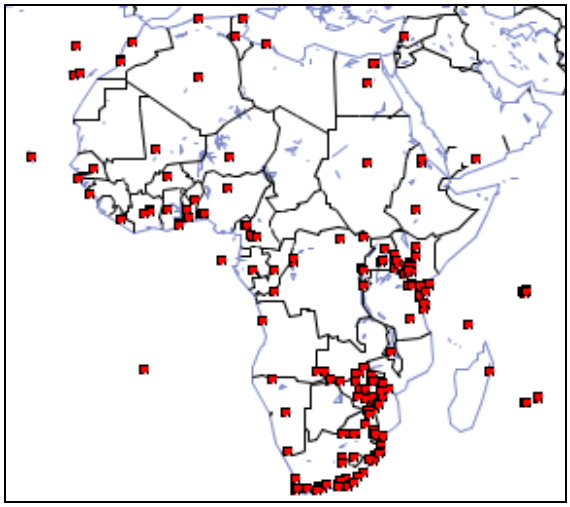
Pest fruit fly species *Genus (Subgenus) species*	**Common name**	**Male lure**	**Reared from fruits**	**Present in West Africa (WA)?**
C. (Ceratalaspis) cosyra (Walker)	Marula (or Mango) Fruit Fly	TA[1]	Mango [1,2,3], citrus[10]	Senegal, Mali, Guinea, Benin, Cote d'Ivoire, Sierra Leone, Nigeria[2,3]
C. (Pterandrus) rosa Karsch	Natal Fruit Fly	TML, TA[1]	Mango, avocado, peach, cashew, papaya, guava, coffee, star apple, cashew, fig, aubergine, mangosteen and many other fruits[1,2]	**Believed not present in WA**, one old record from Yaoundé, Cameroon[2]; Cote d'Ivoire records[7] should be referred to *C. fasciventris*[11]
C. (Pterandrus) fasciventris (Bezzi)	-	TML, TA (Vayssières)[2]	Mango, guava, loquat, coffee, peach, avocado, cocoa [2,3,11]	Guinea, Mali, Sierra Leone, Ghana, Nigeria, Sao Tomé & Principé, Benin, Cote d'Ivoire[2,3]
C. (Ceratalaspis) quinaria Bezzi	Zimbabwean Fruit Fly	TA (Vayssières)[2]	Mango, guava, peach, apricot [2, 3]	Mali, Benin, Cote d'Ivoire[2,3] trapped in mango orchards in Cote d'Ivoire[6]
C. (Pardalaspi)s punctata (Wiedemann)	-	ME, TA[1]	Mango, cocoa, guava[3], sapotilla[7]	Guinea, Sierra Leone, Ghana, Nigeria, Sao Tome & Principe, Liberia, Togo, Benin, Cote d'Ivoire [2,3] trapped in mango orchards in Cote d'Ivoire[6]
C. (Pterandrus) anonae Graham	-	TML, TA (Vayssières)[2]	Mango, guava, avocado, citrus[10],' papaya[6], cocoa[1,2,3]	Guinea, Ghana, Nigeria, Sao Tomé & Principé, Liberia, Togo, Mali, Benin, Cote d'Ivoire [2,3]
C. (Pardalaspis) ditissima Munro	-	TML, TA (Vayssières)[2]	Mango, cocoa, cola [2,3], citrus[6, 10]	Mali, Nigeria, Sierra Leone, Ghana, Guinea, Sao Tomé & Principé, Cote d'Ivoire [2,3] ;
C. (Pardalaspis) bremii Guérin Ménneville	-	ME[2]	Mango [2,3]	Guinea, Nigeria, Benin, Ghana, Senegal, Togo, Ganbia, Mali, Cote d'Ivoire[2,3] trapped in mango orchards in Cote d'Ivoire[6]
C. (Ceratalaspis) silvestrii Bezzi	-	Nu-lure, cue lure, TA[2]	Mango, shea butter [2,3]	Senegal, Nigeria, Niger, Mali, Benin, Cote d'Ivoire[2,3,6]
C. (Pterandrus) flexuosa (Walker)	-	Not known	Mango, fig, cocoa, coffee [2]	Togo, Guinea, Ghana, Cote d'Ivoire[2]

Table 5 (*continued*). Economic fruit fly species associated with fruits in Africa and their male lures

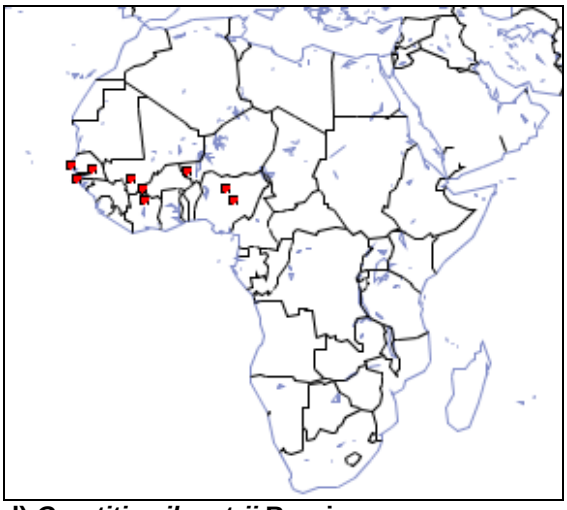
Pest fruit fly species *Genus (Subgenus) species*	**Common name**	**Male lure**	**Reared from fruits**	**Present in West Africa (WA)?**
C. (Pterandrus) flava De Meyer & Freidberg	-	TML, TA, nu-lure[2]	Not yet reared from mango, but trapped in mango orchards in Cote d'Ivoire, Mali, Guinea[2]	Cote d'Ivoire, Mali, Guinea[2]
C. (Pterandrus) pedestris (Bezzi)	Strychnos Fruit Fly	TML, TA[1]	Not yet reared from mango [2]	Cote d'Ivoire, Mali, Guinea[2]
C. (Pterandrus) penicillata Bigot	-	TA + TML combined[2]	Not yet reared from mango, but trapped in mango orchards in Cote d'Ivoire [2,6]	Cote d'Ivoire, Ghana, Guinea, Nigeria[2,]
C. (Ceratalaspis) connexa (Bezzi)	-	TA[2]	Not yet reared from mango, but trapped in mango orchards in South Africa [2]	Mali, Nigeria[2]
C. (Ceratalaspis) striatella Munro	-	Not known	Trapped in mango orchards in Guinea & maybe reared from mango[2].	Mali, Nigeria, Guinea, Ghana[2]
Trirhithrum coffeae Bezzi	-	CL, ME[7]	Coffee, not reared from mango [2]	Siera Leone, Togo, Ghana, Nigeria, Cote d'Ivoire, Sao Tomé & Principé[2,7].

[1] White & Elson-Harris, 1992/1994; [2] De Meyer & White, 2004; [3] Vayssières et al., 2007 ; [4] White, 2006 ; [5] Quilici, 2006 ; [6] Barbet, 2000 ; [7] Ossey, 2006 ; [8] White, 2007 ; [9] Drew et al., 2005; [10] Ouattara, 1998; [11] De Meyer, 2001; [12] De Meyer, pers. comm.

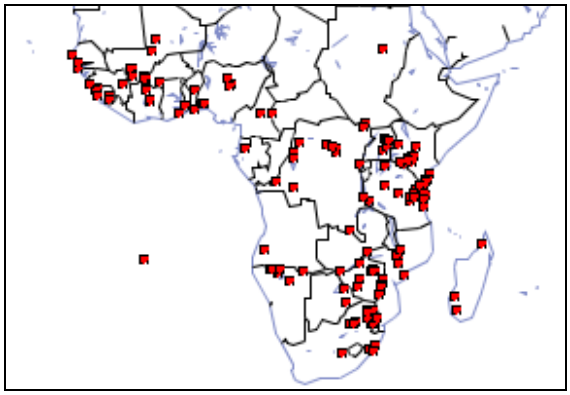
Figure 8. Distribution maps of African *Ceratitis* species with larvae feeding on mango.
Source: De Meyer, M. & I.M. White. 2004. True fruit flies (Diptera, Tephritidae) of Africa. A queryable website on taxon and specimen information for afrotropical Ceratitidine fruit flies. Tervuren: Royal Museum for Central Africa. Access date: 08/10/2007. http://projects.bebif.be/enbi/fruitfly



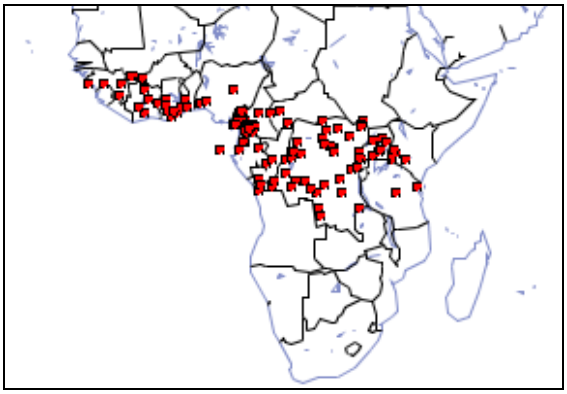
a*) Ceratitis capitata* (Wiedemann)



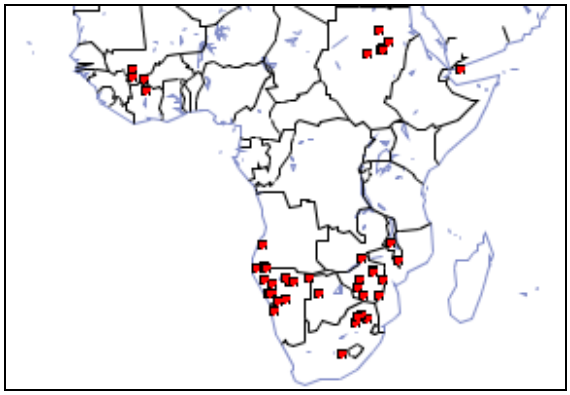
d) *Ceratitis silvestrii* Bezzi



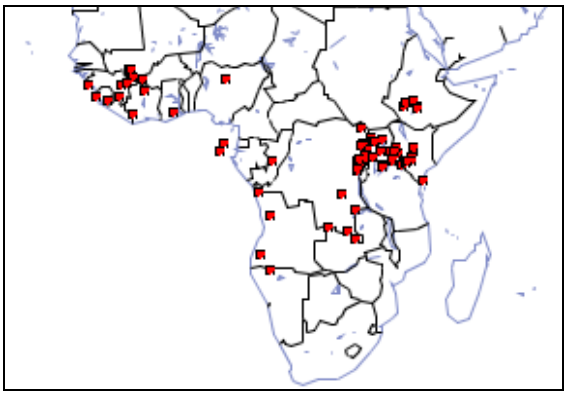
b) *Ceratitis cosyra* (Walker)



e) *Ceratitis anonae* Graham

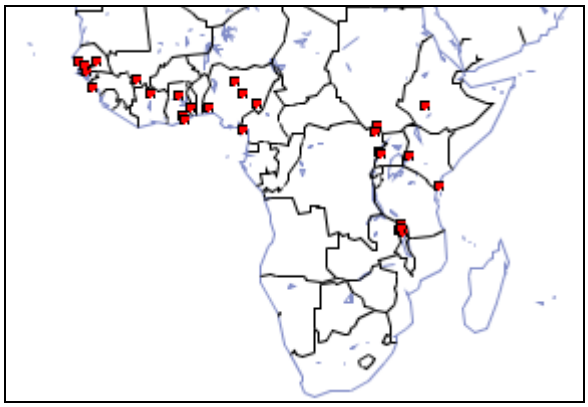


c) *Ceratitis quinaria* Bezzi

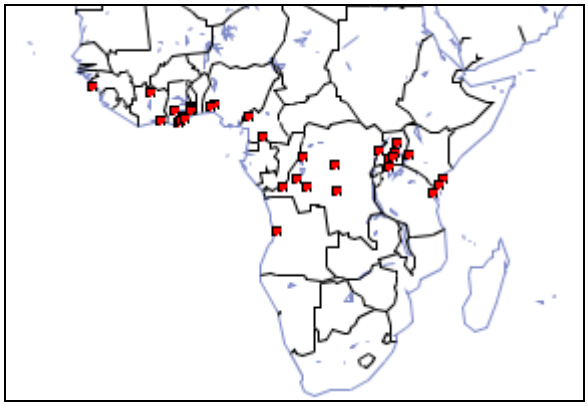


f) *Ceratitis fasciventris* (Bezzi)

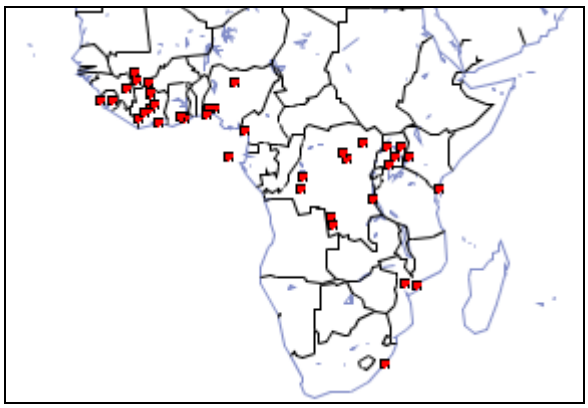
Figure 8 (*continued*). Distribution maps of African *Ceratitis* species with larvae feeding on mango. Source: De Meyer, M. & I.M. White. 2004. True fruit flies (Diptera, Tephritidae) of Africa. A queryable website on taxon and specimen information for afrotropical Ceratitidine fruit flies. Tervuren: Royal Museum for Central Africa. Access date: 08/10/2007. http://projects.bebif.be/enbi/fruitfly



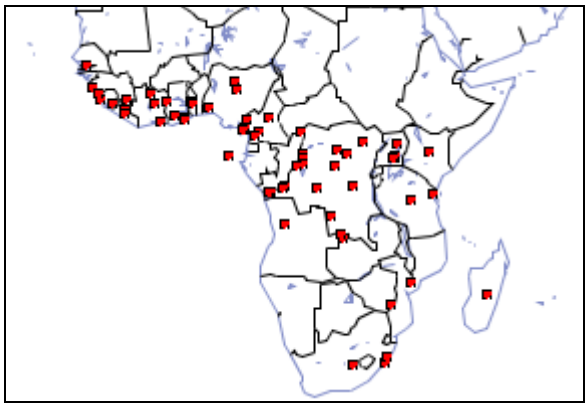
g) *Ceratitis bremii* Guérin-Ménneville



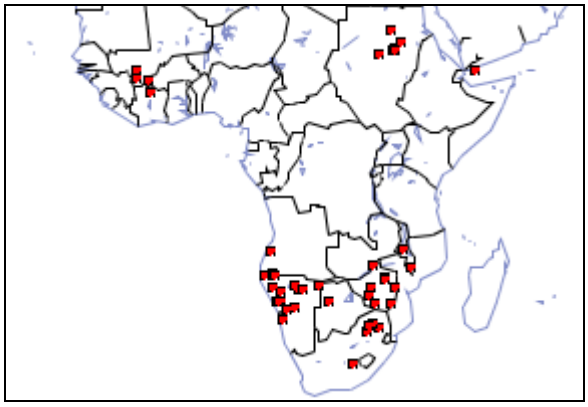
j) *Ceratitis flexuosa* Walker



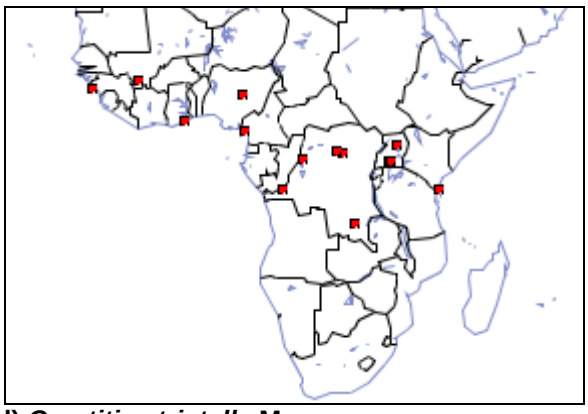
h) *Ceratitis ditissima* Munro



k) *Ceratitis punctata* (Wiedemann)



i) *Ceratitis quinaria* Bezzi



l) *Ceratitis striatella* Munro

Table 6. Economic fruitfly species in Africa associated with Cucurbits and solanaceous vegetable fruits.

Pest fruit fly species	Common name	Male lure	Reared from?	Present in West Africa (WA)?
Bactrocera invadens Drew, Tsuruta & White	Invasive Fruit Fly	ME[1]	Aubergine[5]	Present[3]; South Asian species, now suspected possibly to have been present in Mauritius in 1996, before detection in Kenya in 2003 and WA in 2004[4]
Bactrocera cucurbitae (Coquillett)	Melon Fruit Fly	Cue lure	Serious pest of cultivated cucurbits (including cucumber, melon, water melon, pumpkin)[1]	Present in WA since before 2000 (Senegal, Nigeria, Guinea, Gambia, Benin, Cote d'Ivoire, Mali)[2] ; Asian species
B. latifrons (Hendel)	Solanum Fruit Fly	Lati-lure[36]	Cultivated Solanaceae (including tomato and aubergine) and chilli[5]	Native of S and SW Asia, **believed not yet present in WA**, but present in Tanzania, 2006[5]
Dacus vertebratus Bezzi	African melon Fly	Vert lure[1,2,4]	Cultivated cucurbits (especially water melon, also cucumber, melon, squash)[1,2]	Senegal, Gambia, Benin, Burkina Faso, Ghana, Liberia, Mali, Niger, Nigeria[1,2,3]
D. punctatifrons Karsch	-	Cue lure[1,2]	Cultivated cucurbits (pumpkin, cucumber) and tomato[1,2]	Benin, Ghana, Equatorial Guinea, Cote d'Ivoire, Sierra Leone, Liberia, Nigeria[1,2]
D. bivittatus (Bigot)	Pumpkin Fly	Cue lure[1]	Cultivated cucurbits (including pumpkin, cucumber, squash, melon water melon), tomato, aubergine [1,2]	Benin, Gambia, Ghana, Guinea, Cote d'Ivoire, Liberia, Nigeria, Sierra Leone, Senegal, Togo [1,2]
Dacus ciliatus Loew	Ethiopian Fruit Fly	Not cue lure or vert lure or ME[1,2]	Cultivated cucurbits (water melon, melon, pumpkin, cucumber, squash), ?tomato[1,2]	Benin, Burkina Faso, Cote d'Ivoire, Gambia, Guinea, Senegal, Sierra Leone, Togo, Ghana, Niger, Nigeria[1,2]
Ceratitis (Ceratitis) capitata (Wiedemann)	Mediterranean Fruit Fly	TML, TA[1]; nu-lure[6]	Bell pepper, aubergine, chilli pepper[6]	Present throughout West Africa[6]

[1] White & Elson-Harris, 1992/1994; [2] White, 2006; [3] Vayssières et al., 2007 ; [4] methyl-4-hydroxy-benzoate; [5] Mwatawala et al., 2007; [6] De Meyer & White, 2004;

[36] Quilici, S., 2006. Rapport de Mission au Sénégal du 7 au 15 December 2006. Orientations pour un programme de lutte contre les mouches des fruits sur manguier (en appui au programme USAID/SAGIC). 17 pp. Mimeo.

4.5.2 The Afro-tropical genus Dacus

The genus *Dacus* has 177 Afro-tropical species, with a further 71 species occurring in the Indo-Australian region. Most species feed on plants of the families Apocynaceae, Passifloraceae and Cucurbitaceae (**Table 6**). Males of many species of *Dacus* are attracted to cue lure. Four species of this genus (*D. vertebratus*, *D. punctatifrons*, *D. bivittatus* and *D. ciliatus*) have been reared from cucurbits in West Africa. Apart from *D. punctatifrons*, all of these attack melon and water melon. *D. vertebratus* is particularly attracted to water melon[37]. Some records of *Dacus* spp. from fruit (mango, papaya) are listed in **Table 5**, but *Dacus* species are not serious pests of fruit.

4.5.3 The Asian fruitfly genus *Bactrocera*: exotic quarantine threats to West Africa

In addition to representatives of the subgenera *Daculus* and *Gymnodacus* considered to be indigenous to Africa, a succession of Asian *Bactrocera* species have invaded Africa along important trade routes during historical times. This process is still actively continuing and is of extreme importance for African horticulture. The species of fruit flies which currently menace Africa are all species of *Bactrocera* originating from Asia. Two of the three adventive *Bactrocera* species already present in West Africa and the three further species which constitute the most important quarantine threat to West Africa are all listed in **Table 7**. *B. mesomelas* is a little-known species, widely distributed in West Africa, but which does not usually occur on cultivated fruits (apart from a recent record on guava). It has been listed in **Table 5**, but not **Table 7**, as it is not clearly seen as a direct threat. Two other species, *B. cucurbitae* and *B. invadens* are also already present throughout West Africa, having arrived in the late 1990s and around 2003, respectively. The remaining three species, *B. zonata*, *B. latifrons*, and *B. dorsalis*, are not yet present in West Africa, though *B. zonata*, has reached Libya (2003) and *B. latifrons* has reached Tanzania (2006).

Table 7. Fruit fly pests recently arrived in West Africa or posing imminent quarantine threat

Pest fruit fly species	Common name	Reared from	Present in West Africa (WA)?
Bactrocera cucurbitae (Coquillett)	Melon Fruit Fly	Cultivated cucurbits, including melon, water melon, cucumber	Present throughout WA since before 2000
Bactrocera invadens Drew, Tsuruta & White	Invasive Fruit Fly	Mango, also guava, papaya, citrus, carambola and many other fruits	Present in WA by 2004: Benin, Senegal, Togo, Ghana; Nigeria, Guinea, Mali, Burkina Faso, Cote d'Ivoire.
B. zonata Saunders	Peach Fruit Fly	Mango, guava, papaya, citrus, peach	Believed not yet present in WA, present in Egypt 1997, Libya 2003
B. latifrons (Hendel)	Solanum Fruit Fly	Chilli, tomato and aubergine, mango?	Believed not yet present in WA, present in Tanzania 2006
B. dorsalis (Hendel)	Oriental Fruit Fly	Mango and many other fruits	Believed not yet present in Africa, Present in Oman since 1984

4.5.3.1 Bactrocera invadens

Currently most attention is focused on *Bactrocera invadens*, a species unknown to science until detected in Kenya in 2003, but now known to have originated in Sri Lanka or Southern

[37] White and Elson-Harris (1994).

India[38]. At present *B. invadens* is the only member of the Dorsalis species group to have become established in Africa. It is now widely distributed throughout Africa and is certainly present in all the countries involved in this Scoping Study. This species has probably been spread by human agency owing to poor phytosanitary surveillance and control of fruit movements between countries by air and by surface travel[39]. Trapping programmes for fruit flies in Kenya and in Ivory Coast and elsewhere in West Africa in the period 1999-2003 did not indicate the presence of *B. invadens* before 2003 in East Africa and 2004 in West Africa. It therefore appears likely that this species travelled across Africa within 1-2 years of its arrival in Kenya and Tanzania. Mangos are frequently carried in small numbers for food during journeys and they are readily discarded when found to be rotten or maggot-infested. Phytosanitary personnel used to assessing large container trucks of fruit are less likely to pay attention to small amounts of fruit carried in hand baggage.

4.5.3.2 Bactrocera cucurbitae

B. cucurbitae is a well-known pest of cucurbits in Asia which has spread through Africa, apparently only becoming widely reported in West Africa since 2000. It has occasionally been recorded as feeding on a wide range of fruits, including mango.

4.5.3.3 Bactrocera mesomelas

B. mesomelas is a little-known species but widely distributed in West Africa. It is listed in **Table 5** because it has recently been confirmed as feeding on guava in Cameroon (White, 2007). It is not yet known from mango but may be expected to turn up in fruit rearing and trapping surveys in West Africa. No male lure is yet known for this species.

4.5.3.4 Bactrocera zonata

B. zonata, the oriental Peach Fruit Fly, is a native of India and Pakistan which has been increasing its range over a long period, reaching Mauritius by 1942, and becoming widespread in Eqypt by at least 1997. In 2003 specimens were identified from the Libyan border and it is clear that it is now a serious quarantine threat to West Africa, meriting a programme of rigorous quarantine and the use of ME “sentinel” traps at all major points of entry (airports, border crossings) along the eastern borders of West Africa to detect its arrival. *B. zonata* is a very serious fruit pest in Asia with mango among its main hosts. It is said to be causing annual losses valued at 190 million Euros in Egypt currently and damage estimated at 320 million Euro for the Near East as a whole (EPPO, 2006[40]). If it becomes established in central and western Africa, its ability to withstand drier conditions than *B. invadens* (a humid forest species) will ensure that it displaces *B. invadens* in the northern part of its range, which could be expected to increase existing damage levels on mango significantly.

4.5.3.5 Bactrocera latifrons

B. latifrons, the Solanum Fruit Fly, was recently reported from Africa (Mwatawala et al., 2007) for the first time, in Tanzania (**Table 6**). It feeds on tomato, aubergine and other solanaceous plants and has been included in **Table 5** because of some Asian records from

[38] Drew, R.A.I., Tsuruta, K. and White, I.M., 2005. A new species of pest fruit fly ((Diptera: Tephritidae: Dacinae) from Sri Lanka and Africa. African Entomology 13 (1): 149-154.
[39] Cassidy, D. 2006. Review of Zambia’s current system of phytosanitary management. World Bank Working Paper, June 2006.
[40] European and Mediterranean Plant Protection Organization. Data sheets on Quarantine pests. *Bactrocera zonata*. 5 pp. Web version 2006-03. Available online at http://www.eppo.org/QUARANTINE/insects/Bactrocera_zonata/DSDACUZO.pdf

mango and other fruits (White & Elson-Harris, 1992/4). *B. latifrons* is not yet known from West Africa, but it may be expected to increase its range in Africa since no eradication campaign has been developed. The male of this species only responds to a special lure, latilure (see **Table 11**).

4.5.3.6 Bactrocera dorsalis

B. dorsalis, the Oriental Fruit Fly, is a polyphagous fruit pest of great economic importance in Asia where it occurs as one of a complex of more than 50 closely related species, referred to as the Dorsalis species group[41]. This species is known to have reached Oman by 1984, having been expanding its range westwards in tropical Asia over many years. Members of the Dorsalis group are very difficult to identify, even for experts. It is now thought that the invasion (later eradicated) attributed to *B. dorsalis* in Mauritius in 1996 may actually have been *B. invadens*, a then unknown member of the Dorsalis group[42]. If *B. dorsalis* invades Africa, it is probable that it will be mistaken initially for *B. invadens*, since both species respond to ME lures and are morphologically closely similar species.

The quarantine threat posed to Africa by these and other *Bactrocera* species highlights the importance of installing a monitoring network of parapheromone traps. It also provides ample justification for providing training in species recognition of fruit flies for key professional and technical staff in all the countries of the region. A new website has been set up to enable crop protection specialists to recognise important species of invasive fruit fly pests in Africa (De Meyer, Mohamed & White, 2007)[43]. This includes *B. cucurbitae* and *B. invadens* which are already widely distributed in West Africa as well as *B. zonata* and *B. latifrons* which do not yet occur there. However it does not include *B. dorsalis* which has so far only reached the Arabian Peninsula. The website provides diagnostic photographs, current distribution maps and host plant data for each species and leads into the literature on a wide range of topics related to biology and management of these pests, together with a bibliography.

4.5.4 Competition between species and displacement

Invasive fruit flies have a tendency to displace indigenous species in at least part of their host range and geographical distribution. This has been observed most strikingly in La Réunion Island where the native *Ceratitis* species, *C. catoirii* has been displaced by a succession of later arrivals, to the extent that it is now rare in La Réunion and possibly extinct in Mauritius[44]. The latest species to arrive was *Bactrocera zonata* which has established dominance in major host plants previously colonized in sequence by the two non-native *Ceratitis* species (*C. capitata* and *C. rosa*) which had each established themselves at the expense of *C. catoirii*. The types of competitive displacement include displacement of laying females of smaller species from fruit by larger and more aggressive species and interference with rival species by faster-developing larvae. *B. zonata* has larger larvae, but these develop more rapidly at optimal temperatures than larvae of *Ceratitis* species.

[41] Drew and Hancock 1994.
[42] White, I.M., 2006. Taxonomy of the Dacina (Diptera Tephritidae) of Africa and the Middle East. African Entomology Memoir No. 2. v + 156 pp.
[43] Invasive Fruit Fly Pests in Africa. A diagnostic tool and information reference for the four Asian species of fruit fly (Diptera, Tephritidae) that have become accidentally established as pests in Africa, including the Indian Ocean Islands. Marc De Meyer, Salah Mohamed & Ian M. White. http://www.africamuseum.be/fruitfly/AfroAsia.htm
[44] Duyck et al., 2006.

4.5.5 Taxonomic studies and databases on African fruit flies

Identifying fruitflies has been complicated by the different concepts of genera and higher groups (tribes, subfamilies) used by different taxonomists working on different regional faunas. The most significant recent synoptic studies of African fruitflies are the monograph (and CD ROM) on the taxonomy of Dacina[45] (the subtribe which comprises the genera *Dacus* and *Bactrocera*) of Africa and the Middle East by White (2006), and a series of revisionary studies of the subgenera of *Ceratitis* by De Meyer (1996, subgenus *Pardalaspis*; 1998, subgenus *Ceratalaspis*; 2000, subgenus *Ceratitis*) and De Meyer and Freidberg (2005, subgenus *Pterandrus*). The CD accompanying White (2006) includes diagnostic images of all species and a database of label data of specimens which have been authentically identified.

De Meyer and White (2004)[46] developed a database website which includes taxonomic descriptions, images, distribution maps and specimens data for the ceratidine fruit flies of Africa south of the Sahara. The genera *Dacus* and *Bactrocera* are not included in this website. Examples of species maps derived from this website are given in Figure 1. The website is now slightly out of date since some revisionary work has occurred since it was assembled. However, an update of this website is in preparation by the Belgian Biodiversity Platform, incorporating the latest revisionary work of White (2006) and this should be available early in 2008[47]. The new database will include all available *Dacus* and *Bactrocera* information, in addition to the *Ceratitis* data already present, totalling around 400 species of African fruit flies. This upgraded version will only leave out a few non-economic species feeding on mistletoes for which data are currently incomplete.

During 2007, a new website has been compiled providing diagnostic information on the four different invasive *Bactrocera* species that are currently found in Africa. The species included are: *Bactrocera cucurbitae, Bactrocera invadens, Bactrocera latifrons, and Bactrocera zonata*. The website focuses on identification and differentiation of these species, distribution and known host plants; and gives some references for further reading[48]. It should be noted that at present *Bactrocera dorsalis*, currently reported from eastern Arabia is not included, although this species also constitutes a threat to African horticulture. It would be helpful if this species could be included in an updated version of the website.

4.5.6 Provision of training in identification of African pest fruit flies.

A small number of key researchers have been trained at the Musée Royale de l'Afrique Centrale, Tervuren, Belgium, in taxonomic skills necessary to distinguish most (but not all) of the major adventive and indigenous pest fruit fly species likely to be found on fruit in Africa. A list of these individuals is given in **Table 8**, below. It must be stressed that discrimination between different species of *Bactrocera* is often difficult even for experts. Further training based on the invasive fruit fly diagnostic website and the larger African fruit fly database

[45] The subtribe Dacina, including the genera *Bactrocera* and *Dacus*, is classified within the Tribe Dacini of the subfamily Trypetinae of the family Tephritidae.

[46] De Meyer, M. & I.M. White. 2004. True fruit flies (Diptera, Tephritidae) of the Afrotropical Region. A queryable website on taxon and specimen information for afrotropical Ceratitidine fruit flies. http://projects.bebif.be/fruitfly/index.html Tervuren: Royal Museum for Central Africa. Access date: 29/10/2007

[47] M. De Meyer, personal communication. I am indebted to Dr De Meyer and to Dr White for free access to all their information on African fruit flies. It is to be hoped that researchers at ICIPE and IITA will be equally generous in contributing to a future regional programme on fruit flies.

[48] De Meyer, M., Mohamed, S., & White., I.M., 2007. Invasive Fruit Fly Pests in Africa. A diagnostic tool and information reference for the four Asian species of fruit fly (Diptera, Tephritidae) that have become accidentally established as pests in Africa, including the Indian Ocean Islands. http://www.africamuseum.be/fruitfly/AfroAsia.htm

website is needed for plant protection personnel in every fruit-producing country in West Africa.

Table 8. Summary of taxonomic training provided to trainees from Africa by MRAC, Tervuren

Country	Name	Affiliation	Date of training
Senegal	Ndiaye Mbaye	Ministry of Agriculture	2006
Congo	Aristide Mbale	University of Kinshasa	2006
Ivory Coast	Hala N'Klo	Centre National de Recherche Agronomique	2005
Benin	Desiré Gnanvossou	IITA	2005
Nigeria	Vincent Umeh	National Horticultural Research Institute	2005
Cameroon	Ndzana Abanda	Institut de Recherche Agricole pour le Développement	2005
Tanzania	Maulid Mwatawala	Sokoine University of Agriculture, Morogoro	2004

Source: Dr M. De Meyer, personal communication

4.6 Strategies for pre-harvest control and monitoring fruit fly pests (Activity 1.3)

4.6.1 Life History of fruit flies

The adult female fruit fly lays eggs in the tissue of maturing fruits. The distinctive wasp-like body shape of female fruit flies is derived from the presence of a slender egg-laying tube, the ovipositor, at the tip of the abdomen, permitting the fly to pierce the skin of the fruit in order to inject its eggs into the flesh. The larvae hatch from the eggs after 3-10 days and burrow into the flesh of the fruit, causing it ripen rapidly and rot, often inducing early fruit fall. The period of larval development may last in different species and under varying conditions from 6 to 30 days. The duration of all life stages of fruit fly species depends on the temperature during the developmental period, as well as on nutrition and intrinsic genetic factors.

Rotting fruit is not a suitable environment for the immobile resting stage or puparium (formed by the last larval skin), within which the adult fly develops, because of the dangers of drowning in liquefying pulp or being invaded or poisoned by fungi and bacteria. Most fully-grown fruitfly larvae therefore leave the fruit in which they have developed and burrow into the ground before forming the puparium. In *Bactrocera* and *Ceratitis* the larvae are able to jump a few centimetres at a time in order to disperse from the fruit or to escape from predators such as ants. The puparial stage lasts around 7-30 days in different species. The adult fly then hatches and pushes its way to the soil surface before inflating its wings and hardening its outer shell.

4.6.2 Biology of adult fruit flies as a basis for control strategies

4.6.2.1 Protein-based baits for attracting females

Adult female flies of most species require a food source of protein to ensure maturation of their eggs and many are attracted to sources of hydrolysed protein that give off ammonia. This attraction has been used as the basis for a control strategy based on protein bait sprays

(see below). Some non-proteinaceous chemicals which also release ammonia have also been used in bait formulations.

Protein-based baits have been manufactured by hydrolyzing maize protein using hydrochloric acid, then neutralizing the resulting low pH solution using sodium hydroxide. However the reactions in this mixture lead to the formation of common salt (sodium chloride), which is phytotoxic when sprayed on crop foliage and may also deter flies from feeding. A more recent and highly successful manufacturing method has been to autolyse waste yeast from breweries through a process of heating and addition of the enzyme papain together with a food preservative (potassium sorbate)[49]. The resulting mixture is highly attractive to young female flies, though if the surrounding fly population is large and the number and distribution of bait points is inadequate, enough females will survive to cause severe damage, especially late in the season. Gravid female flies are not attracted to baits, but instead are seeking laying sites. The method is best suited to area-wide application, covering several adjoining orchards to eliminate untreated areas between them. Some commercial lures (e.g. BioLure) are synthetic chemical blends which mimic the effect of protein baits. The commonest protein and synthetic food attractants used for fruit fly control are listed in **Table 9**.

Table 9. Protein and synthetic food attractants commonly used for fruit fly baiting & trapping

Type	Name	Composition	Supplier	References
Single matrix synthetic food attractant	Biolure	Putrescine [= 1,4 diaminobutane]	Suterra LLC	http://www.citrusresearch.com/documents/dd8c3cf8-05ca-48d9-a30c-65275bb54659.pdf
synthetic food attractant	Three-component lure	Putrescine [= 1,4 diaminobutane], ammonium acetate, trimethylamine	Scentry, Montana, USA	Mwatawala et al. 2006
Corn (maize) protein hydrolysate	Nu-Lure®	proprietary	Miller Chemical and Fertilizer Corporation, Hanover, USA	Fabre et al., 2003
Liquid protein hydrolysate	Buminal	5% solution	Bayer SA, Puteaux, France	Rousse, et al., 2005
Enzymatic yeast hydrolysate	Brewery waste hydrolysed with papain	Brewery yeast waste hydrolysed with 2% papain	Local brewery	Rousse et al., 2005
Protein hydrolysate	Questlure®	proprietary	Quest Developments, South Africa	Ware, 2002
Protein hydrolysate	GF-120® NF Naturalyte® (Success Appat®)	Proprietary bait with Spinosad (spinosyn A and spinosyn D) 0.02%	Dow agrosciences	Michaud, 2003
Inactivated yeast	Torula yeast	Bait in granules (usually with borax) to be mixed with water for use in McPhaill-type traps		

[49] Allwood et al., 2001. Fruit Fly Control Methods for Pacific Island Countries and Territories. Plant Protection Service, Secretariat of the pacific Community, Pest Advisory Leaflet No 40.

Table 10. Trap types commonly used for fruit fly monitoring

Trap type	Description	Disadvantages
Jackson trap or delta trap	A delta-shaped plastic or cardboard trap with a sticky lining. A male attractant (e.g. trimedlure) is hung inside the trap and flies enter through the open ends, settling and becoming trapped on the adhesive interior surfaces.	Flies are difficult to remove and identify
McPhail trap	A bell-shaped invaginated plastic bucket trap for wet trapping, using protein baits	Flies rapidly decompose and sorting and identification is difficult
Sensus® trap (Quest Developments CC, South Africa)	A plastic dry bucket trap used with a bait in South Africa	
Steiner trap	A horizontal plastic cylinder with an opening at each end; one end is removable. Cotton dental wicks treated with the lure/pesticide solution are suspended inside the trap**.**	
Recycled plastic water bottle trap	A used water bottle is cut below the neck and the upper portion (minus lid) is inverted and inserted within the body to make an entry funnel. Alternatively holes are drilled around the neck of an intact bottle, containing lure and toxicant.	Very low cost but less durable and effective than commercial traps

Source: Ware (2002); http://www.spc.int/pacifly/Fruit_fly_manual/Surveillance_trapping_1.htm

4.6.2.2 Fruit fly trapping using baits: a monitoring tool

Use of baits for attracting female fruit flies needs to be combined with a method for killing the flies. There are two approaches to this problem. Flies may be killed by the use of a trap containing liquid or solid bait with or without the addition of an insecticide. Some common trap types are described in **Table 10**. Some trap designs do not allow flies to leave the trap once they have entered. They are either drowned in the liquid in the bottom of the trap or are killed by overheating due to greenhouse effect. However most bait trapping involves the use of a pesticide to kill the flies which enter. The pesticides most often used in traps are organophosphate compounds: naled, dichlorvos (DDVP) and malathion. The commonest is malathion, an inexpensive pesticide with a strong odour, which is toxic to fruit flies both by contact and by ingestion. Trapping of female flies with poisoned bait is an excellent monitoring technique for pest fruit fly populations, especially in situations where the males are already being lured and killed by deployment of male attractants. However, the main problem of female trapping as a control method is that traps cannot be deployed in sufficient number to ensure eradication of fly populations over a wide area, because of the prohibitive expense of purchasing, setting and servicing the traps.

4.6.2.3 Fruit fly control using area-wide bait application technique (BAT)

The dominant approach to the area-wide control of female fruit flies using baits, has involved the deployment over large areas of protein hydrolysate bait sprays containing malathion, an approach sometimes called bait application technique (BAT). At orchard scale bait sprays are applied using spraying equipment to the sides of trees or bushes, avoiding the fruit and trying to penetrate the foliage. The application may be intermittent or involve one side of a row of trees only. In West Africa, a major problem is the lack of formal row spacing and regular pruning permitting easy access for spray personnel. In eradication programmes or maintenance of fly-free zones in the USA, bait sprays with malathion may be sprayed from the air. For example in Florida in 1998, more than 6,285 gallons of ULV malathion (approximately 96-98% pure malathion) were applied in combination with nu-lure® bait over an area of 128 square miles (Michaud, 2003) as part of a medfly eradication programme. There has been increasing concern in recent years regarding the environmental effects of malathion on humans and non-target organisms (NTOs).

Although Malathion is a WHO Class III pesticide (classed as "slightly hazardous"), it is regarded as a potential endocrine-disrupting chemical and was listed in Category II of the recent EC Community Strategy for Endocrine Disruption[50]. It is also regarded by the US EPA as a potential carcinogen which is likely to lead to its being progressively abandoned for large scale control operations. Michaud (2003) concluded that widespread spraying of nu-lure®/malathion bait was not compatible with an IPM approach to citrus production because of serious adverse effects on natural enemies. Because malathion does not need to be consumed in order to kill insects, it causes mortality to the natural enemies of orchard pests, including ants, lace wings, predatory bugs and beetles and especially to parasitic hymenoptera.

A more recently developed alternative to malathion in baits is the GF-120® bait (success appat®) developed by Dow Agrosciences, which uses Spinosad as the toxicant. Spinosad is a mixture of two complex organic chemicals, spinosyns A and D, which are produced as a result of a fermentation process using a naturally occurring soil bacterium, *Saccharopolyspora spinosa* Mertz and Yao[51]. Since 2006 in Benin, Success Appat® (GF120®) has been tested by spraying a limited foliage surface of only 1 m^2 per tree. A decrease in losses of about 73% in sprayed orchards as compared to untreated fields has been reported[52]. Similar tests have been carried out by the COLEACP PIP in Burkina Faso, Senegal and Gambia with comparable results. A homologation process has been launched in CILSS countries under the authority of the CSP to register this pesticide for use by growers. The use of spinosad in place of malathion is expected to reduce impact on NTOs since this is a stomach poison which must be ingested rather than killing insects on contact. However scavengers on dead flies ingest the entire dose already consumed by the flies and this may become significant.

Bait sprays can be applied in spots (taches) by hand with a knapsack sprayer equipped with a high volume nozzle. When pest populations are high (as judged by monitoring traps) smaller bait spots can be applied at more frequent intervals, keeping the overall quantity of active ingredient the same per hectare. The method has been described in the CTA Practical Guide produced by COLEACP. A gel formulation for dispensing baits and lures on

[50] Commission of the European Commmunities, 1999. Community Strategy for Endocrine Disruptors, a range of substances suspected of interfering with the hormone systems of humans and wildlife. COM (1999) 706 final.
[51] Vargas, R.I., Miller, N.W., and Stark, J.D., 2003. Field trials of Spinosad as a replacement for Naled, DDVP and Malathion in methyl-eugenol and cuelure bucket traps to attract and kill male oriental fruit flies and melon flies (Diptera, Tephritidae) in Hawaii. Journal of Economic Entomology 96: 1780-1785.
[52] Vayssières, J.-F., 2007. GF 120 spot treatment in Benin. COLEACP. Fighting Fruit and Vegetable Flies Regionally in Western Africa. Newsletter No 7. October 2007.

the foliage of fruit trees known has been developed by ISCA. This is referred to as Specialised Pheromone and Lure Application Technology (SPLAT). The formulation is prepared from powder with the required lure and toxicant for different pests. The inert biodegradable gel matrix retains the chemicals and resists rain. However it is not expected to be economically viable for West African orchards.

4.6.2.4 Chemical lures for attracting males

Adult males of many (but not all) fruit fly species are also attracted to chemical substances, called parapheromones, which appear to be necessary for their sexual maturation. It has been suggested that these substances occurred in the ancestral food plants of the fruit flies and served to lead the flies to suitable egg-laying sites. A number of species including guava (*Psidium guajava*) and the Indian almond (*Terminalia catappa*) do indeed contain methyl eugenol in their fruits and even their leaves (Siderhust & Jang, 2006[53]). Other authors point to the fact that these substances are usually more attractive to males than to females. In at least one *Bactrocera* species (*B. dorsalis*) methyl eugenol is definitely known to be a precursor of the pheromone deployed by male flies to attract females (Siderhust & Jang, 2006). Male fruit flies are attracted to these substances from great distances (up to 0.8 km for methyl eugenol) and this powerful attraction has been used as the basis for development of male lures which are mixed with insecticide (see below) and deployed in traps or bait stations. This control strategy is known as the Male Annihilation Technique (MAT) (see below).

4.6.3 Male Annihilation Technique (MAT)

This approach to fruit fly control involves combining a suitable parapheromone lure for a particular fruit fly species with a suitable pesticide in order to lure and kill the flies. The mixture is either absorbed onto wicks placed in traps, from which the attracted insects do not escape, or soaked into plywood, wood or fibre board blocks. The size of these blocks is usually approximately 50 mm x 50 mm x 10-12.5 mm. In the Pacific islands coconut husk blocks of similar dimensions have been used as an alternative and lengths of 6-ply cotton string 30-45 cms in length soaked with ME have also been used in the Torres Straits Islands against *Bactrocera papayae*[4]. As indicated above a modified approach using spots of lure mixed into an inert gel can be applied to vegetation (SPLAT-MAT) as an alternative to bait blocks. At present this approach seems likely to be uneconomic for use in West Africa. Use of MAT blocks is recommended by the CTA Guide (COLEACP, 2007). It should be noted that the illustration in the guide showing a block being fixed to a tree without the use of gloves, is incorrect. Insecticide-impregnated blocks must always be handled with rubber gloves, even when dry, because the pesticide can be dissolved in perspiration and skin secretions and absorbed via the skin.

Establishing the best recipe of para-pheromones to attract males of specific species is the subject of active research programmes. However there are currently several “best bets” which are known to be highly effective. Male attractants used for trapping of different species are shown in **Table 11**. Some workers have used combinations of lures (e.g. TA + TML). However this has been found unsatisfactory, because it leaves in doubt the identity of the more attractive component and in any case mixtures have been shown, on occasions, to be less attractive than either of the individual components alone. It is important to note that the attractiveness of ME for *Bactrocera* species is much greater (by a factor of two or three times) than the attraction of any other lures for *Ceratitis* species. This has the effect of

[53] Siderhust, M.S. and Jang, E.B. 2006. Attraction of Oriental Fruit Fly, *Bactrocera dorsalis*, to *Terminalia catappa* Fruit extracts in Wind tunnel and Olfactometer tests. Formosan Entomol., 26:45-55.

increasing the required density of MAT dispensers to effect control of *Ceratitis* and therefore the costs of the operation.

Table 11. Chemicals most often used as male lures for African fruit flies.

Abbreviation	Common name	Chemical name
ME	Methyl Eugenol (sometimes marketed as Dorsalure)	4-allyl-1,2-dimethoxybenzene or 3,3,dimethoxy (1) 2 propenyl benzene
VL	Vert lure	methyl-4-hydroxy-benzoate
CL	Cue lure	4-(*p*-acetoxyphenyl)-2butanone (or 4-(3-oxybutyl)-phenyl acetate)
TML	Trimedlure	t-butyl 4 (or 5), -chloro-2-methyl cyclohexane carboxylate
	Capilure	=Trimedlure with extender (Ware 2002)
TA	Terpinyl acetate	alpha terpineol acetate (Barbet, 2000)
LL	Lati lure	alpha ionol (http://www.pestalert.org/viewNewsAlert.cfm?naid=29)
CRL	Ceralure	A mixture of ethyl 4- and 5-iodo-trans-2-methylcyclohexane-1-carboxylate

Source: White & Elson-Harris, 1992/1994.

4.6.3.1 Effectiveness of MAT blocks

MAT bait blocks, using ME as lure, have been shown to be highly effective when used both at farm level and at village level in India against several *Bactrocera* species (Stonehouse et al., 2007), although effectiveness is increased when neighbouring farms all deploy the control technique, preventing immigrant flies from untreated areas from invading protected areas. The danger of "free-riding" where uncooperative farmers may fail to protect their crops and rely instead on the protection provided by control on neighbouring farms is problematic. However it was found that the approach still works well, even if coverage is not complete. MAT using bait blocks is the method used for the Regional Carambola Fruit fly eradication programme in South America (Vayssières et al., 2007). It has been used in eradicating or managing invasive fruit flies in many situations, including Hawaii, Australia, Mauritius, Seychelles and the Pacific Island Territories[54].

Some concern for the future has arisen from the findings of Todd Shelley and co-workers in the USDA, that some individual males of *Bactrocera dorsalis* are non-responsive to ME and that it is possible to select in the laboratory for this trait. To date however there has been no evidence that use of ME in a lure-and-kill pest management strategy has increased the proportion of non-responsive males. Males given pure methyl eugenol in the laboratory are also subsequently less attracted by other sources of ME. However in the field natural sources of ME tend to be of low concentration and trap catches are not reduced by exposure to such low intensity natural ME sources[55]

[54] Plant Protection Service, Secretariat of the Pacific Community, 2001.
[55] Dr T. Shelley, personal communication to J. Stonehouse, in email of 10 August 2007.

4.6.3.2 Costs of impregnated MAT blocks for fruit fly control

In Seychelles, where importation relatively expensive, costings were made for local production of MAT blocks[56]. The resulting unit cost (**Table 12**) varied from 14 to 24 cents per block, not counting capital costs and individual packaging materials cost. Overall it is probably realistic to work on the basis of 15 – 25 cents per block. The normal application rate for MAT blocks would be around 10 per hectare, giving a cost of around €1.50-2.50 per hectare, for a large campaign. In Mauritius about 0.5 million blocks were used in the successful eradication of an adventive *Bactrocera* species, originally thought to have been *B. dorsalis*, but which may actually have been *B. invadens* (see section 4.5.3.6).

Table 12. Cost of local production of MAT blocks in Seychelles (€/block)

Item	Estimated cost
Plywood for the 50x50x10mm blocks	about €0.04 per block, not including the labour
Lure, solvent and malathion	<€0.005 per block
Nails	€0.012 per nail
Labour (cutting, soaking etc) variable depending on local opportunity cost of labour	c €0.12 per block for a public campaign without much packaging; Labour (with individual packaging) €0.20 per block
TOTAL cost	€0.141 – 0.241 per block

4.6.3.3 Piloting of packaged MAT Blocks in Ghana

Individually packaged MAT blocks from an Indian manufacturer have been imported into Ghana by Mr Ransford Noble Attatsi, Managing Director of Winfield Farms Ltd and President of the Papaya and Mango Producers Association of Ghana (PAMPEAG). The blocks have been sold at 7USD per packet of 1 block with a suggested rate of application of 5 blocks per acre, which at 35USD/acre is very expensive. Mr Atatsi indicated that his high unit cost was because he had to bring the blocks over as excess baggage. If air freighted normally they would be cheaper. The block is said to be impregnated with a standard malathion and methyl eugenol mixture (but the contents are not declared on the packaging).

Mr Atatsi also has some cue lure impregnated blocks for use against *Bactrocera cucurbitae*. He has been doing some trials with the Plant Protection Department since May 2006, but no details are available. The blocks are 50 x 50 x 10mm. A yellow plastic fold up box (65 x 65 x 110mm) is also available to hold the block. However in Mauritius it was found that the flies mainly come to the edges of the blocks, so in the plastic holder the edges would be obscured, which might reduce the effectiveness. Also, in Mauritius a single MAT block killed enough flies to fill a 1 litre trap tub in a week at the height of the season, so these little boxes would need emptying on an almost daily basis[57].

[56] Personal Communication, Professor John Mumford, Imperial College, London, email 1 Nov 2007.
[57] Professor John Mumford, personal communication, email 1 Nov 2007.

Table 13. Lures or bait stations for fruit fly control using male annihilation technique

Type	Description	Advantages/Disadvantages
M3® bait station (Quest Developments CC, South Africa)	Horizontal plastic disc trap with solid medium for dispersing attractant mixed with pesticide to lure and kill male fruit flies hung from tree branch	Bait is not exposed to rain so long lasting effect. Expensive compared to killer blocks
MAT block, Killer block (plaquette)	Wood, plywood or fibre-board block (soaked in a mixture of attractant (ME) and toxicant (usually malathion 96%) at a ratio of 3:1) nailed to a tree	Cheap and simple to construct but exposed to rain and handling needs gloves.
BactroMAT	An MAT block developed by Aventis Crop Science Australia using Fipronil instead of malathion	Fipronil degrades in sunlight and blocks must be replaced after 8 weeks

Sources: Ware, 2002., Vayssières et al., 2007

4.6.3.4 Impact of malathion MAT bait stations on non-target insect fauna

A recent paper (Vayssières et al, 2007[58]), conducted experiments to determine what non-target insects (NTI) were killed by bait stations using ME and malathion. They concluded that NTI deaths were random rather than indicative of attraction to the baits, and that the effect on NTI populations was negligible. However if this technique becomes widespread in West Africa, against *B. invadens*, some additional work would be needed to eliminate environmental impact as a significant factor from the use of bait blocks. Flies are killed by these blocks in large numbers and fall to the ground below the blocks, where they are picked up by ants – the genera *Camponotus*, *Monomorium* and *Oecophylla* being examples. There would be several genera and possibly many species involved.

In an effective MAT programme all the flies in an area are likely to be poisoned and killed. Most of these corpses would probably be eaten by scavengers, especially ants which would even alter their foraging behaviour to search the area below the traps more thoroughly. These ant populations already have some ecological importance in defining population levels of a range of other insects (e.g. Homoptera) in plantations. What proportion of dead flies are scavenged and what impact this may have on the local ant nests is unknown and needs to be measured. Similarly, impacts on reptiles feeding on dead and dying flies should also be considered. These may include skinks, geckos and lacertid lizards. Once again research studies are needed, but these concerns should not delay the provisional registration and deployment of bait stations (MAT blocks) containing Spinosad and ME which can be expected to reduce the population of *Bactrocera invadens* very significantly.

4.6.3.5 Organic protocols and Spinosad

Vayssières et al (2007) have suggested that spinosad MAT blocks will be acceptable for use in organically registered orchards since spinosad is "*registered for organic use in the USA, European Union and much of latin America*". However this assertion was not accompanied

[58] Vayssières, J.-F., Cayol, J.P., and Midgarden, D., 2007. Impact of methyl eugenol and malathion bait stations on non-target insect populations in French Guiana during an eradication program for *Bactrocera carambolae*. Entomologia Experimentalis et Applicata 125: 55-62.

by any reference documenting acceptability of Spinosad for organic fruit production in the EC. This is an issue of very special interest to producers in Burkina Faso where a significant proportion of production is currently certified as organic. Different organic regulation systems have different standards for Spinosad and it is essential as an immediate action to define and codify exactly the terms of use required for organic acceptance of an effective MAT regime in West African mango production for export to the European Union. It must be understood that detections of any non-compliant practices during an audit of organic mango production would lead to disqualification and a process of re-registration which entails a conversion period of three years during which organic practices must be observed, but during which produce cannot be marketed as organic production[59]. This would entail loss of the organic price premium and profitability. This means that organic producers cannot risk any practice which might threaten their organic status.

The EC Regulation for organic produce utilised by the main organic certifying institution in West Africa (ECOCERT) is No 2092/91 of 24 June 1991[60]. However this regulation has been repealed by a new Regulation which will come into effect on 1st January 2009[61]. Currently Annex IIb to Regulation 2092/91 of 1991 does not list spinosad as a permissible pesticide. The UK Advisory Committee on Organic Standards (ACOS) specifically refused to support the inclusion of Spinosad in Annex II[62], despite the fact that an earlier meeting had been told that some third country organic coffee imports into the EC are produced from crops treated with spinosad under an official programme for medfly eradication, without the spinosad coming into contact with the product.

Under the current Regulation 2092/91 of 1991, Annex IIB - Pesticides, has three categories of pesticides which are relevant in considering the case of spinosad for admission as a permissible substance. Category I covers substances of animal or plant origin. Clearly spinosad could be included in this category if it would be accepted that the spinosyns are the product of a natural organism. Secondly Category II covers micro-organisms used for biological control of pests. However spinosad is not itself a living biological agent, but rather a product derived from a micro-organism. Category III covers substances which are used in traps or dispensers. In this case "*the traps and/or dispensers must prevent the penetration of the substances in the environment and prevent contact of the substances with the crop under cultivation*"

This would cover the case of spinosad used in blocks, but only if it would be accepted that the blocks do not cause contamination of the fruit trees by contact and that the rain of dead flies which have ingested spinosad would not be considered as allowing "*penetration of the substances in the environment*". Curiously, under this clause of the regulation, deltamethrin and lambdacyhalothrin are actually permitted for use "*only in traps with specific attractants… only against Bactrocera oleae and Ceratitis capitata… need to be recognized by the inspection body or inspection authority*". Under this same clause "*pheromones*" are listed as permitted under the condition: "*attractant; sexual behaviour disruptor… only in traps and dispensers*".

A further complication of the new Regulation (834/2007) of 2007 is that it does not include or directly refer to the detailed Annexes included under the previous Regulation 2092/91 of 1991. Instead under Article 38, it defines a procedure to adopt "*detailed rules as regards the*

[59] Charlotte Coppee, ECOCERT, personal communication.
[60] Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91.
[61] Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91.
[62] Minutes of the ACOS meeting, 7 December 2006.
http://www.defra.gov.uk/farm/organic/standards/acos/pdf/acos-mins061207.pdf

production rules laid down in Title III, in particular as regards the specific requirements and conditions to be respected by operators". From the above discussion of the organic regulations it appears that there is an urgent need for discussion, involving the EC Committee on Organic Production and the control authority or body recognised by the Commission (in this case ECOCERT) to establish what lures and toxicants may be used under what conditions in organic agriculture for third countries exporting tropical fruit to the EC. It may perhaps be desirable to involve a sponsoring EC member country authority which wishes to import organic mangoes from West Africa in this discussion.

4.6.4 Cultural control of fruit flies

The main method for reducing fruit fly infestations in West Africa currently practiced involves orchards hygiene. This is recommended by Ministries of Agriculture in most countries and also by the CTA Guide (COLEACP, 2007). The principal activity is to pick up and destroy fallen fruit in order to prevent oviposition by adult flies and to ensure that any eggs already laid cannot give rise to adult flies. The recommended methods are to dig a hole and bury fruit beneath a layer of soil or to burn the fruit. Alternatively fruit may be piled beneath plastic sheet or into plastic bags and exposed to the sun to raise the temperature of the fruit sufficiently to kill the eggs and larvae. Other approaches suggested involve placing the fruit in water-filled drums or in bags with netting of a mesh sufficient to retain emerging flies while permitting parasitoids and ants to enter and leave the bag.

Leaving aside the issue of supply of drums, plastic bags and netting bags in rural areas, this approach is extremely labour-intensive. Surprisingly no experimental studies have been conducted to show that it is either effective or efficient in controlling flies. The approach rests entirely on the presumption that all flies in fallen fruit can be killed and that this will reduce the overall population. Some contrary indications are that mature larvae may leave fallen fruit rapidly, even before it can be picked up, and that local predator populations (e.g. ants) can play a role in killing larvae as they leave the fruit. It has been shown that emerging fruitflies can reach the surface of soil after burial, from depths as great as 0.5 metres (Stonehouse, personal communication). If pesticides are added to buried fruit to kill the flies, this is an added cost and potential environmental impact which cannot be tolerated in or near to organic orchards. The use of firewood to burn fallen fruit is also a severe environmental and domestic burden.

To learn more about labour costs of orchard hygiene, the consultant interviewed M. Zani[63], representative of FEDAF, a mango producers association which exports fruit to UK from Burkina Faso. M. Zani is both a small producer and a pisteur. Asked about the severity of field losses to fruit flies, he estimated an average figure of 50% overall in his area (Koloko). Asked about control strategies M. Zani indicated that currently orchard hygiene is the only strategy. It is necessary to pick up all fruits and dig a hole to bury them. He places dry wood, twigs and straw from the bush on top of the fruits and sets light to it to burn the fruit before covering with soil. He says that sometimes he cleans his neighbour's orchard as well in order to protect his own. The work is mostly carried out by his wife and family without any payment. However he estimates that it must be done 2-4 times per week. Based on figures for a hectare of orchard he estimates that the job takes two people ten hours on each occasion (=20 person hours). If this is repeated only twice in a week, then that is 40 person hours per hectare per week just devoted to this one activity. This represents a huge opportunity cost to the family in terms of time diverted from other activities.

The second cultural practice advocated by CTA (COLEACP, 2007) is to remove all vegetation in mango orchards. This removes any alternative hosts and resting places for

[63] Interview with M. Zani at Bobo Dioulasso, 5 September 2007.

fruit flies while making it easier to see and remove fallen fruit. In addition it is proposed that the surface soil (top 5-10 cms) beneath the trees should be cultivated, exposing fruit fly puparia to predation by ants. These practices involve further labour costs which may be unaffordable. While woody vegetation should be removed, it is questionable whether the area should be completely cleared and tilled, since natural enemies of orchard pests need some habitat other than bare soil and tree roots may be damaged by cultivation. Once again no direct comparison has been made between these practices, and there is no economic assessment of return on investment.

The CTA Guide points out that because the flies are polyphagous, the presence of other wild and cultivated hosts of fruit flies within orchards or in their vicinity must be avoided. This may be very difficult to achieve in much of West Africa where orchards are informal and mixed and adjoin farmers houses and gardens. However if these areas are protected by MAT as well as the orchards, there should be no problem. It is necessary to ensure that MAT blocks or traps are running before the mangoes ripen since the fly population may already have grown using alternative hosts of which the fruit become available earlier.

4.6.5 Bagging of mangoes to exclude fruit flies

In some fruit producing areas, bagging of fruit is used as a possible means of fly damage avoidance. Throughout China, fruit bagging using paper and thin polythene bags (sometimes both together) is routinely used to protect valuable fruit from damage close to harvest, especially Chinese Golden Pears which are exported to Europe. The bags are produced in huge numbers at a relatively low price. A sample was shown to M. Claude Bovey, Director of BurkiNature Sarl, and a discussion took place regarding the possible benefits or disbenefits of this approach.

It was agreed that bagging could potentially offer protection against wind and mechanical damage, fruitfly and weevil egg-laying, bird damage, honeydew from colonies of *Rastrococcus* mealybugs, ant damage and even anthracnose. However a number of potential disbenefits were suggested, which are listed in **Table 14**, below. Despite these issues, it was felt that if paper bags could be obtained for trials at low cost (e.g. by donation from the Chinese embassy), some tests could be carried out in non-organic orchards before the start of the rainy season.

4.6.6 Biological control of fruit flies

4.6.6.1 Predation by ants

Parasitic nematodes, lizards, ants and other predators can all play a role in reducing fruit fly populations. In Asia and Africa, weaver ants are a common constituent of tree crop plantations where they exercise a significant regulatory function on populations of other insects. A recently issued review (Van Mele, 2008) has examined this association with a view to promoting weaver ants as biological control agents[64]. In northern Benin, studies of fruit fly damage to mango trees with and without colonies of weaver ants, *Oecophylla longinoda*, showed that the ants were capable of greatly reducing fruit fly oviposition on fruit. The percentage damage of fruit fly pupae per thirty mangos was reduced from 24% to less than 1% (**Figure 9**) (Van Mele et al., 2007).

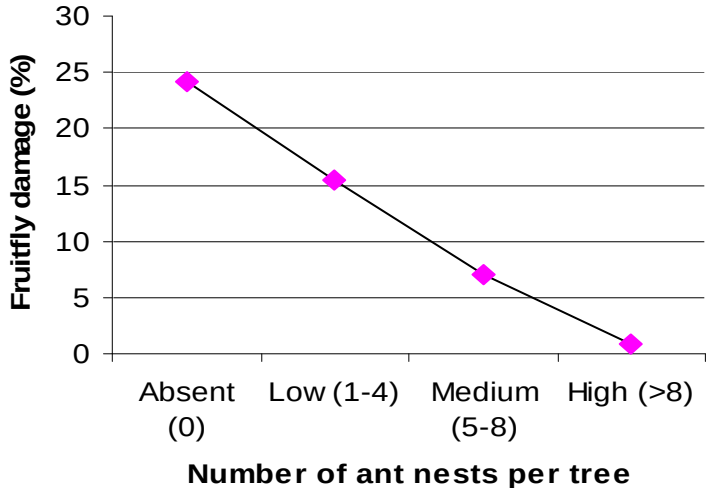
[64] Van Mele, P. (2008) A historical review of research on the weaver ant *Oecophylla* in biological control. *Agricultural and Forest Entomology* **10**, 13–22.

Table 14. Possible problems associated with application of fruit-bagging to West African Mangoes

- Mango trees are often very large and it is too difficult to reach and bag the higher fruit. Not only that but a single tree may produce several hundred mangoes, rather than the 30 or so fruit found on a Chinese pear tree. The cost and effort of bagging in such cases would be prohibitive.
- Heavy rainfall occurs during the fruiting period in West Africa. This would destroy paper bags and might flood plastic ones, leading to fruit rotting.
- Conditions in general in mango orchards may be more humid than in pear orchards in China. This might cause disease problems.
- Ripening of fruit involves desirable colour change in response to sunlight which might be prevented by bagging, though green varieties such as Amelie would be unaffected.
- The use of plastic bags would be unacceptable in organic orchards as the waste bags would be non-biodegradable and would pollute the orchard.

Source: discussion with M. Claude Bovey, Director Burkinature, Bobo Dioulasso, September 2007.

Figure 9. Percentage fruit fly damage in six orchards in Parakou, Northern Benin, 2005 with and without *Oecophylla* weaver ant nests.



Source: Van Mele et al., 2007.

African farmers dislike ants in mango trees, partly because they are bitten by them while harvesting, and partly because they protect and distribute scales and mealybugs which weaken the trees by their feeding and drop honeydew which attracts microorganisms which blacken the leaves and interfere with photosynthesis. They often spray or burn ant nests. However in Asia farmers conserve the ants as "farmers' friends" combating pests. Field observations suggest that harvesting fruit between 1 and 3 pm when ants are resting in the nest will reduce ant nuisance[65]. Similarly putting ash or repellent plant substances on feet and hands may deter attacks. However this is unlikely to appeal to villagers who also prefer to rest during the hottest part of the day. There appear to be opportunities for augmenting ant populations by providing sugar solution as food[66] while at the same time substituting the ants' usual source of sugar from honeydew. However severe problems of farmer acceptance

[65] Dr J.-F. Vayssières (personal communication)
[66] Dr J.-F. Vayssières, personal communication.

remain. In Burkina Faso where the premium price earned through organic production makes up for the increased distance from European markets, ant predation of flies might be better received, as an organic method. In Benin women and children (who buy from growers to sell in local markets) are said to specifically focus on harvesting ant-infested trees because the fruit are better quality.

4.6.6.2 Parasitoids of fruit flies

Numerous species of parasitoids which attack indigenous *Ceratitis* fruit flies are known from Africa, belonging to genera such as *Diachasmimorpha*, *Tetrastichus*, *Psyttalia*, *Dirrhinus* and *Coptera*. Many have been introduced elsewhere to control adventive fruit fly pests. However although some of these parasitoid species may attain high levels of parasitism at certain times during the season on crops such as coffee, parasitism rates on fruits such as mango have been found to be generally low (Lux et al., 2003). Mass rearing of parasitoids is expensive and inundative releases of reared native parasitoids are not thought likely to be cost effective. The major problem in selecting a parasitoid against fruit flies on mango is the difficulty for the wasp to lay its egg within the body of the fly larva feeding far below the surface of mango fruit. The egg stage of the fly is more accessible just beneath the surface of the fruit but only for a few days. Only parasitoids with very long ovipositors are able to effectively attack fruit flies in mango.

At least 32 natural enemies of fruit flies have been introduced into Hawaii since 1946 for classical biological control against the medfly *Ceratitis capitata* and the oriental fruit fly, *Bactrocera dorsalis*. Of these only three Braconid wasps of the subfamily Opiinae have become widespread and abundant. *Fopius arisanus* (Sonan), *Fopius vandensboschi* (Fullaway) and *Diachasmimorpha longicaudata* (Ashmead). *F. arisanus* is now the predominant fruit fly parasitoid in Hawaii, exercising significant control of fruit fly populations. *F. arisanus* has now been introduced into at least 13 countries[67]. Since 2003 it has been acclimated on Reunion island where it has a significant controlling effect on *Bactrocera zonata*. ICIPE has had some success in laboratory rearing of this species on *Bactrocera invadens*[68].

F. arisanus is an egg-pupal parasitoid which exploits the more accessible egg stage of the fruit fly host. The parasitoid larva remains dormant within the growing fly maggot and completes its development only in the puparium of the fly, once the fly larva has left the sticky liquid interior of the fruit and is resting beneath the soil surface. The probing activity of female parasitoids destroys more fruit fly eggs than are actually parasitized, increasing the value of the parasitoid. *F. arisanus* is only known to attack fruit flies of the genera *Bactrocera*, *Anastrepha* and *Ceratitis*. It therefore seems unlikely to become a threat to biodiversity of wild non-pest fruit flies, some of which are themselves important control agents of potentially weedy plant species. The wasp is not responsive to protein baits and would therefore not be harmed by the use of MAT blocks using Spinosad, whereas they would be at risk from blocks with malathion since this is a contact poison, while Spinosad must be ingested to kill.

These characteristics, together with recent advances in rearing technologies which make it much less problematic to produce a large population of wasps for release, make *Fopius arisanus* a very attractive prospect for release in west African mango orchards. It must be noted however that removal of fallen mangos and tilling the ground under mango trees may become distinctly counter-productive once such a species has been introduced, since the parasitized fruit flies will be destroyed along with the unparasitized ones. Currently ICIPE

[67] Rousse et al., 2005.
[68] Programme Régionale de Protection des Végétaux dansl'Océan Indien (PRPV). Méthode de lutte contre *Bactrocera invadens*. http://www.prpv.org/index.php/en/content/view/full/2399

has obtained laboratory populations of putative parasitoids of *Bactrocera invadens* from its ancestral area of origin in Sri Lanka. These colonies in due course are likely to lead to further useful options for field release in Africa to counter this invasive species. However, this should not stand in the way of more immediate action based on use of *Fopius arisanus*.

4.6.6.3 Pathogens as biocontrol agents for fruit flies

A number of different group of pathogenic microorganisms attacking fruit flies have been reviewed by Lux et al., (2003). These include *Bacillus thuringiensis* (a bacterium), *Nosema tephritidae* (a protozoan) and several different genera of entomopathogenic fungi, including *Metarhizium anisopliae*, *Paecilomyces fumosoroseus* and *Beauveria bassiana*. At ICIPE the African Fruit Fly Initiative (AFFI) considered two delivery mechanisms for fungal pathogens against fruit flies: soil inoculation against pupae and auto-inoculation using baiting stations. Soil inoculation was found to be quite effective in reducing numbers of flies emerging from puparia. Some flies were actually infected and killed by fungus in the soil during emergence from healthy puparia, while others were killed in the early stages of pupariation. Large amounts of conidia of the fungus are required for soil treatment but the pathogens are said to be quite resistant to drought and high temperatures, while apparently being "quite benign to parasitoids". Auto-inoculation with *Metarhizium anisopliae* uses less conidia in a more targeted way, and has the added benefit that few NTOs are exposed and the fungal spores are protected from UV light and any fungicide spraying which may be carried out in the orchard. Results using M. anisopliae in bait stations in mango orchards at Nguruman in Kenya showed a 70% reduction in fruit fly populations, equivalent to the effect achieved using malathion in the same dispensers[69].

Given the restrictions facing organic mango production in particular, it would seem important to carry the development of best-bet fungal pathogens to the stage of commercialization and routine field application in the same way as was done by the LUBILOSA project for locust control. Annex 2 of the current organic Regulation 2092/91 of 1991 permits the use of micro-organisms (including fungi (champignons) for biological control in organic production. There is a need for this research to be pushed ahead to the point of use in West Africa. Together with the release of an effective parasitoid such as *Fopius arisanus*, availability of a bioinsecticide based on *Metarhizium anisopliae* would relieve farmers of the crushing burden of clearing fallen fruit which would then become a source of further inoculum for biological control, turning a liability into a benefit. This research would require a biodiversity risk assessment to ensure that non-pest species of flies are not put at risk. However past use of *Metarhizium* as a sprayed bio-insecticide on locusts has not led to population decline of other indigenous grasshoppers (which has occurred with the use of *Nosema*). The restriction of use to orchards is likely to ensure that it rarely impacts non-target fruit fly species and due to its specificity to Tephritidae other organisms are not likely to be impacted (unlike the case with pesticides).

4.6.7 Control of fruit flies using sterile insect technique (SIT)

Sterile insect technique (SIT) has been promoted for fruit fly eradication since the 1990s by IAEA. SIT relies on having a species in which the female mates only once to fertilise all her eggs. This is the case with fruit flies. SIT involves sterilising large numbers of male fruit flies and releasing them to compete with normal males across a wide area. Sterilization is accomplished by exposing insects to a specific dose of gamma radiation emitted by radioisotopes (Cobalt 60 or Cesium 137). No other methods are available or appropriate to achieve sterilization. The technique works best in areas where there is a degree of isolation

[69] Lux, S.A., Ekesi, S., Dimbi, S., Mohamed, S., and Billah, M. Mango-infesting fruit flies in Africa: perspectives and limitations of biological approaches in their management. Pp 277-293 in Biological Control in IPM Systems in Africa. Ed. P Neuenschwander, C. Borgmeister and J. Langewald. CABI Publishing 2003.

and the cleared area cannot easily be re-invaded (e.g. islands, isthmuses, peninsulas, isolated valleys with mountains or deserts around them). It is also more likely to succeed in areas where export values are high and growers are well organised.

SIT has three special attributes which make it especially attractive:

- It is species-specific, leaving related fruit fly species and all other NTOs unaffected. However in West Africa with several pest fruit flies, this is a disadvantage, not an advantage.
- SIT is inversely density-dependent, meaning that as unmated wild females become rarer, the efficiency of the SIT increases, since sterile males compete to seek out all remaining females. This is especially an advantage in an eradication campaign, which is anyway not possible in West Africa, given the huge area to be covered and the absence of a regional phytosanitary system.
- SIT is compatible with other pest management strategies, such as biocontrol. However monitoring of males using trapping with lures after SIT is no longer an option unless the strain released is distinguishable from wild males (e.g. by colour).

SIT for medfly (*C. capitata*) has been running for 30 years now. The efficiency of SIT for medfly has been greatly increased by the development of "male-only" strains from which females can be eliminated before release, to prevent damage to fruit by released females which probe with their ovipositors even though they cannot lay viable eggs. Such strains are not available for other species yet, greatly increasing the cost of a suitable package. Sophisticated cost-benefit models have been developed at Imperial College for the medfly, *Ceratitis capitata*. These would need to be redone for West African mango in a multi-species context (i.e. with several other commercially important fruit flies present in an area) as is the case in West Africa. SIT for any of the *Ceratitis* species (e.g. *C. cosyra*) in West Africa is unlikely to be cost effective as these are no longer the main pest of mango or other fruit, and damage is caused by more than one species of *Ceratitis*. Classical criteria for the utilization of SIT were originally advanced by W. Butt in 1973. These are shown in **Table 15** below and discussed in the context of West Africa.

There are sterile male programmes for some species of *Bactrocera* in Asia and Australia, including the melon fly *B. cucurbitae* and the Queensland fruit fly, *B. tryoni.* However, IAEA itself has specifically proposed that *Bactrocera* species for which methyl eugenol is the known lure (this includes *Bactrocera invadens*) are not priority targets for SIT[70]. This is because the attraction of ME is so strong that it can be used to lure and kill almost all the males in a given area (again, provided that there is a degree of isolation), instead of making the enormous capital investment in rearing, sterilisation and release needed for SIT. In this context it is not possible to recommend SIT as a "silver bullet" for the West African fruit fly problem.

[70] IAEA, 1999. Thematic Plan For Fruit Fly Control Using The Sterile Insect Technique. www.iaea.org/nafa/d4/public/ff_thematic_plan.pdf

Table 15. Comparison of classical criteria for successful SIT with the situation pertaining in West Africa.

Criteria for successful SIT (W. Butt, 1973)	**Situation in West Africa**
Efficient mass-rearing available?	No, the only mass-rearing of *Bactrocera invadens* is at ICIPE in Nairobi
Effective sterilization methods available?	The only radioactive source in West Africa is at Ghana Atomic Energy Corporation which has never done SIT
Quality control in rearing, sterilisation & release available?	No facilities and staff for this activity at GA
Effective release methods available?	Release methods have been developed for *Ceratitis capitata* elsewhere
Effective method for monitoring target pest available?	Yes, bait traps in mango orchards (to catch females)
Low native insect population?	No, populations are enormous and not confined to mango orchards.
Effective means of reducing localised wild populations?	Yes, could use MAT to reduce male population before release of sterile males (but if so why not continue?)
Reasonably isolated release area?	No, the area is huge; although the commercial mango production areas of each country could be delimited, they are surrounded by infested local mango trees.
Knowledge of ecology and biology of target pest available?	Have knowledge of fruit flies generally, but only three years experience with *B.invadens*, mostly at ICIPE
Effective organizational structure with adequate funds and trained personnel available?	No suitable organizational structure at present in Ghana. Best entomological infrastructure in the region is at IITA, Benin.
Area-wide control (AWC) concept accepted by organization?	AWC would need to be explained to and accepted by small-scale growers who are poorly organised in associations in most countries within the region. There is no effective regional phytosanitary organization either.

Source: Criteria reprinted in IAEA, 1999.

4.7 Review of post harvest management of West African mangos (Activity 1.4)

The study will concentrate its analysis of the post-harvest situation on the mango. Although the consultants who undertook the field work enquired about risks and damage caused by the fruit fly to other crops, it emerged that in the various visited countries, very little if any research has been undertaken concerning damage caused by fruit flies to other horticultural products. This makes it difficult to evaluate with precision the parasitic pressure on other host crops.

In addition, it is difficult to talk about post harvest procedures for fruit which does not pass through packaging or processing units (*stations de conditionnement*). Passing through a packaging unit generally leads to an increase in costs which can only be justified if the goods are intended for export (mainly towards European markets or other, non-neighbouring, African markets). For produce exchanged by land, it is difficult, given the present state of

means at the disposal of the plant protection departments, to evaluate their real amounts and records of fruit fly infestation in local trade are unavailable.

For these reasons, the study with respect to post harvest treatments related to the Tephritidae, will utilize the results and estimates made using the data collected in ports and airports, which mainly concern mango. During the field work carried out in the different ECOWAS countries, it became obvious that the various administrative departments meant to inform us were meeting several problems which complicated the collection of production data. Moreover, concerning volumes traded, although we have at our disposal relatively precise data in terms of air and sea exports (through ports and airports), the situation is totally different concerning the large quantities of products traded by land and often roughly evaluated or under-estimated.

The problems are mainly due to the fact that the data concerning the production areas are patchy. In all the countries visited by the team of experts, people were capable of identifying and delimiting the production areas, the available varieties, those meant for export (European and regional markets) and those consumed locally. Unfortunately the identification, at least for the time being, is limited to an evaluation of these areas without more detail. The collection of data concerning production is often very approximate, although in some countries the team came across projects aiming at identifying and mapping the production areas. Regrettably, even in those cases, the areas chosen were not representative of the overall production.

In the individual country commodity chain presentations which follow, in order to enable us to standardize the data, we based ourselves, when national data were lacking, on the production data provided by the FAO. None of the countries visited by the team of experts was in a position to give us a precise estimate of the substantial quantities of mangos traded by land between ECOWAS countries. The data collected concerning these exchanges mainly take into account producer organisations and their members, but do not integrate the trade which occurs outside these organisations whose volumes we consider significant.

4.7.1 Post harvest quality management in packing stations in West African countries

Only mangos for export via ports or airports go through packing stations. Mangos for local consumption are not sent through a packing station and are directly introduced to the marketing channel. There are several types of packing stations deployed in the production areas and in ports and airports. Most packing stations remain very basic. Their purpose is to provide premises where grading and packing can take place. However, more elaborate units exist, responding to quality criteria, which generally belong to companies certified under EUREPGAP or GLOBALGAP.

The following description applies mainly to the station run by the PDMAS, in Senegal, whose management should shortly be handed over to a service provider. However, in the majority of cases and with few variations, work in a packing station can be broken down as follows:

- reception of the mangos. Some stations carry out a preliminary and rapid inspection to pick out the fruit which for various reasons (size, defects, weight) will be turned down at the end of the classification process.
- Once received, mangos are washed, generally by hand.
- Some stations may be equipped with little soaking baths and may then submit the fruit to a dip in hot water to which a fungicide such as prochloraz has been added in order to fight anthracnose.
- The mangos are then dried (sometimes polished or brushed) and go through a grading system which distributes the fruit according to their size which for the European market is between 300g and 800g.

- In some stations, a further inspection based on visual criteria is conducted, generally by women, known as “trieuses”. These are generally specially trained and are capable of identifying even slight traces of insect punctures. Some of these have been trained by expatriate trieuses from other ECOWAS countries, especially Ivory Coast.
- The fruit are then packed into cardboard boxes.
- The pallets are stocked up as the fruit boxes are completed.
- It is according to the volumes of palletized, and therefore exportable, fruit that the collectors (pisteurs) are paid. The fruit disqualified for export form the second choice, the return from which can be more or less valuable, depending on the variety in question.
- When the station is equipped with cold rooms, fruit pallets are immediately stored in it before being dispatched. The mangos may be pre-cooled with cold air before storage in the cold room.
- In the absence of a cold room, the fruit may be directly loaded into the containers.

4.7.2 The main phytosanitary constraints managed in packing stations

Although mango can be the target of several attacks, packing stations mainly concentrate on the management of two types of problems which affect exports, fungal problems such as anthracnose and pest problems linked to the fruit fly and the cassava mealybug (la *cochenille farineuse de manioc*), *Rastrococcus invadens*.

Anthracnose affects the fruit’s appearance as well as its shelf life. During the latest campaign (2007), the problem of fungal attacks has been added to the fruit fly problem. For the moment, in addition to the maintenance of the orchards (regular cutting back and pruning), in packing stations, pest management related to anthracnose type problems consists in submitting mangos to a treatment (less than 5 minutes) of hot water and products which delay the appearance of the fungus once the fruit have arrived in Europe.

The fruit fly is a major problem for the mango sector as it is considered a quarantine pest in Europe. The discovery of a single live larva is sufficient reason to destroy a whole consignment (lot). The management of this problem is undertaken exclusively through the selection process operated in packing stations by personnel specially trained to detect traces of fly punctures. In the case of exports by plane, the consignments arrive at the station at a more advanced stage of maturity which can simplify the work. However, the expertise of these women is put to the test with exports by boat for which mangos are picked at an earlier stage. The only post harvest control measures undertaken to manage the fruit fly problem are the inspections carried out by the selectors (trieuses) trained to detect the slightest trace of insect punctures on the fruit (spots, shape alterations and many others).

These efforts are complementary to the work of the collectors (pisteurs) or any person in charge of bringing fruit to the packing station. These people are meant to have already made a stringent preliminary selection which leads to the rejection of much of the fruit in the orchards. The importance of the work carried out at this first stage in the supply chain has led to the organisation of training sessions for fruit collectors.

4.7.3 Regulatory constraints and the necessity for harmonising phytosanitary controls

During the field visits, the team was confronted by the diversity of national situations. For each country, there exists a different legislation for imports and for exports with respect to phytosanitary inspections. Very often agents are not up to date with the texts currently in force. The need for harmonisation expressed by goes further than a simple harmonisation of texts. We were often asked to suggest the setting up of a Vade-mecum for all the countries in the sub region which would set out the methods and inspection procedures to be followed. All the plant protection services met expressed a need for more human resources, before even mentioning financial aspects. During the mission's visits we observed variation in rigour of phytosanitary inspections. In some countries inspections were made even of informal trade flows, whereas in others a inspection had been delegated to private companies, on the basis of the good faith of exporters.

It appears urgent at a time when we are about to lay the basis for regional cooperation in fruit fly control to seize this opportunity to boost the process of regulatory reform. We have been informed of the existence of an ECOWAS project which goes in this direction, without however having been able to see the proposed documents which have not been accepted by everyone. The problem could be solved by an audit of the phytosanitary services in the different ECOWAS member states. This would permit the precise human and material needs of these services to be assessed and further the process of phytosanitary harmonisation already launched by the ECOWAS.

4.8 The post-harvest eradication of fruit fly eggs and larvae from fruit

After harvest, several methods presently exist to eliminate the risks linked to the presence of quarantine pests such as the larvae and eggs of fruit flies. It is important to remember that the application of these different techniques depends essentially on the destination market as this determines the methods judged adequate to reduce the risks and thus facilitate imports to its fresh produce markets prone to be affected by fruit flies. For the moment, only the American market appears to fix with precision the type of treatment that it requires, according to the areas of origin of the goods and the flies present in these areas, before accepting fruit (such as mango or guava) onto its territory.

European Union authorities have not, for the moment, fixed any specific measures to apply to products such as mangos exported to its market. They therefore leave to the exporting country the responsibility of establishing at the post harvest level, the methods which enable to guarantee the harmlessness of the merchandise received and, more particularly, the absence amongst imported consignments of quarantine pests such as fruit flies.

Mangos being sensitive to cold, most of the post-harvest solutions proposed to control fruit fly larva and eggs call upon heat, with the exception of the fumigation processes which although cheaper are more and more criticised due to the gases they use (*ethylene dibromide, methyl bromide)* considered to polluting and dangerous for human health. Besides, whereas fumigation treatments, involve the use of chemical agents, those based on heat (at least for the eradication of fruit fly eggs and larva) do not involve any chemicals. Although, the use of post harvest fruit fly control methods based on cold is mentioned for some countries, it must be said that the methods referred to, applied to fruit harvested early, aim mainly at delaying the appearance of damage symptoms caused by fruit fly punctures or the development of larvae. In any case, these are only solutions of last resort which in no way resolve the problems linked to the presence of organisms living inside the fruit.

4.8.1 Heat-based treatments

In the present state of our knowledge, it would appear that most insect larvae or eggs do not survive temperatures above 45°C. The objective of heat treatments is therefore to elevate the fruit's core temperature and maintain this temperature during a more or less long period of time depending on the procedure used and on the size of the fruits treated. The point where the pests are destroyed must be determined. However, this technique has a drawback in the sense that it can lead to the destruction of the treated fruit. It must therefore be adapted according to each case for each pest species and each variety of fruit treated as the composition (flesh, density) and the sensitivity to heat vary from one variety to another. The post harvest fruit treatments using heat are of three kinds: treatment by immersion, treatment by steam and treatment with forced hot air.

4.8.2 Treatment by immersion

The treatment by immersion or hydro-thermal treatment consists in elevating the fruit's temperature with hot water. As explained above, the length of the immersion as well as the temperature of the water vary according to the fruit (variety, species and size) and the pest that one wishes to eliminate. Treatments by immersion can be of two types: by batch (sometimes also called "Jacuzzi" system), or by "continuous circulation". Both these methods require that the packing station in which the equipment is placed have access to water and have a thermostat enabling it to regulate properly the baths at the appropriate temperature.

Treatment by batch or "Jacuzzi" system
This is the most common immersion treatment. It consists in loading crates of fruit on a large tray, the tray is then hoisted under water in a tank were the fruit are left for a length of time which varies according to the fruit treated. Once the time is finished, the tray is taken out. The system includes security measures which are designed to prevent a batch from being taken out before the end of the prescribed treatment.

Treatment by "continuous circulation"
This system consists in laying the fruit under water in openwork crates placed on belts which move slowly from one side of the tank to the other. The speed at which the belt moves must enable all fruit to be sufficiently heated. This system requires equipment which records on the same document the speed of the belt/band, the temperature of the tank and the length of immersion. Smaller fruit need less treatment time so it is important for the speed of the belt to be variable in speed. This system presents a higher level of risk of damage to the fruit (if they are not in an openwork crate) and it requires a greater surface area than the "jacuzzi system". Although in this system the water temperature is less high, the time of immersion, on the other hand, is longer and can vary (according to mango varieties and their size) between 30 and 90 minutes.

4.8.3 Treatment by steam

This system is almost the same as the one with hot air. The difference between the two system is the condensation of water on the fruit which occurs with steam but is absent from the hot air system. The treatment by steam uses hot air saturated with steam to elevate the temperature of the treated fruits. The latent heat produced by the condensation of steam on the fruits increases the temperature of the pulp. The treatment time and the temperature which has to be reached vary according to the varieties and the pests that one wishes to destroy. It is estimated that for the pulp of a fruit to reach a temperature around 43°/44°C, an exposure of between 6 to 8 hours is necessary. Once the temperature has been reached, the fruit are still maintained during 6 to 8 hours at the indicated temperature. It is then necessary

to cool down the fruit immediately after the treatment. The length of the treatment can vary according to the market of destination and its requirements, the variety of fruit treated, the organisms to eliminate and the country of origin of the fruit.

4.8.4 Treatment by forced hot air

This system is based on the use of hot and humid air which is forced to circulate amongst the fruit until they reach the desired temperature. According to the air's point of entry, which can be either above or below, the layout of the parcels in the room will vary as well as that of the detectors or thermostats. Unlike the method which uses steam, this system does not generate condensation on the fruit. It reduces the injuries due to the treatment as well as the loss of weight of fruits.

4.8.5 Microwave treatment

The energy produced to treat the fruit comes from waves which correspond to radio frequencies used within an electromagnetic spectrum between 10Khz and 10Ghz, according to the principle of conversion of electromagnetic energy to thermal energy. At present, the process has been tested but not yet used commercially. The first results demonstrate that it is possible to increase the temperature at the heart of the fruit more rapidly, which can prove useful, particularly for the treatment of problems linked to the fruit's stone (weevils), as it reduces the damage caused to the pulp. However, the popularisation of such a process is blocked not only due to the weakness of research but, more importantly, because of the high costs that the establishment of such a system involves.

4.8.6 Treatment by fumigation

Methyl bromide is being phased out globally under the Montreal Protocol as an ozone-depleting gas, though currently still permitted for some pre-shipment quarantine fumigation. No fumigation is currently used for fruit and vegetables in West Africa.

4.8.7 Treatment by irradiation.

Treatment by irradiation is realised by exposing the fruit to a dose of X-rays or gamma-rays. Approved USDA quarantine treatment dosage for fruitflies is between 150 and 250 Gy, depending on the species. However the main pest species in West Africa have not been specifically tested for their resistance to irradiation. Though the method appears to give good results in terms of controlling quarantine pests, it none the less raises a series of questions which tend to limit its future development. Ghana which would like to develop its fruit exports to the USA has already, thanks to cooperation with agencies such as the GAEC (Ghana Atomic Energy Council), USAID and APHIS, started to consider this treatment for some fruit. For the moment, the information in our possession indicates that irradiation tests on pineapple have enabled the export to the USA of a few hundred parcels of irradiated fruit. The GAEC irradiator is old and would need substantial refurbishment at considerable cost to be able to handle regular consignments of mangos. The existing arrangement of the facility is also unsuitable for high through-put uses[71].

Although the technique appears to be accepted by the consumers in the United States (at least by part of them), the question of the acceptance of this type of treatment by the European market remains unanswered. At a time when the European consumer is more and more concerned by all the scandals linked to foodstuffs, there is according to us, very little

[71] Marcotte, M., R.M. Al-Hassan, Humado, K., 2005. Irradiation Quarantine. Export Development Feasibility Study. WATH Technical Report No. 11. October 2005, USAID.

chance for Europeans to accept irradiated fresh produce. Besides, there is not much data concerning research applied to fruit and vegetables. Finally, the question of the cost of the method remains, as irradiation requires the establishment of a complex and costly organizational structure[72].

Considering the different techniques and procedures presently in development and which have already been tested on certain mango varieties other than those commonly produced in Africa, and taking into account the work published by the CIRAD, we believe that the techniques which make use of hot water (treatment by immersion or by steam) are those which are the most likely to offer a solution with respect to the control of quarantine pests. However, as we have indicated, for their transposition, these techniques need more research to determine the different thresholds (temperature, length of treatment and organisms to eliminate). The CIRAD, which already undertakes work of this type and some of whose researchers we have met during our field visits, could be an interesting partner to work with.

Whatever methods are used, it is necessary to have closed storage areas where fruit can be stored, after treatment to prevent any new contamination by insects, as recommended by the USDA. Due to the short time allowed for each country visit, it was impossible to visit all the existing packing stations. This would have been all the more difficult as there are a large variety of basic structures which claim to be “packing stations”. However, some packing stations already have quality equipment and certification. This type of station already operates as a service provider. If research succeeds in determining the type of treatment that could guarantee the destruction of fruit fly larvae and eggs whilst maintaining the organoleptic qualities of the fruits, and if the market continues to develop, it is likely that these service provider stations will enhance their services by incorporating treatment infrastructure with them.

However, as we have said earlier, the European market does not require, at least for the moment, specific treatments for mangos. Besides, the establishment of this type of infrastructure will generate additional costs (borne by exporters) whereas service providers, despite the good quality of the work they offer, have difficulty in justifying their presence and the costs of their services although those that use them obtain the most benefit through the fact that their consignments are no longer seized or destroyed as a result of pest infestation. As a result, at least for the present, we do not believe, for reasons of profitability that the solution involves the development and popularisation of the methods described above.

4.8.8 Treatment against anthracnose and fruit flies by biocidal coatings

The only biocide currently used on mangoes destined for the EC is the broad spectrum fungicide prochloraz. Prochloraz is applied during washing in hot water as a treatment for anthracnose. It is not clear whether this treatment will continue to be acceptable in the EC in the long term, owing to the endocrine disruptive and androgenic effects of prochloraz exposure in mammals[73]. For precautionary reasons, it is probably not advisable to expose pregnant women to prochloraz solutions for washing mangos, since the chemical will be readily absorbed through the skin and has been shown to have perinatal effects on male offspring in experiments with rats. In Mexico emulsion coatings (a hydrodispersion containing maltodextrin, carboxymethylcellulose, propylene glycol and sorbitan esters) have been shown experimentally to prevent development of *Anastrepha* fruit fly larvae and reduce anthracnose incidence by 70%[74]. It is not clear whether costs of application and removal of the coatings and the chemicals used would be economically feasible, nor whether the technique would be compliant with food safety regulations in the EC market.

[72] Estimated capital cost of 4 million USD (IAEA, 1999).
[73] Vinggard, A.M., et al., 2005.
[74] Diaz-Sebac, R., et al., 2000.

5 NATIONAL SITUATION SYNOPSES (RESULT 2)

5.1 National Situation Synopsis: SENEGAL

Positioned on the Atlantic West Coast of Africa Senegal experiences a climate characterised by one rainy season of variable duration according to latitude (3-4 months) and a dry season occupying the rest of the year (November – June). The country can be divided into two broad climatic regions (each with two subregions) to the north and south of the 500 mm isohyet. The Sahel to the north can be divided into the north Sahelian region receiving less than 300 mm per year and the southern Sahelian zone with 300-500 mm. The Sudanian region to the south of the 500 mm isohyet is composed of the northern Sudanian zone with 500 – 800 mm and the southern Sudanian zone receiving 800-1200 mm annually.

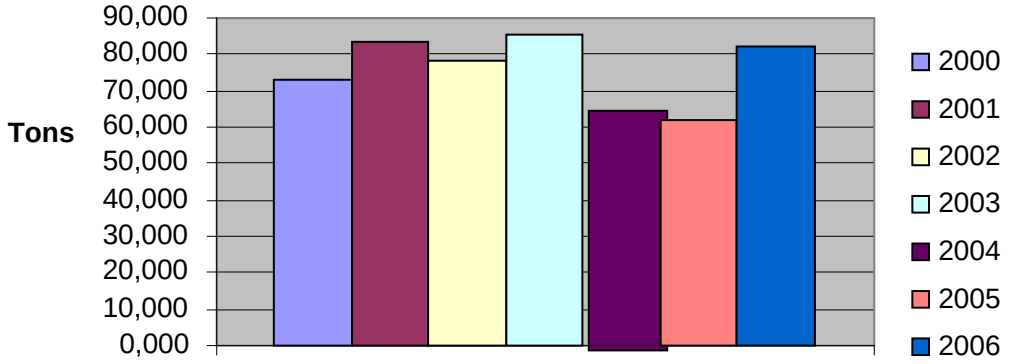
5.1.1 Fruit production in Senegal

Senegal's fruit production is estimated at around 120,000 tons. The World Bank supported Agricultural Export promotion Project (Projet de Promotion des Exportations Agricoles) has helped to revive product and export diversification and to professionalise the operators in the sector. The main fruit products in Senegal include banana, mango, papaya, citrus (orange, clementine, lemon, grapefruit), avocado, water melon, melon and pineapple.

5.1.2 Mango production in Senegal

Due to the lack of national data concerning production, we have relied on information provided by the FAO, according to which mango production in Senegal enjoys a steady growth. Estimated at over 73,000 tons in 2000, it has increased over 12% reaching over 82,000 tons in 2006 (Figure 9). This production corresponds to an area of around 5005 ha. It is estimated that over 56,200 tons are produced for local consumption. According to a USAID Croissance Economique (USAID/CE or SAGIC) study in 2005 concerning the analysis of value chains, local consumption represents a value of over 2,810 billion CFA (2005). Due to the keen interest aroused by the mango commodity chain, an increase in orchard area can be observed. This should enable the production to continue its increase in the years to come.

Figure 10. Mango production in Senegal, 2000-2006



Source: FAO

5.1.2.1 The main mango production areas in Senegal

Fruit production in Senegal is concentrated in three areas:

- The Niayes zone is apparently the most developed and the most important area. It harbours the new mango orchards and most of those producing for export. This region alone produces over 60% of mangos exported from Senegal, mainly the Kent (70% of exports) and Keitt varieties. Losses in this area due to *B. invadens* have been estimated between 20 and 60% in different types of orchards.
- The Casamance region, considered as the food basket of Senegal, produces mangos, citrus and cashew nuts. Due to the type of orchards in the area, losses due to *B invadens* have been estimated there between 50 and 75%.
- The petite Côte and Bas Saloum region is also a mango production area. Here, due to the type of orchards, the losses are typically much higher, averaging between 50 and 85% and in extreme cases, reaching 100%.

The seasonal production in different regions is shown in **Table 16**. The season last from March to mid-May in Cote d'Ivoire and from July to September in Senegal. *Bactrocera* peaks in July-August. The export campaign ends when fly-struck fruit (*piqures*) reach 30% of harvested fruit reaching the packing station.

Table 16. Seasonal nature of mango production in Senegal

Months: Regions	May	June	July	Aug	Sept	Oct
Western Casamance	X	X	X			
Sine Saloum West	X	X	X			
Petite Côte Mbour		X	X			
Niayes South		X	X	X	X	X

Source: SAGIC/Senegal

5.1.2.2 Types of orchards

The development of mango production in Senegal is mainly the result of the type of orchards. One can distinctly distinguish three types of orchards:

Traditional orchards
The traditional orchards which still represent most of the land dedicated to mango production. They are often old orchards (average age between 25 and 35 years) whose mangos, said to be local, are mainly produced for national consumption though they can occasionally be sold in the sub-regional markets. They are orchards which have been planted but then left to themselves without any particular maintenance. They only present an interest if they produce fruit. They represent the main source of attraction of the fruit flies. The situation is all the more difficult to manage in these orchards, because their lack of maintenance makes access difficult. This prevents the collection and burial of fallen fruits attacked by the fruit fly which represent a further source of contamination of the orchard.

Improved traditional orchards
The improved traditional orchard is an intermediary orchard category. It appeared with the development of mango exports to Europe. At first, they are often the result of agreements between a producer and an exporter. The latter renews a part of the orchard by grafting and maintenance activities (help in cutting, establishment of traps to control the fly population), in exchange for which he has exclusive rights to the improved production over a limited period

of time. These orchards served as tests to develop the know-how and the export potential of mango production. Planted in part with fruit in demand on the export market (mainly Kent and Keitt) and in part with fruit considered as local, they enabled the emergence of the modern orchards.

Modern orchards
The modern orchards are the logical follow-up to the improved traditional orchards. The results of the sale of mangos from improved traditional orchards led a certain category of exporters to establish, mainly in the Niayes area, modern orchards based on those observed in South Africa, Israel or Brazil. Trees are planted at a standard density which can vary between 250 and 450 plants per hectare. The space between trees is regular and enables a mechanical and easier maintenance of the orchard. Trees are pruned and cut back so as not to exceed a certain size. Often, thanks to an irrigation system, each plant receives nutrients. As opposed to other types of orchards, these are generally planted with a single variety of mango, occasionally two varieties at most. A period of 5-6 years is necessary for the trees to reach their full yield potential. Although in the minority, these modern orchards are the most profitable. They generally belong to exporter-producers with access to significant investment capital.

5.1.3 The national and sub regional market

The quantities consumed on the national market, as well as those exported throughout the sub-region are considerable, but overall precise data are not available. Sub-regional exports are not always registered because they are transported by land, and part of the trade is undertaken informally, without phytosanitary certificates. National and sub-regional mango consumption concerns mainly the traditional varieties as well as the “second choice” fruit removed from export due to non-compliance with export criteria. The amounts of fruit exchanged on the national and sub-regional markets is estimated at over 68% of the national production. An indication of prices on the national market is provided by **Table 17**.

Table 17. Indication of the price of mangos on the Senegal national market (FCFA/kg)

Marketing stage	Local varieties (Mango)	Improved varieties (2nd choice local market)	Improved varieties for export
Field side	25-35	50-100	200-250
Wholesaler popular market	50	150	
Urban wholesaler		200	300-350
Urban retail stalls and major roads		400	400-500

Source: SAGIC Senegal

Despite a national production which according to the FAO is around 82,000 tons, Senegal does not manage to meet local demand for mango (local varieties), or to meet its commercial commitments (export varieties). It therefore often has to import fruit from neighbouring countries, particularly Gambia, Guinea and Mali. According to the information collected during this mission, these quantities are held to be around 600 tons (based on 1994/95). However, we reckon these numbers are significantly underestimated. Mangos are imported into Senegal from the month of March, before the national production becomes available.

Senegal is a hub of agricultural trade in the sub-region, with several fruit markets, particularly that of Diourbel, a weekly fruit market where large quantities of mango, citrus and various other fruit can be found, arriving from Gambia, the two Guineas (Bissau and Conakry), Mali, Mauritania and other regions of Senegal. One cannot doubt that the amounts of mangos

traded by land are very important and represent a high risk of contamination for Senegalese orchards as a result of non-observance of phytosanitary regulations. Unfortunately, data on volumes and value of the overland subregional export trade from Senegal to neighbouring countries are unavailable.

5.1.4 The Senegalese export markets

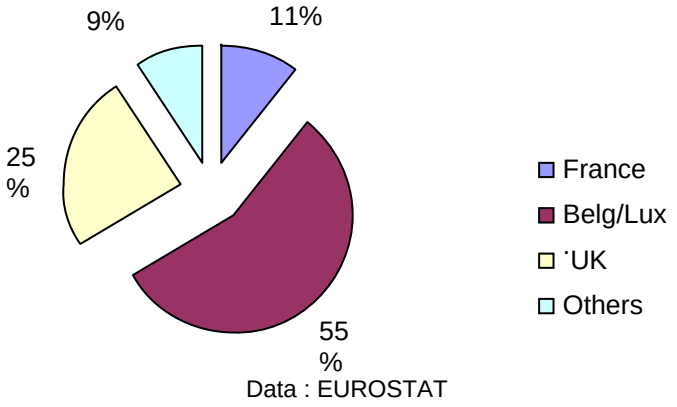
Dr Rey commented that the economics of mango are different in Senegal to the situation in other countries. The local market in Senegal is more valuable for producers than the export market is elsewhere. Local prices for Kent variety are from 80-200 CFA/Kg, but 200-300 for export quality. By comparison, in Mali Kent is sold locally for 25-60 CFA/Kg and 50-125 CFA/Kg for export and in Cote d'Ivoire 60Kg of late mangoes can be bought for 1000 CFA! In Senegal the "*circuit*" is less well organised, since in Senegal the exporter pays for all the fruit delivered at the packing station, so the labour, freight charges and fruit costs are more expensive. In other countries the pisteurs are only paid for those fruit that are accepted and only the best quality are acceptable, so they are careful to bring good fruit (e.g. in Mali, Burkina and Cote D'Ivoire). Senegal exported 6,000 t in 2006 (double the 2005 export crop). By comparison, Mali exported 3,500 and Burkina only 2,500 in 2006.

From May until the end of August, the market is stocked up with various mangos of big or small size, juicy and very fibrous which are not the object of exports to Europe but which supply the national and sometimes sub-regional market. These mangos are obviously attacked by fruit flies, without this significantly affecting the fruit trade. The damaged fruit are simply dumped and pest attacks thus lead to a decrease in the offer (and therefore in the food available for the population) rather than to a cessation of trade. The export varieties such as the Kent and Keitt are available, in season, from mid-June to the end of October. Unfortunately, problems linked to fruit flies or other phytosanitary hazards (anthracnose for example) generally prevent exports from extending further than August/mid-September. This results in serious income losses for export-orientated operators. In 2006 and 2007, the Association des Planteurs de l'Arrondissement de Diouloulou (APAD) has sold mangos to Radville in Gambia, for export to UK by boat from Banjul.

5.1.5 Senegalese exports to Europe

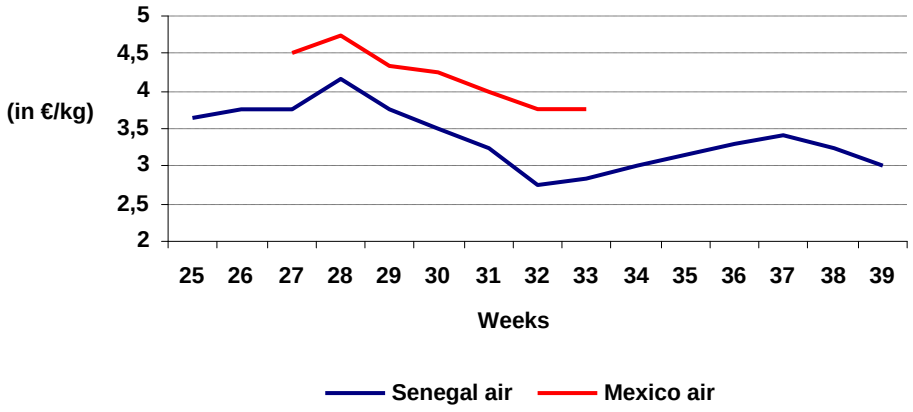
One should distinguish exports to Europe from those to other countries in the sub-region. The USA's market remains out of reach for the time being due to the treatments and procedures required for importing mangos there. The mango market in Senegal between 2002 and 2006, progressed from 1600 tons to over 7000 tons exported per year. Operators remain convinced that losses due to the fruit fly have prevented them from reaching the 10,000 ton objective they have fixed for the latest campaign. The main recipient of Senegalese mangos is the Benelux market with 55% of exports, followed by the United Kingdom (29%) and by France (11%) (**Figure 11**).

Figure 11. Mango exports from Senegal to the European Union in 2006



Data : EUROSTAT

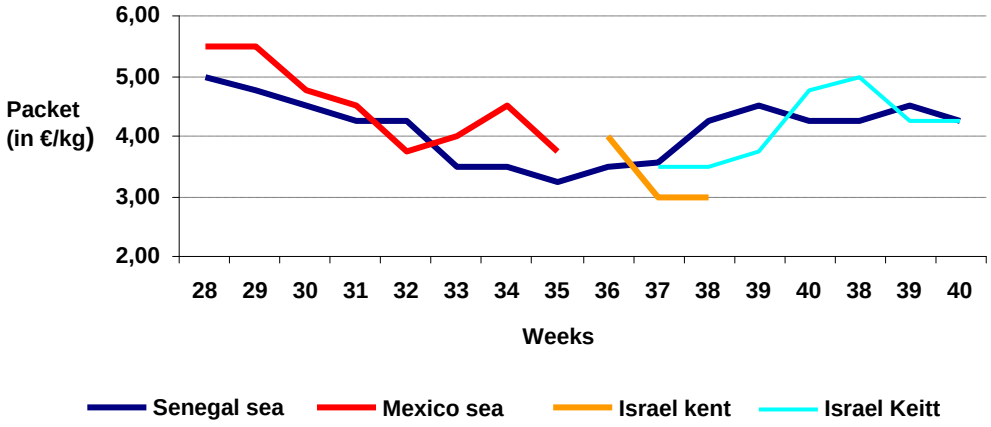
Figure 12. Average price of Kent mangos from Senegal and Mexico on the French market (2007)



Source: Pierre Gerbaud

Senegal represents a great opportunity for the European air transported mango market. Unfortunately, the Senegalese product suffers from an image problem, mainly due to the problem of frequent quarantine interceptions of consignments. This has an impact on the price received compared to competitors (**Figure 12**). All the seizures operated against Senegal due to the fruit fly were made on consignments sent by plane. As early as week 33, importers turned away from Senegal as a supplier. The explanation given was the risk of interception and the high costs linked to an interception. Only a few consignments were sent after week 33 by one or two exporters. They are the proof of the availability of mangos and the losses suffered by operators which as early as mid August cease to export to Europe.

Figure13. Average price of mangos (by boat) on the French market



(2007)

Source: Pierre Gerbaud

The situation is more or less identical for the sea freight mango market (**Figure 13**). During the latest campaign (2007), there were no seizures/destructions of container loads due to pest infestation. However, as early as week 35, exports from Senegal to the European markets were conducted by a single company. As dynamic as it may be, a single company cannot represent an entire commodity chain. This resulted in a considerable decrease of quantities exported as compared to the previous campaign, when Senegal exported around 170 to 180 containers. The early interruption of the 2007 campaign by operators fearful of losing money led to a decrease in volumes offered, amounting to less than 120 containers.

Table 18. Breakdown of export costs for a kilo of Senagalese mangos

	Operations	Mangos by plane Cfa/kg	Mangos by boat Cfa/kg
1	Producer price	225	225
2	Picking costs	25	25
3	Transport and bulking	20	20
4	Grading (triage) and packing	70	70
5	Transport and container loading	20	20
6	Putting in FOB	20	20
7	Commissions & other costs	75	75
8	FOB price – CFA/Kg	550	550
9	Dakar freight - Destination	800	150
10	Unloading - -warehousing	20	20
	Price in CFA/Kg	1.370	720
	Price in Euro /Kg (655 F Cfa=1€)	2.09	1.10
	Price in Euro /Mt (655 Fcfa=1€)	2.090	1.100

Source: SAGIC

5.1.6 Processing of mangos in Senegal

Mango processing is a central activity for many women's groups, often organised into Groupements d'Interet Economiques (GIE). Most of these groups are involved in dried mango production, using a combination of solar and gas-fired drying. This activity has been boosted by Taiwanes cooperation with the Government of Senegal. These groups are often affiliated to the Federation Professionelle de Agro-alimentaire (FP2A), an inter-professional which has more than 100 members involved in production, processing and export. A few organizations are involved in small-scale production of preserves, juice and sirop. APAD is

proposing to develop a juice factory with a capacity of 1000 litres/day at its packing station premises. Further details of processing capacity are given in Annex 3.

5.1.7 Mango producer and exporter groups and associated companies

Senegal has between 3,000 and 5,000 planters of mangos involved in production at various levels of technology. More than 40,000 persons draw their income from the subsector. Mostly these are orchards of 2-10 ha with a few large plantations exceeding 30 ha. These industrial operators number less than 300, including the company SEBI-MANGO, with more than 200 ha, which in 2004 accounted for 45% of exports from its own orchards. It should be noted that SAFINA represents 50% (approximately, but variable between years) of Senegal mango production.

More than ten associations and federations of producers exist, mainly based on geographical zones, such as Niayes and Casamance. These generally have similar functions, including organizing production and distribution, improving produce quality, negotiating contracts and prices and liaison with providers of training and finance. The regular exporters number 15-20 and are organised into two important inter-professional organizations of the subsector, Organisation Nationale des Producteurs Exportateurs du Sénégal (ONAPES) and Sénégalaise d'Exportation et de Service (SEPAS).

5.1.7.1 ONAPES

ONAPES brings together seven of the largest exporters, together representing 70 – 75% of the fruit and vegetables exports of Senegal and 80% of the mango exports. It plays an important role in negotiating with government and with the banks.

5.1.7.2 SEPAS

SEPAS[1] is a membership-based professional organization created in 1994 under an adminstrative council of six elected member representatives. It organises air and sea freight and facilitates market access including development of quality control mechanisms. It has the objectives of boosting quantity and quality of production, market access and training member operators. It is represented on the National Fruitfly Committee. Larger growers in Senegal buy from neighbours who don't have formal orchards. SEPAS supports harmonization and enforcement of regional phytosanitary regulations, effective policing of frontiers and rapid identification of pests (though this is admitted to be difficult). The fact that produce from Mali is sold through Senegal in June, before the Senegal crop comes on stream, and the presence of the important market at Diourbel drive these concerns.

SEPAS liaises closely with DPV, SAGIC and ONAPES and holds monthly meetings to discuss issues facing the market. SEPAS seeks to formalise and strengthen vertical coordination between producers and exporters. The process has reached different stages with different members, with Sanepro and Ets PDG among the leaders. Some do not produce for export every year while others have their own pack-houses. SEPAS networks with foreign buyers and facilitating organizations such as the Centre for Promotion of Imports from Developing Countries (an agency of the Dutch Ministry of Foreign Affairs). SEPAS is the focal point in Senegal for the Conference des Ministres d'Agriculture de l'Afrique de l'Ouest et de Centre.

[1] The team interviewed M. Doudou FALL, Secretaire executif, Senegalaise D'exportation de Produits Aricoles et de Services (SEPAS) and briefly met M. Alione Sow, President of SEPAS and also of Ets PAMI, one of its members.

5.1.8 Other export crops which could serve as hosts to fruit flies

5.1.8.1 Melon exports

Melon exports between 2000 and 2006, increased 50%, from 500 tons to over 760 tons. France and Spain are the first recipients of Senegalese melons, taking in respectively 56% and 32% of its exports (88% between them). These exports are also threatened by fruit flies, but probably not by *B. invadens*. Several important fruit fly pests of cucurbits occur in Senegal and some will certainly be reared in due course. These are shown in Table 6, and include *Bactrocera cucurbitae, Dacus veterbratus, D. bivittatus* and *D. ciliatus*. *D. punctatifrons* may not yet have been recorded in Senegal, but should be expected to occur.

5.1.8.2 Other alternative hosts of fruit flies

- citrus, mainly consumed in the sub-region and on local markets. The Senegalese offer is not competitive and does not correspond to European market demands; however, it serves for the national and sub-regional market. According to FAO data, orange production in Senegal approached 35.5 tons in 2006. According to the Senegalese Plant Protection Department (DPV), we know with certainty that after incubation in citrus fruit (orange, grapefruit, lemon and clementine), it has been possible to observe *B. invadens* as well as *C. cosyra.*
- sapodilla plums

No incubation has been attempted in Senegal and therefore no comparative data are available for: papaya, watermelon, cashew, sapodilla plum. Fruit flies are known to breed on a locally consumed wild plant, the mbeurbeuf or *Momordica balsamina* (balsam apple), The DPV told the mission that incubation trials would be undertaken in the near future to determine if these crops are the object of fruit fly attacks and, if so, to determine the species responsible for the damage observed. It would appear that lack of means is offered as the principal reason for the delay in determining with precision the other host crops which suffer from fruit fly pest attacks. However it should be pointed out that collection of fruit and vegetables and rearing out of flies uses very few resources. A survey could be commissioned for a few thousand Euros, using existing staff and facilities.

5.1.9 Estimates of fruit fly damage

In Niayes, Central zone and Petit Cote, the mean severity of fruit fly attack is estimated at 36-50% fruit loss. In the Casamance Zone it is estimated at more than 50% loss. In 2006 damage in Casamance exceeded 80% and the national average was estimated at 60%[2]

5.1.10 Research activities on fruit flies

In 2004 there was a problem of heavy damage to mango attributed to *Ceratitis cosyra*. The DPV signed an MOU with COLEACP/PIP and CERES-Locustox to carry out an inventory of fruit flies at Niayes which used Tephritraps either with trimedlure, terpinyl acetate or protein hydrolysate. This collected nine species of *Ceratitis*, one *Dacus* and two species of *Bactrocera*, including the first captures of *B. invadens* in Senegal, which was misidentified initially as *B. dorsalis*[3]. Fourteen fruit flies of economic importance are now known in Senegal. The DPV sent out a letter of information. Subsequent trapping by DPV in 2006 using methyl eugenol (ME) showed the dominant presence of *B. invadens*. Multi-lure traps were found to be more effective in the rainy season as they do not allow the entry of rain.

[2] Le Soleil, 18 Aug 2007. http://www.lesoleil.sn/article.php3?id_article=23945
[3] Vayssières, J.F., 2004. Rapport de mission sur l'essai « Piégeage de Tephritidae du manguier » au Sénégal, du 11 au 20 décembre 2004. Rapport CIRAD/COLEACP-PIP, 15 pp.

Comparative trials of traps with ME against traps baited with a local beauty cream "Net" showed that ME was superior. Various other preparations or plants (e.g. incense, nutmeg, basil) were also found to be attractive, usually because they contain some ME.

Incubation studies of mangos and citrus in cages by DPV during the 2006 campaign confirmed the host plant status of these plants for *C. cosyra* and *B invadens*, and similar studies were to be carried out during 2007 with a wider range of fruits. Sieving of soil from beneath mango trees is envisaged to determine the reservoir population of different species. (This could also be useful for determining if there is any indigenous parasitism, if the pupae of *B. invadens* could be separated from those of *Ceratitis* species and incubated in damp soil).

Most interestingly, M. Ndiaye of DPV indicates that tests are to be initiated of an isolate of the insecticidal fungal pathogen *Metarhizium anisopliae (*isolate ICIPE 20*)*, which is in culture at ICIPE. ICIPE is formulating this isolate as granules which can be scattered under mango trees in order to attack larvae emerging from fallen fruit and adults eclosing from puparia (Maxwell Billah, personal communication). The team was made aware that an organization run by the wife of the President of Senegal, Mme Wade, Fondation Agir pour l'Education et la Sante (FAES)[4], has previously been involved in mass production of the fungal biocontrol agent *Metarhizium anisopliae* (Isolate IMI 1330189) "Green Muscle" under license from LUBILOSA in Dakar. This is applied against locusts and grasshopper pests at 50g/ha. Constituents are: 0.7 litre diesel (*gazoil*); 0.3 l peanut oil; 50g Green Muscle. FAES is keen to obtain material of the ICIPE Metarhizium said to be effective against fruit flies. The national fruit fly committee is understandably wary of such a politically sensitive involvement.

Other research on monitoring and control strategies is being carried out by the University of Thiès and ISRA (see below).

5.1.11 Government agencies providing support for farmers and exporters in the horticulture industry

A fuller review of these institutions, including ITA (Institut de Technologie Alimentaire), DHORT (Direction d'Horticulture), ANCAR (Agence National de Conseil Agricole et Rural) and DRDR (Direction Régionale de Développement Rural) is given in Annex 3.

5.1.11.1 Direction de la Protection des Végétaux (DPV)

The team met with M. Mame Ndene Lo, Directeur de la DPV and President de Comité de Lutte Contre les Mouches des Fruits, who stressed the need for country-specific strategies to match differences in the structure of the mango sub-sector. Legislation needs to be harmonised between countries as an alternative to banning produce. He sees quality as a key issue in Senegal and stresses that concentration on exports must not exclude support for the local consumer. He favours action through Heads of State while ensuring regular scientific contacts and exchange visits within the subregion and with Egypt and Mediterranean countries.

DPV has prepared a TCP proposal for FAO which must not exceed 200 million FCFA (their first draft was for 330 million FCFA). This is called « Project pilote de surveillance et de lutte integrée extensive contre les mouches des fruits ». This covers only two mango-growing areas and does not cover staff costs, but only materials and equipment. The Logical Framework for this proposal is reproduced in the Senegal Country Report (**Annex 3)**. At the Minister's request, in September 2007, Mbaye Ndiaye and colleagues also prepared a

[4] (BP 6792, Route du Front de Terre, Dakar, Senegal; Tel +221 8592200; Fax +221 8592210; email aesante@sentoo.sn)

separate document for the donor meeting which is not specifically linked to one donor but addressed to World Bank, USDA, USAID etc. This would be a complete national programme and would have to have a Govt of Senegal component as well. The draft budget for the donor-financed elements of this complete national programme (amounting to some 2.025 billion FCFA) is also given in the Senegal Country Report (**Annex 3)**.

5.1.11.2 IFAN

The Institute Fondamental de l'Afrique Noire (IFAN) was previously a French colonial regional body which conducted research in anthropology and natural sciences in francophone Africa. Its staff built up and it still retains a major collection resource for insect identification (unfortunately somewhat peripheral to economically important groups). The current entomologist Dr Abdoulaye Ndiaye has been out of Dakar but was contacted by telephone. He is a member of the National Fruit fly Committee. He confirmed that some assistance was received from USDA with their collection maintenance and the start of an electronic database of the collection. This finance has ended and the database (a massive undertaking) is still incomplete. USDA's pest risk assessment has also involved IFAN but no details were available.

5.1.11.3 Université de Thiès, Unité de Formation et de Recherche en Sciences Agronomiques et Developpement Rural (UFR-SADR)

The Université de Thiès, Unité de Formation et de Recherche en Sciences Agronomiques et Developpement Rural (UFR-SADR), was previously the Ecole National des Sciences Agronomiques (ENSA), and is still known widely by that name. The Director of Studies, Dr Saliou Ndiaye, was the Moderator of the World Bank videoconference for Senegal. He was previously Head of the Plant Departments, including the Laboratoire d'Entomologie. Currenly one student is working on a six months project for the Ingenieur Agronome degree and 2 others are studying for the MSc with one year projects. A small Programme of research by students on fruit flies entitled « Etudes préliminaires sur les mouches téphritidae inféodées à la mangue dans la zone des Niayes » has been financed via SAGIC. Technical assistance is provided by a technician, as well as supervision from Dr J-Y. Rey and a post-doctoral fellow. Dr Pape Diedhiou was away at the time of the mission's visit and no information about his activities was gathered. The project outline and a progress report for July 2007 were given to the team.

Bactrocera was first identified from Senegal by Vayssières in 2004. Damage in 2006 was very severe but 2007 has been somewhat better. Students are experimenting at 5 field locations. Experiments include comparing trap insecticides (neem oil (200 ml/l in water with detergent), karate and telstar) in 18 traps, and different attractants. Alternatives include ME (3 traps)and terpinyl acetate (TA) (3 traps) as attractant. Other traps have different attractants including ME +TA together (3 traps), nutmeg (*muscade* - a source of ME); Secret attractant (SA) from Dow, Torula bait, "Net" – a skin cream made in Senegal. One field experiment is looking at applications of Dow's "Succes Appat" product (in Z-shaped spot sprays). This is a mixture of protein (secret formula) and insecticide which contains Spinosyn A and D (0.02%) as active ingredient.

Laboratory experiments are looking at fertility and fecundity from 20 males and 20 females on different fruits as well as duration time of development. Flies and parasitoids are also being reared from fruits in covered buckets in the lab. Students are contending with the usual laboratory problems of ant attack and *Drosophila* invasion of fruits. They appear not to have training in microscope use to investigate fly biology (e.g. ovarian condition). If they are to look at diapause in winter populations later this will be needed. In general it looks as if these are just student projects and both design and implementation would need to be

significantly “hardened” by closer supervision by a trained fruitfly entomologist if definitive results are to be obtained.

5.1.11.4 The Institut Senegalais de Recherches Agricoles - the Senegalese Agricultural Research Institute – ISRA

The team met Dr Macoumba Diouf, Director General of ISRA, but was unable to meet with ISRA researchers, specifically working on the fruitfly problem who are based in areas outside Dakar. Dr Jean-Yves Rey, the veteran mango agronomy authority, works for CIRAD and was previously in Guinea working with funds from the French Foreign Ministry. He is now attached to ISRA at Thiès, Senegal (where ISRA have no office). Dr Rey was promised a budget by ISRA of 2 million CFA which has not materialised as yet. He has a small budget from CIRAD and uses his own vehicle to take students to the field. He expressed concern about the cacity of DPV staff to actually carry through effective and sustained installation and monitoring of current field experiments on mango fruit flies. He has prepared a proposal to the Fonds National de Recherche Agronomique (FNRAA) to study fruit fly and fungal diseases of mango. FNRAA is a competitive funding mechanism financed by the World Bank under its Programmes des Services Agricoles et appui aux Organisations Paysannes – PSAOP. In the field Rey works with the Thiès students and they link up with the local activities of Encadrement Rurale (ENCAR) a World Bank-funded project. ISRA does homologation for PIP (COLEACP).

Dr Rey is concerned about the lack of knowledge of *Bactrocera* activity in the winter season and wants to put a fourth student (at Thiès) onto this problem. He sees movement of flies, dry season activity and the effect of first rains as important issues. Orchard hygiene remains the first defence against attack however. Trapping is very variable, with up to 350 males of *Bactrocera* per hour being trapped at peak times. He believes that leakages of sap from *gummose* (gummosis) on mango trees may contain methyl eugenol (ME), which would explain their attraction for male *Bactrocera* fruitflies. He has observed that Gummosis deposits sometimes cause flies to avoid being trapped by nearby ME traps.

5.1.11.5 Programme de Développement des Marchés Agricole du Sénégal. (PDMAS)

PDMAS is a World Bank project working with exporters to overcome critical quality constraints in the value chain. The accent is on quality control and GAP, in support of the national label “Origine Sénégal”. The project began in March and aims to have EurepGap certificatuion for mangos by year 5. Fruit fly is not a principal issue for PDMAS, but they are supporting trials of integrated control strategies by a consultant entomologist to be carried out on 20 hectares, 10 ha in two regions of Casamance and 10 ha in Niayes. Saliou Djiba of ISRA, based at Kolda will be involved (though since he is a public employee it is not clear if he is the consultant).

In an interview with Ndeye Coura Mbaye DIOP, Monitoring & Evaluation Specialist, and Youssoupha BADJI, Manager, it was not possible to get precise details of strategies to be assessed, though these apparently include local lures and familiar pesticides. It was stressed that all this would be done under the aegis of the National Committee and proposed methods would be checked by them. There are apparently links to the Societe d’amenagement des terres du Delta (SAED) and with ANCAR. It was not possible to clarify these in the time available. In the coming months PDMAS will propose to the World Bank that they should Validate the SAGIC Report as a basis for intervention in the mango value chain. PDMAS assumes that the needs of the internal market are similar to the export market, though less demanding: there is thus a need for competitiveness, quality, markets and storage.

5.1.12 Post harvest practices and quality management in packing stations

5.1.12.1 The equipment of packing stations and certified companies

There are over twenty packing stations distributed over the different production areas which belong to private landowners or are under common ownership. Of these perhaps half are well equipped and organised. Thanks to the help of projects such as the PPEA, and of programmes such as the PIP, some operators have managed to obtain the EUREPGAP/GLOBALGAP certification, but only a few operators are certified for their mango exports. Presently, Senegal numbers 9 companies which have obtained this certification, which implies investments in terms of company management and in the design of the packing stations. However, the PPEA has established a packing centre, the Feltiplex, equipped with modern infrastructure and which is about to be handed over for management by a service provider. Unfortunately, this efficient centre was constructed close to airport infrastructure at a time where Senegalese exports were made mainly by plane. The situation has changed since 2000. Faced with an increase in volumes and in air freight charges, exporters have turned to maritime freight, which has in a few years taken precedence over air traffic, to the point where the continued maintenance of the Feltiplex installations next to the airport may be in question.

5.1.12.2 The main phytosanitary constraints managed in packing stations

As described above (Section 4.7.1) mangos for export via ports or airports go through packing stations and are subjected to inspection and grading. The description given above relates to the packing station run by the PDMAS, whose management should shortly be handed over to a service provider. Although mango can be the target of several attacks, packing stations in Senegal mainly concentrate on fungal problems such as anthracnose and pest problems linked to the fruit fly. Research undertaken by the Cheikh Anta Diop University and the University of Thiès has indicated the presence of a fungus other than *Colletotrichum gloeosporioides* (responsible for anthracnose), whose attacks cause patches of brown rot. This fungus is currently referred to as *Dothiorella* sp., but its taxonomic position is uncertain and research is being conducted on its taxonomy in South Africa[5]. Apparently some degree of control is achieved by regular pruning. Pre-harvest control measures include copper oxychloride sprays and post-harvest control measures include postharvest hot water treatments and prochloraz (if permitted). Another promising control measure is said to be the use of biocontrol agents but no details have been obtained.

The problem of Mango mealybug (*Rastrococcus invadens*) has largely been dealt with through the introduction of two encyrtid wasp parasitoids by FAO and the DPV from IITA. The main quarantine problem now is presented by the fruit flies. Eight interceptions in 2005 and 7 in 2006 have led to the early termination of the annual campaign to avoid harming the reputation of the Senegalese mango.

5.1.13 Supply of Plant Protection Products

SENCHIM AG, based in Dakar, distributes the products of ICS (Industries Chimiques du Senegal), principally fertilizers, worldwide, as well as manufacturing at its own factory. SPIA (Societe des Produits Industrielles et Agricoles) is a pesticide formulator and dealer with an office also in Guinee. Both are large concerns producing more than 1 million litres of pesticides annually.

[5] Forestry and Agricultural Biotechnology Institute, University of Pretoria. http://www.up.ac.za/academic/agrirural/old/mango/disease/sbr.html

5.1.14 Government Phytosanitary control

The duties of the DPV are defined by Decree 00-3309 of 15 March 2000 in accordance with Decree No 3307 of 15 March 2000, dealing with organization of the DPV. These cover phytosanitary control of plant materials entering or leaving the country and organization of pest management issues within the country, including control of agrochemicals. As the official department in charge of plant protection, the DPV through its Division de la Legislation et de la Quarantaine des Plantes (DLQ), delivers the phytosanitary certificates for exports. The DPV agents are also in charge of the national plant quarantine system. Senegal is a member of CILSS and its pesticide registration law follows the regional legislation.

There are nine inspection points (airports, ports and land units) supervised by DPV agents. However, they are inadequately staffed and need both more and better trained personnel to reinforce border controls which presently remain too permeable. Current Senegalese phytosanitary legislation dates back to 1994. Since 1960, any plant material entering or leaving the country must be accompanied by a phytosanitary certificate. Unfortunately, certification does not always include visual inspection by a DPV agent. Very often, the officer in charge of inspection and certification trusts the operator whose interest, according to him, is to have sound merchandise. However, this assumption has been invalidated 12 times in 2007.

At the sub-regional level, the UEMOA is attempting to organise, following the example of the Sahelian countries in pesticide practice harmonisation, an efficient form of cooperation which would lead to phytosanitary harmonisation. But several problems appear to be blocking this initiative, including the fact that Senegal has not ratified the agreement.

Since March 2006 EU Regulation 530 has enabled five African exporting countries to undertake quality control in the source country (Kenya, Morocco, Senegal, South Africa and Zimbabwe(?)). This covers phytosanitary and commercial quality of haricots, tomatoes, mangos, melons asparagus etc. Decree 259 of 25 March 1999, covering phytosanitary inspection is being revised now. DPV extension agents make inspections at source and final verification is made at the airport/port. There is a pesticide residue control laboratory. It was mentioned that there is or was a small biological control programme in the South of Senegal but no details were obtained.

The DPV needs assistance with risk assessment for 5 products including tomatoes and mangoes. Apparently French beans (haricots verts) has been done. Anthracnose on mangoes by ship is a quarantine problem for Europe. The Prochloraz technique was developed in New Caledonia (20 g in 20 litres of water). This delays fungal development by 20 days, but the treatment is only accepted in France. Hot water treatment for fruitfly (47minutes at 55 degrees F) is not suitable for Kent and Keitt varieties because of their thin skins. Quality suffers. The Project de Promotion des Exports des produits Agricoles (PPEA) financed central facilities for fruit assessment and hot water treatment (*trompage*) but these are at the airport and 70% of exports go by boat. There is a Station de Conditionment at Sangalkam 10 kms N of Dakar. It was felt that staff need more training in quality control of mangos. There are said to be no chilling facilities available in Senegal. All processes happen at ambient temperatures.

The team met with M. Al Housseynou HANNE, Chef de Bureau, Controle Phytosanitaire et Qualite, Div Legislation & Quarantine, M. Seni DIEME, Head of Division Legislation & Quarantine, DPV, El Hadji Omar DIENG, Div Legislation & Quarantine, Dr Aliou DIONGUE, Div Legislation & Quarantine, and Kemo BADJI, Chef de Laboratoire d'Entomologie, all of the DPV. In several interviews they indicated that there were 76 destructions of mango

exported from Senegal to Europe between 2001 and 2004. Some examples of letters received from the French embassy were shown to the team. There were 35 interceptions of *Helicoverpa armigera* on green beans to Netherlands between 2000 and 2007 but these were reduced to a single instance in the last two years. There were some citrus interceptions and also some untreated pallets were rejected because of boring beetles. These need to be stamped with a special mark to show they have been treated. Quarantine Division has produced a small leaflet about their role.

There are said to be 9 phytosanitary posts in Senegal. These include Dakar railway station, the port and airport of Dakar, a post at 13 km from Dakar at Bargny and 5 frontier posts. Border posts include Kaolack, Ziguinchor (S to Guinea Bissau) and Tambacounda (SE, to Guinea). A specific problem for Senegal is the regional significance of the Marche de Diourbel which attracts vendors of mangoes throughout the region with the attendant risks of transhipment and local sales of mangoes en route to the market. 2 inspectors from Kolda have been transferred to Diourbel to address this risk. However there are still other routes of entry to Senegal which are not covered in their view

Concerns were expressed that the DPV needs to address issues of staff numbers and quality as well as operational budget. Fruitfly control is apparently done by the entomology laboratory (Kemo Badji). However identifications of flies have been done by Mbaye Ndiaye and El Hadji Omar Dieng, a senior technician who does rearing. Records of rearing *Ceratitis cosyra* and *Bactrocera invadens* from a number of wild hosts were mentioned but the species involved were not always clearly indicated. Wild hosts of economic flies mentioned include Notto (a cactus – presumably prickly pear), *Calotropis procera* (for *Dacus longistylus*), *Momordica*, Sapotila, etc.

The nine Sahelian country members of CILLS have developed a common text for phytosanitary legislation. Four countries have ratified this, but Senegal has not done so. In 2002 there was a 21 day meeting in Niamey under a Quality Project which proposed common legislation for the UEMOA countries. However for this to be finalised it will be necessary to have a joint meeting of the CILLS, UEMOA and ECOWAS/CEDAO and the member countries to obtain agreement. For importation Senegal needs a risk assessment based on an analysis which includes listing of species known to be present in Senegal and those known to be absent. This data is said to be presented for some commodities in a database (base de donnees =bd) on the Phytosanitary website <bdphyto.gouv.sn> However this website was not working on the day of our visit.

For exports the service follows the requirements of importing countries which includes an obligatory phytosanitary certificate for the EC. Senegal has had quality control certificates since 1994. Since 1997 there has been a Comité National de Qualité Intrinséque, with representatives from DPV and the exporters and with links to COLEACP PIP, for exports. Seven companies have EurepGap certification for cherry tomatoes and *haricots verts*, but none as yet for mangoes. In 1998 exports of mangoes were only 500 t, but in 2007 the figure was approximately 6500 tons. Informants believed this could easily be raised to 10-12000 t were it not for the fruit fly problem. Of an estimated 100,000 t of mangos produced, it was believed that 50-60% are lost due to fly damage.

5.1.15 Senegalese responses to the fruit fly problem

In response to the fruit fly invasion, in 2004 the Comité National de la Qualité Intrinsèque des Produits Horticoles d'Exportation initiated several meetings to define an Action Plan, which included: capacity builing for the SPS personnel (DPV),

- Awareness raising among produces
- The fruit fly inventory on fruits and vegetables

- Identification of authorised pesticides and their MRLs
- Development of an action sheet for producers (superceded by later productions)
- Training financed by PPEA

Producers, professional associations, USAID representatives, USDA, universities, and public and private partner institutions were brought together under the aegis of SAGIC in 2006 to form the Comité National de Lutte Contre les Mouches des Fruits. This committee developed an ambitious Action Plan which started with a fact-finding mission in the producing areas. The further aims of the Plan were to conduct an awareness-raising campaign using the media and produce a video film. A control programme aimed at creating sites of low prevalence was defined.

This involved orchard sanitation and deployment of male annihilation technique (MAT), spot spraying of food baits and use of plant attractants, as well as conventional chemical treatments (using diazinon as a soil drench), and even aerial spraying as a method of last resort. The plan also recommended reinforcement of phytosanitary inspection procedures and a programme of research and monitoring, including rearing from fruit and the use of pheromone traps to provide information on different species of fruit flies and their population dynamics.

The proposed research programme majored almost exclusively on sterile male technique, which is not regarded by USDA experts as feasible in Senegal, to the exclusion of more practical research activities. It also suggested researching varieties of basil in order to find natural oils for fruit fly control. This proposal is not regarded as a wise use of scarce resource funding by this reviewer. Pure methyl eugenol is easily available on the world market and should be imported as necessary (or eventually synthesised locally if the price is competitive enough). It is important to deploy attractants of maximum strength and reliable quality so that the effect on fruit flies is large and consistent, in order to measure relative population size and for use in lowering the population to below the economic threshold.

Subsequently the committee has been a means of keeping stakeholders informed of developments and linking producers' needs with technical and financial support. An illustrated field manual "Guide pratique de lutte contre les mouches des fruits dans les vergers de mangue au Sénégal" was produced in March 2007, under the aegis of the Fruit Fly Control Committee (Comité de Lutte contre les Mouches des Fruits de Sénégal). This was financed by USAID (SAGIC). A second manual dealing with the use of locally available materials for making traps and for attracting fruit flies was produced in June 2007. This was authored by Mame Niang of SAFINA who claims to have limited mango losses to flies on his own orchards to 3% while his neighbours experience 20% losses. This guide[6], also was financed by SAGIC.

Companies have experimented with preventive methods of control, such as early harvest and cleaning of orchards. One company, SEBIMANGO, started using monitoring traps and chemical control (partial or complete coverage). Field trials were also conducted by ISRA under the aegis of COLEACP/PIP of two pyrethroid insecticides for blanket spraying, plus Success Appat as a spot treatment. COLEACP/PIP also assisted DPV to mount demonstrations of the methods recommended in the manual published by CTA which appeared in mid-2007.

[6] Niang, M., 2007. Guide d'utilization des matèriaux locaux dans lutte contre les mouches des fruits dans les plantations de mangues. Guide Pratique No 2.

5.1.16 Activities of International donors

A more dertailed survey of donor-funded project and programmes in relation to the fruit fly problem is given in **Annex 3**.

5.1.16.1 US Agency for International Development (USAID)

The USAID Economic Growth Office in Senegal[7] has two programmes in the Natural Resources Sector, both of which are managed by International Resources Group (IRG). The first is an agricultural and NR Programme based in Kolda and Tambacounda (2003-2008), while the other is the Economic Growth Programme (Croissance Economique) (generally known as SAGIC) which is involved with developing private sector businesses. This began in 2005 and is scheduled to end in 2010. They see quarantine issues as a very important constraint and are especially keen to protect the Casamance region. They link closely to the USAID regional programme based in Accra Ghana. SAGIC (see below) works with the DPV and has scientific backstopping from Virginia Polytechnic Institute and State University in Blacksburg, Virginia, who also are involved in a locust project. USAID is discussing VT's future programme of fieldwork in Senegal[8]. A small project within the programme (La lutte contre les mouches des fruits) has run for five months and was due to end in Nov/Dec 2007. Together with USDA, USAID sponsored the visit of fruit fly control authority Serge Quilici (CIRAD, Reunion) in December 2006. For a summary of the findings of that mission, see Section 5.1.16.3.

5.1.16.2 Programme Croissance Economique (SAGIC)

USAID's Croissance Economique SAGIC programme assists the DPV and the Fruit fly control committee (as described above). The team was briefed on SAGIC activities by Massamba Diop (Sub-sectors and Value chains specialist) with Christophe Poublanc (Business Development Services Expert). This project has three sectors of which one is services for development of export businesses. This focuses on four value chains (Mango, cashew, bissap, artisanat) but is interested in helping others (e.g. gum arabic, dairy etc). It has identified and brought together key actors in the mango value chain and was involved in creating the national committee for control of the mango fruit fly which was seen as the key constraint to the subsector.

Considerable momentum has been maintained: 1st meeting of committee August 2006; national survey by Mbaye Ndiaye at three sites, September 2006; production of a film (Oct 2006); presentations at the Conference des Ministres d'Agriculture des pays de l'Afrique de l'Ouest et de Centre in Conakry (SAGIC sent Mbaye Ndiaye and Cheikh Ngane); commissioned Serge Quilici's visit and report (funded by USDA) and launched the National Plan of Action with an inaugural meeting (Dec 2006); Manuelle de Lutte produced by DPV in French and Woloff (March 2007); organised training of trainers (ToT) in Niayes zone in conjunction with the Cooperative de ONAPES with which SAGIC has an MOU and which selected the trainees. Also in the Niayes zone (which produces 80% of Senegal's mango exports), SAGIC has provided funding for activities at University of Thies (see below). It is not clear how these will be funded in the future.

SAGIC also focused on Casamance for a number of reasons. The fly was first found here and because of the high rainfall is more serious here than elsewhere. Also the value chain is less orgainised here. (Of course Casamance has also suffered a history of political problems and any potential danger of alienation from the central government would be regarded as

[7] Peter Trenchard was absent but his Assistant, Madame Aminata Badiane (Agriculture and NRM Specialist) briefed the team.
[8] Contact at Virginia Tech. is Larry Vaughan larryjv@vt.edu

serious). SAGIC works with l'Agence National de Conseils Agricole et Rural (ANCAR), through its Bureau Regional de Casamance. ANCAR networks with CARE.

5.1.16.3 Visit by S. Quilici to assist in defining a programme of IPM for fruit flies on mango.

The visit by Dr Quilici was made in December 2006 at the request of USAID/SAGIC to review the Plan of Action prepared by Ndiaye et al. (2006) under the aegis of the Committee for Control of Fruit Flies. He noted the structure of the Plan of Action which covered three main areas: 1, information/awareness raising; 2, control methods; and 3, support and applied research.
Quilici (2006) first noted that no single method in isolation will permit an effective control of this type of pest. The approach needs to be wide-scale in space and in time, and not confined to the periods when the flies are numerous. It is necessary also to consider the simultaneous control of *Ceratitis* spp and *Bactrocera invadens*, since one will replace the other if both are not controlled simultaneously. The objectives of the control programme must be clear and realistic. These are: 1, to aim at total absence of damage in fruit exported and 2, a very large reduction in levels of damage in fruit for local consumption. Dr Quilici proposed for 2007 two pilot areas, one in the principle mango export production zone of Niayes, and one in the semi-natural "mango forest" of Casamance.

In Niayes the proposed pilot would concentrate on half of the zone (c. 675 ha). A monitoring trap network should be set up, covering each orchard, with at least four traps per farm, two with TA for *Ceratitis*, and two with ME, for *Bactrocera*, using commercial attractant "amulettes" which last for around two months. DDVP insecticide blocks would need to be renewed monthly. Two traps, each with Torula yeast bait pastilles (with borax) dissolved in 200 mls of water, renewed weekly. The control strategy would involve:

- Prophylaxis in orchards by bagging or burial of damaged fruit
- use of MAT/TEM blocks throughout the year;
- localised bait application from March to November with weekly application of Success Appat (pending results of any alternative localised baiting method).
- Potential corrective treatments by blanket application of registered insectcides (as a last resort), depending on trap catches.
- Biological control using *Fopius arisanus* in the nearby "reservoir areas" not treated with insecticide. See Section 4.6.6.2 for a brief review of the comparative advantage of this parasitoid.

In Casamance where most mangos are destined for local consumption, it would be appropriate to have a higher threshold for economic damage requiring intervention. In this region the control strategy would be:

- Prophylaxis in orchards by bagging or burial of damaged fruit
- Priority release of *Fopius arisanus* (if deemed suitable in terms of its climatic preference)
- use of MAT/TEM blocks
- localised bait treatment adapted to tall trees

Short-term Applied research needs identified by Quilici (2006) include:

- The need to identify the geographical distribution and host range of the fruit flies affecting fruit and also vegetables (cucurbits and solanaceous plants). This could partly be derived from the network of monitoring trap catches (the attractant traps, not the bait traps since the insects caught in the latter are largely rotted by immersion in the liquid bait). However the best way of obtaining relative damage data for crops by different species is by rearing them with 12 isolated in single boxes, and the remainder kept together as a grouped sample. In considering vegetables it would be desirable to set traps with latilure as attractant to check for the arrival in West Africa of *Bactrocera*

latifrons, recently detected in East Africa. See Section 4.5.3 and Table 6 for details of this pest.

- Seasonal occurrence of different species of flies would be revealed by weekly trapping results from a trap network using several different lures and extending throughout all the main fruit production areas in different climatic zones. Traps should be placed where no insecticide treatments are expected. At the same time observation on the presence, abundance and fruiting dates of potential plant hosts in the vicinity of traps would permit evaluation of their possible influence on fruit fly numbers.
- A simple experiment was recommended to determine the appropriate depth at which to bury damaged fruit, by digging holes and covering fruit with differing amounts of soil and detecting emergence in cages placed over the buried fruit.
- Simple experiments were also described to compare the effects of block size and thickness, material used, strength and ratio of ME to insecticide, duration of impregnation, and type of insecticide[9]. The ideal comparison at present would be to compare spinosad (novel) and malathion (traditional), since spinosad is expected to have much lower non-target environmental impact. See Sections 4.6.3.4 and 4.6.3.5 of the present report for discussion of the issues involved. Both efficacy against flies and non-target effects against other arthropods can be assessed by hanging a funnel and a plastic tube half full of alcohol beneath traps.
- Research is needed to optimise the use of Success-Appat and the volume of active ingredient and mixture required per hectare. In parallel with this, the various commercial baits (listed by Quilici) could be compared in traps in orchards with each other and with Sccess Appat.
- At a more complex level a study of gels used to thicken sprayed baits to increase their longevity could be undertaken to optimise effectiveness, especially during the rainy season (perhaps at IITA).
- At a local level there is a need to develop baits based on local protein sources (especially brewery yeast residues, which can be autolysed by enzymes such as papain) to produce cheaper baits which are comparable with commercial ones, as has been shown in the Pacific islands and in East Africa.
- Evaluation of losses needs to be undertaken using a more precise methodology (based on quantitative fruit sampling and inspection, with rearing of flies from damaged fruit). This would allow us to know the level of damage in different zones and by varieties and method of control used for protection.

Medium-term Research needs identified by Quilici (2006) were:

- Studies of population dynamics are needed over several years to bring to light the influences of climate, host plants on different species (also competition and the effects of the control strategy). This would be based on the trap network and fruit host collection and rearing.
- TEM can be adjusted using different block densities per hectare to determine economic befit/cost ratio and further insecticides could be evaluated as alternatives to malathion.
- Localised treatments: methods of application can be compared and different baits (treated yeast + insecticides, hydrolysates + insecticides, Success-Appat).
- Use of natural products could also be investigated (as suggested by Ndiaye et al., 2006)
- Biological control of pest tephritids requires that an inventory of species present in Senegal be made. If *Fopius arisanus* is introduced then it will be necessary to follow its dispersion and impact on the fruit fly species of economic importance.

[9] In the final days befoe he became ill, the late Dr John Stonehouse prepared a summary of the work that has been undertaken in recent years on strength, size and spacing of MAT blocks in India. See Stonehouse, in preparation, in the bibliography. It is hope that this will be published in due course as a basis for similar work in West Africa.

- Entomopathogens. Dr Quilici suggests that an assessment is needed of the work already done by ICIPE on *Metarhizium* and *Beauveria* on Tephritidae. After importing the most promising strains, their pathogenicity to *B. invadens* could be assessed in the laboratory. He proposes that work could be developed on "self-inoculation" by use of traps with ME + spore formulations to contaminate males. (This is only one of the approaches used by ICIPE, the other being use of granular formulations applied to soil under trees to kill pupating larvae and emerging adults – see Section 4.6.6.3).

Costs of control operations and research needs were considered by Quilici in outline, noting that the costs of communications needed were not available. He referred to a costing for pesticides for cover spraying prepared by ONAPES (not seen by the Scoping Study mission). In addition COLEACP/PIP should have costings related to the pesticide evaluation trials they have financed in recent years throughout West Africa. Ndiaye (2007) has also attempted a budget for a more ambitious large-scale national programme in Senegal covering 4000 hectares (See **Annex 3 -** Senegal Country Report).

Quilici (2006) produced an approximate cost for the materials needed for MAT/TEM and for localised bait applications per hectare and across the entire growing area of Senegal (see **Box A**, below). He estimated unit cost of MAT blocks as 507 FCFA each (0.77 Euro), whereas Professor Mumford (personal communication) estimated the cost at 0.24 per block or less. See Section 4.6.3.2 and Table 12 for details. In any case, even if Quilici's figures are high, it is evident that male annihilation is much less expensive than bait applications.

If a biocontrol programme was to be undertaken in Senegal, then some capital costs would be needed for rearing rooms and their equipment in addition to running costs and consumables. In relation to applied research, Quilici proposed the endowment of a number of studentships (MSc, PhD) at the University of Dakar or ENSA, perhaps with co-supervision by CIRAD, if desired. Equally in considering possible partnerships, M. Quilici tentatively offered that M, Rey of CIRAD, based with ISRA at Thies could act as a coordinator for the research programme in support of a control programme, if that was desired by other partners. In that event funds would be needed to cover his travel costs. Quilici also proposed a number of possible study visits to enable partners in the control and research activities in Senegal to learn about the current "state of the art" in other institutions and regions, such as the research work at CIRAD in Réunion (local partnerships for fly control, bio-ecology of flies) and at ICIPE (natural enemies, entomopathogens) in Kenya was suggested, together with a possible visit to the US to see large-scale elimination programmes against *Bactrocera*.

5.1.16.4 United States Department of Agriculture (USDA)[10]

The United States Department of Agriculture's Animal and Plant Health Inspection Service (USDA - APHIS) has quarantine-related personnel embedded with US missions throughout Africa. The Ministry of Agriculture requested assistance two years ago with the fruit fly problem because of the drop in mango production. USDA responded by requesting a point of contact trained in fruit fly management. M. Mbaye Ndiaye had been trained to MSc level in Taiwan, so USDA sent him on an IAEA SIT course in Florida in 2005/6 (report available). He is now the APHIS focal point under an MOU between DPV and USDA. USDA is obliged by MOU to work with DPV, but feels that research is best facilitated at present through the group at Thiès. USDA provided traps for Thiès (Dr Saliou Ndiaye's group) under the USDA safeguarding program and was criticised by DPV for not going through them. This is seen as indicative of DPVs poor attitude to cooperation.

[10] Dr Raphael Coly, the Agricultural Specialist, was not available for discussions but very full information was kindly provided by Dr Cheryl M. French, Assistant Regional Director, Africa.

USDA regards Massamba Diop of SAGIC as their main fruit fly resource person. Dr Cheryl French had commented that her view of the National Plan document produced earlier was that it suggested an attack on all fronts simultaneously. She expressed herself as uncomfortable with a large general programme concept and felt the capacities of DPV were more suited to a pilot project validating technologies for scale-up. . USDA has also paid for two visits by Dr Mervyn Mansell of USDA South Africa (previously with the Agricultural Research Council (ARC) of RSA) who covers quarantine issues in RSA and Mozambique. Dr Shawn Robertson was USDA's pest risk assessor for West Africa and was previously based with the USAID group in Accra, Ghana. Unfortunately he has just left Ghana. However his draft PRA for importation of mangoes from Senegal was supplied to the team by Dr French.

Senegal has requested to export melons, asparagus, cherry tomatoes and mangoes to the US. Under the AGOA Act pest risk assessments are required. Counties may offer their own PRA, but these must be checked by the Centre for Plant Health Science and Technology at Raleigh, N. Carolina. The National Committee has asked USDA what they would like to do in Senegal in future. They are not interested in alternative wild hosts etc or economic studies of the mango crop, but would prefer to focus on mitigation methods for fruit fly infestation and testing and implementing baits, traps and lures for fruit fly control. A possible model is presented by the Fruit fly Initiative in Tanzania, but no details have been seen by the team.

Incidentally USDA suspects from discussions with growers that some reports of fruit loss (early fall) attributed to fruit fly may actually be caused by Mango seed weevil, *Sternochetus mangiferae* (F.), which is present but under-reported in West Africa and is also a quarantine pest for the US. USDA does not consider that SIT is feasible in Senegal for reasons of lack of area isolation and compliance control issues. Notwithstanding this they recommend Pedro Rendon of IAEA as a resource on field control of fruitflies. The USDA medfly program in Guatemala also has people with relevant knowledge. In the private sector in Senegal, Dr French recommends Cheikh Ngane as the most technically competent informant. The US has not yet prepared a mitigation plan for potential *Bactrocera invadens* introduction. However an Action Plan was prepared in June 2002 covering other invasive *Bactrocera* species by USDA and Florida State University.

5.1.16.5 COLEACP/PIP Task Force

Faced with the importance of the fruit fly problem and to respond to the various sanitary and phytosanitary requirements of the European Union, a "Task Force" was established in Senegal. This is a platform where the different actors of the mango sector (institutional, private operators, researchers and financial backers) can meet and set up actions to help the sector develop itself. It is composed of about thirty members. Within the framework of its activities across the different Task Forces, COLEACP/PIP conducted several field trials on chemical compounds and trapping systems in Senegal. Within the framework of the Task Force, the principal actions have been:

- A demand for strengthening the survey and pest management capacities of the DPV and the Centres d'Avertissement Agricoles (Centres for Agricultural Alert). However, the DPV lacks both human and technical resources to undertake these surveys. Besides, the idea according to which we should reinforce the authority of the DPV appears difficult to put into practice in the present context (agents unable to identify quarantine pests, methods and methodologies of survey).
- Raising producer awareness of the problem. It was achieved thanks to an aggressive communication campaign with varied media instruments (television and radio spots aired in French and Wolof).

- Inventory of the flies present in the territory and their associated risks from an economical point of view. 14 species of flies presenting a serious economical threat have been identified. 9 of these species are generally found on fruit and 4 others on vegetables.
- Identification of the products authorised for treatment (with their thresholds of tolerance and their Maximum Residue Limit (MRL).
- The elaboration of instruction leaflets intended for awareness raising and for producers.
- Vocational training people involved in the mango sector initiated and paid by the PPEA. This concerned mainly orchard management (pruning, tree and orchard maintenance) and training for collectors (*pisteurs*) and inspectors (*trieuses)*. The PPEA called on professionals from the Ivory Coast recognized for the quality of their work to reach these objectives.

The members of the task force are also considering other types of action which should according to the data obtained, lead to:

- The creation of a fly trap monitoring network. This network could, at first, rely on agricultural and rural advisors as well as on technicians from large plantations, all trained to recognise *B. invadens* and to set up fly traps.
- The centralisation of the information on a weekly basis (or more frequently) within an EWS (Early Warning System).
- Engaging in coordinated pest control based on clear plant protection recommendations.
- Distributing instructions in relation to the treatments to be carried out in the targeted areas with appropriate products.

5.1.17 Difficulties and constraints in fruit fly management

This list is not exhaustive, but focuses narrowly on issues specific to fruit flies. For a more detailed assessment of the problems of the mango export industry, see **Annex 3**. In general Senegal is better resourced both in terms of organization of the mango subsector and in development assistance (especially World Bank and USAID) than other countries. This requires that national stakeholders should work effectively in partnership with one another.

1. Senegal has different types of orchards in different areas, including large modern orchards producing for export in Niayes and smaller semi-natural parkland orchards mainly for local consumption in Casamance. The latter are widely distributed without clear boundaries to production areas. Many trees are very large and senescent. Varieties are usually mixed. There is little or no maintenance and access for removal of fallen fruit (or for bait applications) is difficult. Economic requirements for control differ and pest management needs to be sustainable (see Quilici (2006) summarised in Section 5.1.16.3.

2. There has been no recent survey (by rearing from damaged fruit) of fruit fly species incidence in different zones, on different varieties, and at different times of the year, to determine the current relative impact of the main fruit fly species after the arrival of *Bactrocera invadens*. Initial estimates of damage are very approximate.

3. There is limited access to supplies of materials needed for IPM in fruit trees (traps, lures, baits, pesticides, instruction manuals).

4. There is limited national capacity for identification of fruit flies of economic importance with heavy reliance on occasional external interventions by CIRAD and back-up from the Royal Museum of Central Africa in Belgium. One member of the DPV staff (M. Ndiaye) has already been trained at Tervuren, but has extensive operational duties.

5. There is a lack of adequate training and equipping of phytosanitary inspectors for checking of fruit consignments and in carrying out surveillance to prevent importation of exotic pests.

6. There is very limited scientific information on the impact of fruit flies on other crops apart from mango (e.g. cucurbitaceous and solanaceous vegetable fruits), nor the species responsible for the damage. It will be especially important to evaluate the current fruit fly threat to melons and to cherry tomatoes which are exported.

7. In the context of handling fallen fruit for fruitfly rearing and estimation of damage caused by fruit flies, some screening should be undertaken by DPV (with assistance from USDA if necessary) to check for presence of mango seed weevil (*Sternochaetus*) where this can reasonably be done without incurring additional costs.

8. The eventual scope and activities of the FAO project proposed by DPV are as yet unclear, as is the current status of the very ambitious large scale project proposal prepared by DPV (Ndiaye, 2007). USDA's planned future involvement is also uknown at present. It will be important to avoid duplication of effort in planning any new EC intervention related to fruit flies.

9. Observers have expressed concern at the seemingly proprietorial attitude of the DPV in relation to fruit fly control and research activities. It is essential that all stakeholders recognise the need for genuine partnership and mutual facilitation and assistance in serving the national interest. Roles need to be clearly defined at the level of individual interventions on the ground, but should be flexible in relation to the overall battle against the fruit flies. Conversely there is a danger in seeking to maintain control of functions which it may not be possible for a single organization to discharge adequately. Regular field monitoring arrangements must be robust and collection of scientific data or maintenance of control must not be compromised by poor planning and unrealistic work plans.

5.1.18 Proposals for a National Action Plan: Senegal

A Regional Action Plan (Section 7) has been developed in parallel with National Plans, to ensure effective division of responsibilities and work. Some items in a National Plan need to be in place in all countries (see item 1, for example).

1. Creation of a National Fruit Fly Planning Body

Government and the horticultural industry have already established a joint planning and consultative body (Comité National de Lutte contre les Mouches des Fruits) which has overseen the development of a National Action Plan for Management of Fruit Flies. However the action plan needs to be redrafted to take account of the suggestions offered by Dr S. Quilici (CIRAD, Reunion). The need to adopt different strategies in different areas and to maintain both control and monitoring activities throughout the year, as well as coordinating a significant research programme, argues for selecting pilot areas of limited size, as proposed by Quilici (2006).

2. Research

The research community in Senegal (ISRA, Universities) needs to be perceived as a service provider to the horticulture industry. The implications of this are that funding should be by grants for specific work based on preparation of a concept note or a methodology in response to a call for proposals, followed by a detailed plan of the research with clear time frame and quantified outputs. Results of research should be reported rapidly to the National Committe and should be externally assessed before release of further funds. The list of

research topics below and the short term research needs proposed by Dr Quilici (see summary in Section 5.1.16.3, above) is not exhaustive but deals with some pressing concerns. These items should be seen as priorities.

(a) Assessing damage to mango by individual fruit fly species
A monitoring activity should be carried out by rearing larvae from fallen fruits collected in the orchards, which is the sole method of quantifying the proportional levels of damage attributable to the different species. Since the MAT/TEM technique is likely to play a major role in future control programmes against *B. invadens*, and because the MAT attractant methyl eugenol (ME) is highly attractive to this species, but not at all attractive to the *Ceratitis* species, information on relative damage levels of *Ceratitis* and *Bactrocera* is essential for planning future campaigns. The aim should be to take samples of infested fruit at intervals throughout the season (e.g. monthly) in several different areas, representative of the range of temperature and humidity across all the mango-growing zones. The only materials needed are plastic containers, sand, infested fruit and mosquito gauze.

(b) Evaluation of control methods
A programme of evaluation of control methods (*méthodes de lutte*) should be started, assessing several methods, including spot spraying with baits (including GF-120) and MAT (technique d'eradication des Males - TEM). Fibre board or wooden blocks (plaquettes) impregnated with parapheromones (in particular methyl eugenol) and a toxicant, are effective against males of species closely related to *B invadens* in Asia, but their effectiveness needs to be demonstrated against *B invadens* in West Africa. See **Box A** for a detailed costing (on per hectare basis)for materials needed for a pilot programme of integrated pest management which should be put in place and monitored by researchers with the participation of DPV local field agents and representatives of producers organizations. See also Section 5.1.16.3.for further discussion.

<u>All of these research activities will benefit from regional cooperation.</u>

(c) Surveying fruit fly species composition and damage levels on vegetable fruits
Surveys of cucurbitaceous and solanaceous vegetable fruits are needed to determine which species are present and the level of losses they inflict. Again this needs to involve sampling of produce and rearing of flies for identification, especially on melons and cherry tomatoes, which are export crops.

3. Procurement of supplies for pest management and IPM capacity building
Government (and donors and external partners, e.g. CIRAD) should avoid becoming seen by growers as the providers of inputs for fruit fly control, except for pilot or experimental purposes. Since it is necessary to promote monitoring and control methods using baits (*appâts*), traps and para-pheromones, it will be essential (1) to find sources of supply of these inputs so that producers can buy them and (2) to devise financial instruments to allow them to purchase them (for example financial guarantees for loans to purchase inputs before the start of the mango season). It is also necessary that the physical inputs and the necessary instructions for using them (extension, training) should arrive at the same time, so as to link together the inputs and the information. Ideally a training of trainers (ToT) approach should be used to equip a cadre of trainers from the industry associations to ensure that their farmers are fully capable of applying the methods in their own orchards.

4. Fruit fly identification capacity and reference collection
Senegal needs to be able to identify all likely fruit fly species which may be found on fruit and vegetables, especially in view of imminent quarantine threats to the country (see Section 4.5). This will be best achieved by training senior technical staff of DPV, IFAN and ISRA (not managers), provision of database information and manuals and the designation of a single

national clearing house for identification which will maintain a reference collection on behalf of the horticulture industry (probably IFAN?). Such facilities must not be seen as an end in themselves but as a practical service provider to the industry. Basic storage facilities are needed including a room which can be kept air-conditioned as a collection room and laboratory to prevent deterioration of insect reference collections. Airtight insect pinning boxes are also essential.

5. Capacity building for the quarantine service

Specialised training, part theoretical and part practical needs to be designed and delivered to inspectors of the Phytosanitary Service of the DPV, to enable them to meet their obligations in pre-export inspection of fruit, especially mangoes. A quite separate module of training is needed to enable inspectors to assess incoming fruit and also to operate a system of sentinel traps at border posts and fruit markets. Their working conditions will also need to be improved with better equipment and facilities for SPS inspection and diagnosis, both at exit/entry points and at the post-entry centre. They also need access to current literature and manuals, including internet access.

Regional Issues:

6. Pesticide Registration

Registration of pesticides and other inputs for IPM is an important regional issue. If there will be any changes in the requirements of importing countries (e.g. the pesticides specified for MAT/TEM or baits (appâts), a rapid response will be needed. At present GF-120 is undergoing registration for localised treatment, but MAT/TEM blocks with malathion, fipronil or spinosad also need to be registered as a specific use. Since Senegal is a member of CILSS it can contribute data to the regional registration process from its field trials.

7. SPS Regulations and regional phytosanitary harmonization

ECOWAS has committed itself at the workshop meeting of May 2007 to achieve regional SPS harmonization by 2008[11]. Senegal will need to ensure that its national SPS regulations and procedures meet the new standards set by ECOWAS/CEDEAO regulations.

8. Upgrading inward quarantine surveillance

Quarantine and phytosanitary defence against the arrival of further exotic fruit fly pests such as *Bactrocera zonata*, which has already reached Libya and Egypt, are issues probably better managed at regional level. See Section 4.5 and Tables 5 and 6 for an indication of the importance of this issue. However, at national level, as noted by Bonfour (2006), it is important to develop pest risk assessments for specific quarantine threats (such as the species of *Bactrocera* currently present in North East Africa and Arabia). This is a requirement of the WTO and IPPC as is the development of national lists of pests present and not present in the country. In relation to fruit flies, assistance can be provided by reference to the databases maintained (and recently updated) by the Royal Museum of Central Africa in Tervuren, Belgium, who have the capacity to provide quarantine lists for fruit flies for all West African countries if national research and control staff (and staff of IITA and ICIPE) are prompt and transparent in reporting new records and in sending voucher specimens for verification by the international specialists concerned (Dr I. White and Dr M. De Meyer).

[11] ECOWAS Commission, 2007. ECOWAS SPS Regional Harmonization Workshop for non-UEMOA countries. Final Report.

Box A

Preliminary Estimates of Costs/hectare for the Male Annihilation Technique (MAT/TEM) and for Localised treatments (in FCFA)
(Source: Quilici, S., 2006).

1: Elements of the calculation:

MAT/TEM:
Blocks 5 x 5 x 1.25 cm, Impregnated with 12 ml of a mixture of methyl-eugenol (9 ml) + malathion 96 % ULV (3 ml). Density of blocks 10 /ha. Duration of action: 2 months
(6 renewals per yr).

Estimations made:
1 l methyl-eugenol = 70 € = 44,444 FCFA
1 l malathion 96 % ULV = 2,500 FCFA
1 block = 100 FCFA

Localised Treatments:
Localised application of Success Appât (spinosad + food bait), renewed weekly between March and November. Total: 36 applications / yr

Estimations made:
Cf. document « Plan d'urgence » (Comite de Lutte Contre les Mouches des Fruits, 2006).

2: Estimated Costs / ha:

	Unit cost	**Cost / ha for one application**	**Cost / ha / year**
MAT/TEM	507	5070	30 420
Localised Treatments	1400	1400	50 400
TOTAL			**80** **820**

Estimated cost for application of specific control programme (excluding costs of application and labour):

- across the entire zone of Niayes:
  80,820 x 1350 ha = **109,107,000 FCFA**

- across all the mango production zones in Senegal:
  80,820 x 6000 ha = **484,920,000 FCFA**

These estimates are to be revised once the real costs of products landed in Senegal become available

5.2 National Situation Synopsis: THE GAMBIA

The Republic of The Gambia is situated between 13º04' and 13º05'N latitude, and between 12º47' and 16º50'W longitude on the Atlantic Coast of West Africa, bordered on three sides by the Republic of Senegal and stretching for about 400 kilometers along the banks of the River Gambia with an average width of 30 kms. The River Gambia bisects the country into North and South banks. The natural drainage of The Gambia is centered on the River Gambia and its tributaries. The river Gambia, which is over 680 km long, originates from the Fouta Djallon highlands in Guinea and flows westwards through The Gambia, into the Atlantic Ocean.

The River Gambia drainage system is characterized by permeable soils, low topography, imperfectly drained depressions and drainage channels, which inhibit runoff from the main river. The Gambia has four major landscapes, viz.: the floodplain, the colluvial slopes, the lower plateau and the upper plateau, with different types of soils. The soil types range from fine textured (clays, silty clays and clay loam) to very shallow coarse-textured soils. The wide continuum of soils supports the production of diverse crop varieties

5.2.1 Agro-ecological zones and land-use in the Gambia

The Gambia is situated between the Guinea savanna zone and the Sahelian zone varying in rainfall from semi-arid (600-1,000 mm per annum) inland, to sub-humid Guinea Savanna (more than 1,000 mm per annum) at the coast. The humid and rainy season lasts from July to October with peak rainfall in August. The dry season lasts from late October to end June. Daily temperatures vary between 14ºC to 40ºC. Temperatures are high from March to June, average from June to November and low from December to February. The western Region experiences 4-5 months of rainfall, while the eastern Upper River Region experiences 5-6 months of rain. The country is divided into three distinct agro-ecological zones: 1, Western & Lower River Regions (Guinea Savanna); 2, North Bank Region (half of this region is characterized by Sudano-sahelian); 3, Central & Upper River Regions (Sahelian).

5.2.2 The Gambia's Natural and Productive Resources

The Gambia is a very small country with very limited productive resources. It has a total arable land area of 558,000 hectares of which 290, 000 hectares (52 %), is already put under production (NASS, 2004). The Sudan Savanna which occupies the drier areas in the eastern and northern parts of the country has lower grasses and trees the majority of which do not exceed 15 meters, and are mostly small-leafed and thorn bearing. It is characterized by extensive areas of marginal land with lateritic ridges and shallow soils. There is relatively little undisturbed vegetation in The Gambia and open parkland dominates much of the country, with small groups of well-grown trees. The rest of the country is characterized by tall shrubs and low tree canopy which are secondary fallow vegetation and most often of less than twenty years growth. Salt-water mangrove swamps and fresh water swamps occur adjacent to the river and its creeks, and coastal sand dunes.

5.2.3 Agriculture in The Gambia

The Gambia is one of the most densely populated countries in Africa with a total population of 1,364,507 inhabitants (2003 Population Census) and 128 inhabitants /km² in 2003. About 63% of the population is rural with 37% urban. Urban population growth is around 8% per annum due to rural-urban drift and internal migratory flows into Western Division and Greater Banjul Area (GBA). The Gambia remains predominantly an agricultural country with the sector contributing in the past 40 percent to GDP but this has declined to the current level of between 20 – 29%. Agriculture provides employment for more than 75% of the labor force of

which two thirds are women. It is the main source of livelihood for the rural population and for the majority of households below the poverty line. The main cash crops are: groundnuts, cotton, horticulture, sesame and livestock, while cereals such as millet, sorghum, maize and rice are used mainly for subsistence. Horticultural production is concentrated in the peri-urban areas and contributes about 4.2% to GDP. More than 95% of the domestic export earning is realized from the agricultural sector.

Gambian agriculture is predominantly rain-fed. To date, only 1,500 hectares are developed for irrigation. Only two commodities (rice and horticultural crops) enjoy some established system of irrigation. Irrigated rice production is supported by Government and is concentrated mostly in the Central River Division, while irrigated horticultural production is concentrated in the Western Division. This allows year round production of rice and vegetables although on a very small scale.

5.2.3.1 Fruit and vegetable production in The Gambia

In much of Africa, the dominance of large exporters has given rise to growing numbers of large, commercial farms. As competition has intensified, many small and medium-sized exporters have shifted to growing crops for the large exporters rather than shouldering the risk of exporting. In The Gambia, close to one-third of export farms sell the majority of their produce through Radville Farms, which is owned by a transnational corporation with an import subsidiary in the UK. This trend is likely to continue as more and more large commercial farms find it difficult to secure overseas market contacts and air cargo space in a market which is mainly dominated by Radville (Dolan and Humphrey, 2001).

The range of fruit produced for local consumption is wide, including mango, papaya, melon, watermelon, egg plant, pumpkin, peppers, citrus and star fruit. Estimated production of fruit is shown in **Table 19**. We have not registered any specific boosting or diversification programme for agricultural products. Estimates of the growth prospects for the fresh, fruit and vegetable market as a whole vary, but sales of specialty vegetables and prepared fresh food grew considerably in the 1990s. Fearne and Hughes (1998) estimated that sales of speciality vegetables increased by 21% in volume terms during the period 1993-96. They also drew attention to the rapid growth in sales of ready-to-eat, pre-washed salads, whose sales increased by 34.3% in value terms between 1994 and 1996 (Fearne and Hughes, 1998). In 1999 three UK supermarkets were sourcing round beans and fine beans from the Gambia.

Table 19. Production in (metric tons) of fruits (2000-2006).

Commodity	Metric tons
Mango (non exported varieties)	23, 260
Mango (exported varieties)	15, 000
Citrus & other fruits	5, 500

Source: Jobe (2007)

Three major companies dominate horticultural production: Radville, GHE and Royal Enterprise Ltd. The first two are concerned mainly with fruits and vegetables while the latter is specialized on nuts and grain legumes (**Table 20**). Both Radville and GHE use outgrowers but do not have formal contracts and amounts sourced annually vary (**Table 21**). Major production constraints for fruit are shown in **Table 24**.

Table 20. Major horticultural companies and range of Products (2005).

Name of the Corporate Farm	Range of Products
GHE	Beans, Mangoes, Papaya, Lime, Chillis
Radville Farm	Mangoes, Chills, Okra, Beans, Eggplant, Baby Corn, Pear
Royal Enterprise Ltd	Raw Cashew Nut, Sesame and Groundnut

Source: Field Survey, 2005

Table 21. Use of Contract/ Out Growers, Duration and Volume Produced.

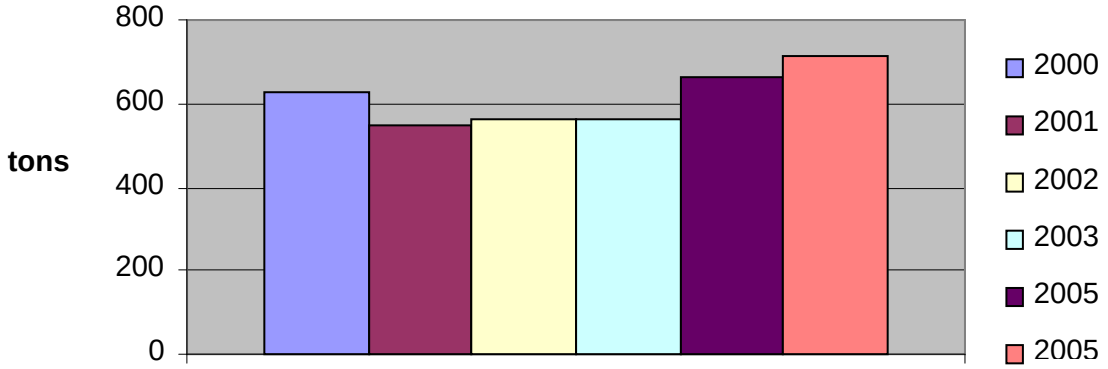
Name of the Corporate Farm	Contract/Out Growers	Duration (yrs)
GHE	Yes	7
Radville Farm	Yes	12

Source: Field Survey, 2005

5.2.3.2 Mango production in The Gambia

Based on FAO data, mango production in Gambia is on the rise. Estimated at 630 tons in 2000, it has progressed over 12% by reaching 710 tons in 2005. Despite its modest quantities, production increases steadily (**Figure 14**).

Figure 14. Mango production in Gambia, 2005.



Source : FAO

5.2.3.3 The main mango and citrus production areas

Fruit production in Gambia is concentrated in two areas. The area to the West of the country is apparently the main fruit production area, accounting for over 70% of Gambian fruit production. It produces mainly mangos of the Kent, Keitt and Jure varieties. Despite the establishment of fly traps to reduce fruit fly populations, the area suffered losses of over 40% linked to these pests. The area in the North of the country produces different locally consumed mango varieties. Mangos are marketed between March and October (**Table 22**). Growing seasons for specific varieties are shown in **Table 23**.

Table 22. Seasonal nature of mango production in Gambia.

Month: / Region	Mar	Apr	May	Jun	July	Aug	Sept	Oct
Western area				X	X	X	X	X
Northern area	X	X	X	X				

Source: NARI

Table 23. Mango Varieties and Their Growing Seasons in Gambia (months).

Variety	Flowering Stage	Fruiting Stage	Maturity	Harvest
Julie	February	April	June	June/July
Sierra Leone	January	March/April	May	June
Keith	Feb./March	April	June	Aug./Sept
Kent	Feb./March	April	June	Aug./Sept
Ruby	Feb./March	April	June	July
Harden	Feb./March	April	June	Sept./Oct

Source: Jobe (2006)

5.2.3.4 Types of orchard

The situation in Gambia is quite particular in the sense that fruit exports and mango exports in particular are controlled by only two companies (**Table 21**). In Gambia, the orchard typology is based on three types of orchards:

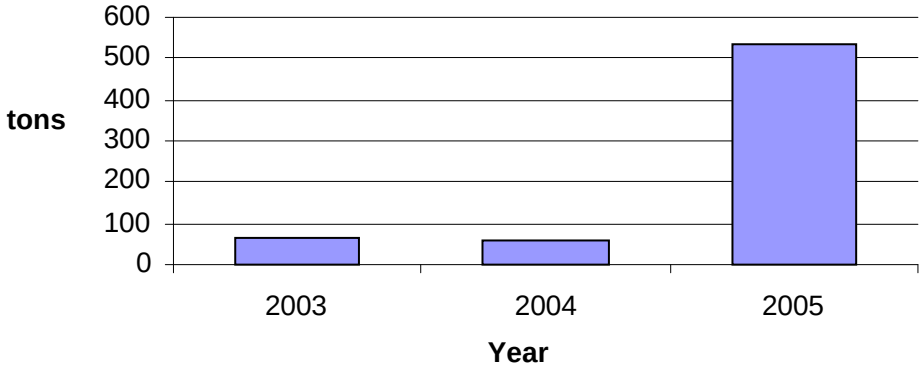
- The traditional or home orchards are often very old (over 40 years on average). They supply the national market. They are not the object of any form of maintenance and are therefore heavily attacked by fruit fly. Without maintenance, traps although they are frequently renewed are totally ineffective as the orchards are difficult of access which prevents the collection and burial of the fruit attacked and fallen to the ground. These represent a new source of contamination of the orchard.
- The improved traditional orchard is an intermediary orchard category. These orchards supply exporting companies. Part of the orchard has been renewed thanks to grafting. In this case, it is the exporter which encourages the producer to maintain the orchard by facilitating its access. If the orchard is looked after, the exporter can collect its fruit more easily. Despite these measures, losses in these orchards have been very important with *B. invadens* affecting between 40 and 60% of the production. The improved parts are planted with several varieties of mango sought on the British market (Kent, Keitt, Ruby).
- Modern orchards are few. Two companies export mangos from Gambia (**Table 21**). Although they are conscious of the fruit fly problem, we have observed two different attitudes. One company has just been certified as “organic” and wishes to maintain this certification at all cost through biological fruit fly control; the other is the biggest exporter and believes fruit flies should be eradicated even though this implies the use of chemicals. Both companies use outgrowers to supplement their own export offer (**Table 22**).

5.2.4 The national and sub-regional market

Agricultural markets in the Gambia are very unsophisticated, with the weekly local markets (lumos) playing a prominent role as a marketing outlet in the rural areas. There are no ‘specialised’ markets for agricultural commodities, with the possible exception of the Abuko market for livestock. Accurate data on sub-regional fruit trade are not available. Gambia due to its geographical location has Senegal as its main commercial partner. Though they are conscious of the arrival on the Gambian territory of trucks from Senegal, authorities have not

been in a position to produce data concerning imports. We have been informed of a flow of about 200 tons from Senegal to one of the Gambian exporting companies. Conversely, mango exports from Gambia to Senegal through the Jiboro border control post between 2003 and 2005, have risen from 65 tons to over 233 tons (**Figure 15**).

Figure 15. Mango exports from Gambia to Senegal (2003 – 2005).



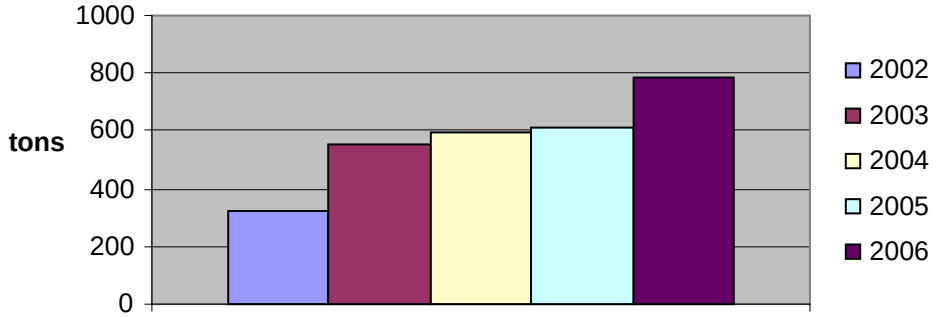
Source: NARI

The availability of local mangos in Gambia long before that of the Senegalese production appears partly responsible for the observed increase. As early as March, the orchards from the northern area start producing and supply local mangos consumed on the local market as well as on the sub-regional export market. This enables some producers to supply Senegal two months before the start of the Senegalese production campaign. We got the impression that there was more rigour in the issuing and management of phytosanitary certificates from Gambia. The consumption of local or traditional mangos on the market appears relatively important and concerns close to the entire production. The varieties intended for export appear to almost all be traded apart from the quantities lost to the fruit fly. The Gambian production period corresponds to the period of full production in Senegal and enables Gambian operators to complement the Senegalese campaign. The mangos are bought by Senegalese companies and re exported as fruit of Senegalese origin.

5.2.4.1 Gambian mango exports to Europe

The offer in terms of varieties such as the Kent and the Keitt does not appear sufficient to satisfy the demand of exporting companies, in the sense that one of the companies which exports has had to call on the Senegalese production to satisfy its commands. The mango exports are almost all sent to a single European destination, the United Kingdom market (**Figure 16**). Amongst the goods exported to Europe, only mangos and papaya represent a risk in terms of fruit flies. The mango market is in full boom in Gambia. Between 2002 and 2006, it has risen by over 141% from 325 tons to over 785 tons exported. Even though the export potential remains rather limited, operators believe they would already have reached the thousand tons for exports mark had the sector not had to deal with several problems including those linked to the fruit fly. Producers have suffered important losses due to *B. invadens* but NARI researchers think that damage to other products, particularly vegetables could be more important in years to come if no measures are taken, particularly considering the presence of B. cucurbitae which they deem just as dangerous.

Figure 16. Mango exports from Gambia to the United Kingdom, 2002 - 2006.

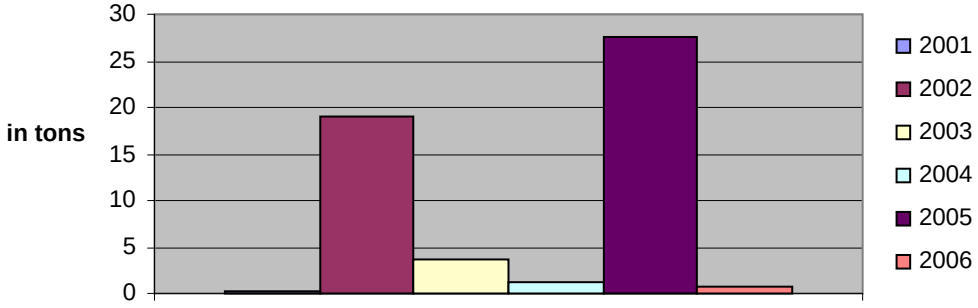


Source: EUROSTAT

5.2.4.2 Papaya exports

According to the results of incubation trials undertaken by the NARI, possible fruit fly hosts which are also the object of exports include the papaya. We have not been able to identify any papaya trade by land. However, papaya exports to Europe appear rather recent (they started in 2001) and rather irregular in terms of quantities, but appear to offer great potential. The cause of this fluctuation is not clear (Has the offer decreased due to the fruit fly problem or is it simply a fruit production problem?). No data on land trade in products other than mango are unavailable, but the mango data leads us to think that either such trade does not exist (very unlikely), or that it is limited and therefore Informal.

Figure 17. Papaya exports from Gambia to the EU (2001-2006).



Source: Eurostat

5.2.5 Pest and disease constraints for fruit production in The Gambia

The main pest and disease constraints on fruit crops are listed in **Table 24**, below. Fruit flies are seen as economically important for all the fruit crops, partly because of their phytosanitary importance in trade. Beside the problem caused by fruit flies, the Gambian mango sector must also face that of the mango mealybug (*Rastrococcus invadens*) which affects fruit well before they reach the packing station. The mango mealybug problem has been the object of a study by government authorities. The solution adopted to fight this problem was integrated pest management through the release of predators of the mealybug. Unfortunately, due to lack of means the operation was not applied to the entire country but only to the western region, only temporarily reducing the mealybug population there and failing to reduce the growing infestation in the northern region. Based on their experience with the mango mealybug, Gambian researchers strongly recommend a regional response to the fruit fly problem. The identification, following incubation by NARI teams, of several fruit fly species raises the question of the type of research needed to respond specifically to the insects present.

Table 24. Major production constraints for fruits in The Gambia.

Commodity	Constraint
Mango	Mango fruit flies, Mango mealy bugs, Mango die-back
Citrus	Citrus die-back, Cercospora leaf spot, fruit flies
Watermelon	Fruit flies, Powdery mildew
Papaya	Fruit flies, white flies
Pear	Fruit flies, Pear rot disease
Guava	Fruit flies, white flies, canker

Source: L. Jobe, MoA

5.2.6 Fruit fly species and their hosts in The Gambia

The NARI agents have done important work over recent years with respect to the determination and identification of quarantine pests. They have made contacts with the IITA in Benin and with European entomologists to help them identify new species of fruit fly. Unfortunately, the NARI lacks means both in terms of personnel and finance to reduce the risks linked to the presence of fruit flies. Though the NARI scientists recognize the economic impact of *B. invadens* attacking fruit, they stressed that *B. cucurbitae* appears to represent a bigger threat for the future, as it attacks both fruit and vegetables without distinction (see **Table 24** for its host range). Several incubation trials have been made in Gambia by researchers from the National Agricultural Research Institute (NARI). The following species have been reared from specific crops and wild hosts.

- *Bactrocera cucurbitae*: This species attacks a wide range of wild and cultivated fruits of the family Cucurbitaceae. *Bactrocera cucurbitae* was first discovered in West Africa in 1999 by scientists in The Gambia[1]. Since then, its importance has attracted attention for vegetable and fruit tree growers. It is responsible for causing serious economic damage of between 30% to 100% for crops such as melon and pumpkin. *Bactrocera sp* has a direct threat to the external market (trade) in the Horticulture sector across the West Africa Region.

- *Bactrocera invadens:* This species has a restricted host range and is a serious pest of mango in The Gambia. Although its economic status is not yet established, the species is responsible of causing enormous damage to mango with some varieties suffering an estimated damage of 50 – 60% of fruits. This can have direct bearings to The Gambia's foreign exchange earning opportunities if appropriate strategies are not taken as a lot of mangoes are exported through Senegal. The improved mango varieties such as (Keitt, Kent, Ruby etc) are more susceptible than the local (non-exported) varieties. *B. invadens* was also reared from citrus (lemon, grapefruit and lime).

- *Ceratitis cosyra* (Marula or Mango fruit fly): The species is recognized and also has restricted host range. It is comparable to *B. invadens* on mango; however, the later species is smaller and less aggressive. Apart from mango, *C. cosyra* is also found attacking horticultural crops in The Gambia. The proliferation of this insect is having direct consequences on the country's external trade. The improved mango varieties are also more prone to this pest than the local varieties.

- *Ceratitis capitata* (Mediterranean fruit fly). This specis has a wide host range in the horticultural sector. The Gambia has recorded a high impact of this species on vegetable (solanaceous) crops. *C. capitata* has never been recorded on mango in The Gambia but

1 EPPO Reporting Service Paris, 2000-06-01. Reporting Service 2000, No. 06. archives.eppo.org/EPPOReporting/2000/Rse-0006.doc

is a serious pest of vegetables, including sweet pepper (capsicum) and egg plant, causing very high loses to small-scale women farmers.

- *Dacus vertebratus* (African melon fly): This species has a restricted host range, mainly attacking watermelon in The Gambia. *D. vertebratus* causes serious damage to watermelon, which is an important commodity crop in The Gambia. Water melon contributes to almost 30% of the household requirements (for those who grow it) for domestic bill settlement and payment of school fees and book bills for the children. The impact of the damage has a very serious health implication due to the frequency of pesticide application on this crop.

- *Dacus longistylus:* was said to have been reared from papaya[2]. Since this species is normally reared from Sodom apple, *Calotropis procera* (White, 2006), and there are no previous records from papaya, this record requires confirmation.

- *Dacus bivittatus* (pumpkin fly): was reared from pumpkin. This species occurs widely on pumpkin in Africa (see Table 6).

5.2.7 Problems of correct pest species identification

Jobe (2007) (**Annex 4**) has reported the presence of *Bactrocera dorsalis* (the Oriental Fruit Fly) in the Gambia. This would be very alarming indeed if it was true, since *B. dorsalis* is one of the most serious fruit fly pests in the World. As indicated in Section 4.5 and Tables 5 and 6 of this report, *B. dorsalis* is not yet reported to have reached any part of the African continent. Jobe reported this species as rare, but causing damage to cucurbitaceous crops. The record is puzzling, since the only other fruit flies damaging cucurbits in West Africa to date are *Dacus* species. However there is an external threat from other fruit fly species. This unconfirmed (and probably erroneous) report from the Gambia indicates just how important it is for any reports of unusual species of fruit flies found to be confirmed by examination of material by competent taxonomists with access to good reference collections.

5.2.8 Responses at National Level to the fruit fly problem

5.2.8.1 NARI Research Activities: Integrated Pest Management (IPM) approach

Research work on fruit flies started in the Gambia in the late 1990s with investigations of two proprietary body lotions (AZ and AD) which were attractive to fruit flies. These were later analyzed in collaboration with Rothamsted Research Station in the UK to determine the different chemical properties. Trials were then conducted on application rates, trap heights and time of installation for maximum attraction and to determine the peak periods of fruit flies in the different locations studied. The sequence of research activities is as follows:-

a) Control of melon fruit fly, *Dacus vertebratus* in watermelon using “AZ” body lotion as an attractant started in 1997
   - Isolation and purification of the different chemical constituents of body lotion 1998-1999
   - Comparison of purified chemical from lotion with body lotion traps 1999-2000
   - First report of *Bactrocera cucurbitae* in West Africa by NARI Gambia 1999-2000
   - Determined & established the flight height of *Dacus vertebratus* 1999-2000
   - Determined the population dynamics of *Dacus vertebratus* 2000-2002
   - Identified susceptible watermelon varieties to *Dacus sp* 2000-2004

[2] Jobe, personal communication to T. Paqui.

- Determine & establish trap density for the control of *D. vertebratus* in watermelon (Not accomplished)

b) Control of mango fruit flies on mangoes
   - Efficacy trials using Talstar and Karate insecticides on *Bactrocera invadens* and *Ceratitis cosyra* 2006-2007
   - Efficacy trial using Success Appat against *Bactrocera invadens* & *Ceratitis cosyra* 2006-2007 (linked to COLEACP PIP).
   - Efficacy trial using bait methods (Methyl Eugenol, Terpinyl acetate, and Torula) 2006-2007

c) Control of Mediterranean fruit flies (*Ceratitis capitata*) on Large pepper & Egg plant using botanical insecticides 1999-2001.

Local varieties of mangos are the first to be attacked by the fruit fly. For the moment, the response to this problem consists mainly in applying the prophylactic measures initiated by the PIP. In theory the first mangos which are damaged by fruit flies and fall to the ground are collected and buried. Sometimes pesticide is applied to the fruit pile before burial to prevent the emergence of new flies. In practice the agents questioned admitted that this is rarely the case and there are few incentives to encourage producers to maintain their orchards.

Perhaps because of the small size of the mango export sector (two operators), there is no mango sector task force in Gambia. Nevertheless, we have been told that, in Gambia, the PIP undertakes trials on chemicals and on cultural practices (as recommended in the CTA booklet). Other actions undertaken include: Training operators in prophylactic techniques based on the PIP modules and research work with the University of Hawaii. Apart from the use of traps farmers and growers are using chemical insecticides to treat their crops but this can and does cause residue problems especially for export vegetables. The trials of bifenthrin and lambda-cyhalothrin cover sprays, and localized spot treatment (*traitement par taches*) using Success-Appat (GF-120), financed through PIP, are part of a multi-locational programme (Gambia, Senegal, Burkina Faso) aimed at securing homologation of this technique by the CSP of CILSS[3].

5.2.9 Extension support for farmers

Provision of research and extension services is the primary responsibility of the public sector, although both services suffer from inadequate funding, resulting in untimely delivery and adoption of appropriate technologies to boost productivity. The Government has also made various efforts to support the provision of credit, especially micro credit to producers. While micro credit organizations exist at the grassroots level in almost all part of the country, the volume of credit available is not sufficient to meet the needs of its clients.

With respect to communication systems, The Gambia has one public television station and a national radio station, although in recent times technical problems have resulted to signals not being received in all parts of the country. Community radio stations were established in the administrative divisions, but many of them are currently dysfunctional. This state of affairs restricts the prospects of using radio and television to disseminate agricultural and market

[3] See : Vayssières, J.-F., 2007. « Les traitements par taches (GF 120) testés au Bénin contre les mouches des fruits inféodées au manguier » and Delhove, G., 2007. « Bientôt des produits de protection des plantes disponibles pour les fruits et legumes dans les pays du CILSS en 2008 ». In : *La lutte régionale contre les mouches des fruits et légumes en Afrique de l'Ouest.* Lettre d'Information No 6, Octobre 2007. COLEACP/CIRAD.

information. The telephone network covers most parts of the country, although the mobile telephone network is yet to achieve national coverage.

5.2.10 Post harvest practices and quality control at packing stations

A number of market centers established and being used in various key areas in the country would require serious renovations to make them appropriate for the purpose for which they were built. Only mangos intended for export via ports or airports pass through packing stations. Mangos for local consumption do not pass through packing stations and are directly introduced to the marketing channel. Storage and processing facilities are generally undeveloped for agricultural commodities. This is evidenced by high post-harvest losses particularly for horticultural crops which has an estimated post harvest lost range of 30% to 50%, depending on crop, with mangoes scoring highest estimates.

Only two companies are involved in the horticultural export sector, both of which have received EUREPGAP/GLOBALGAP certification, thanks mainly to the help of COLEACP PIP. The packing stations therefore depend on the means at the disposal of these two companies. Relevant infrastructure for handling the produce and products have been established by one commercial firm (Radville) which represents 60% of exports by volume. Although we were unable to visit its infrastructure (access difficulties, authorisation problems), we understand that its post-harvest operations are conducted more or less as described in Section 4.7.1, above. However relatively high operating costs have put the facility beyond the every day use of the large number of small-scale producers in the industry. More of such structures would be required especially set up closer to the areas where the producers operate, to minimize long distance transportation of perishable commodities and to improve handling, which in turn will ensure high quality and consequently greater income from the operations.

The most developed station undertakes a fungal treatment (presumably with prochloraz) whilst washing the mangos in a hot bath for a short time. The second company which has developed organic certification doesn't use any chemicals during the washing operations. It seems that in both stations the detection of traces of insect attacks is devolved to specially trained women. This was confirmed for the station which works on organic products but not for the other. Since almost all Gambian mango exports are made by plane, the consignments arrive at the station at a more advanced stage of maturity. It seems that this simplifies the detection of insect attacks. Although both exporting companies are certified EUREPGAP/GLOBALGAP, there exists a significant difference in means between the main exporter and the company which concentrates on organic products. The packing station of the leading company is, so we have been told, well equipped and mechanised which is not the case for the second company. Both stations have cold rooms for stocking mangos before transport to European markets.

5.2.11 The role of National Agencies in relation to Pest Management.

5.2.11.1 NARI (National Agricultural Research Institute), Agricultural Pest Management Unit (APMU) (Department of Agricultural Services, and National Agricultural Development Agency (NADA)

The Gambia is not yet a member of the IPPC. However the Agricultural Pest Management Unit (APMU) is listed as the NPPO under the IPPC[4]. As of 2006, the APMU's Phytosanitary Section was responsible for delivering phytosanitary certificates and for inspecting food stuffs at the borders. The NARI research centre is responsible for training the agents in charge of

[4] https://www.ippc.int/servlet/CDSServlet?status=ND1ucHBvZ20mNj1lbiYzMz0qJjM3PWtvcw~

the inspections. Humado (2006) noted that APMU has 9 entry/exit points for land, sea and air as well as seven phytosanitary stations and a further 28 data collection points for disease surveillance and monitoring. He considered the latter to represent only 40% of the necessary coverage. Inspection of equipment at entry points showed almost 100% non-availability, with no effective lighting, hand lenses, microscopes, vials, slides, stains, tweezers or other equipment. There were no government facilities whatever for treatment or disposal of infested produce. There is no quarantine facility in The Gambia.

Accommodation, communications and transport for APMU's Phytosanitary section were all rated as poor by the SPS Capacity Review (Mumado, 2006). Human resources in APMU are at 40% of the required and planned levels. Diagnostic capacity is lacking for most organisms (Bacteria, viruses, fungi, nematodes and weeds). There is no national capacity for pesticide residue analysis. There is no trained personnel with pest risk analysis capacity and there are few incomplete lists of pests. The APMU has received several notifications of interceptions of the whitefly *Bemisia tabaci* on horticultural exports, frequently on goods which had not been officially inspected at exit from The Gambia. There is poor documentation of surveillance systems and data on pests. Computerization is absent due to broken and obsolete equipment. The APMU was unable to show any knowledge or awareness of emerging pests and diseases and those recently accidentally introduced into the country (such as *Bactrocera invadens*). There is no literature to assist staff in recognising or diagnosing pests and diseases.

During 2007, the SPS responsibilities of the Department of State for Agriculture, together with other technical departments were apparently transferred to a new body, the National Agricultural Development Agency (NADA). It is not clear what the exact functions of NADA are and the process of transition to the new structures appears incomplete. Training is needed to equip the new NADA agents to conduct phytosanitary inspections. There is also a lack of personnel and resources in NADA to undertake even the basic tasks of inspection and delivery of phytosanitary certificates. There is a need to reinforce the inspection personnel at the border. Presently, the principal entry and exit point between Senegal and Gambia is operated by a single agent. There is also a need to harmonise inspection procedures on each side of the border to apply the same methods all along the value chain. A new policy covering agriculture and natural resources is being prepared by the Government of Gambia.

5.2.11.2 National Environmental Agency (NEA)

The NEA is the responsible national body for granting import permits for approved pesticides, and inspection and registration of facilities for the sale of pesticides and chemicals. In relation to homologation of pesticides by neighbouring countries under the PSC of CILSS, it is notable that The Gambia is not a member of CILSS and therefore does not participate directly in joint setting of pesticide standards. No lists of registered pesticides were available.

5.2.12 Difficulties and constraints in fruit fly management in The Gambia

1. Absence of a task force or Committee for Fruit fly Management and a National Fruit Fly Management Strategy.

2. The need to address different fruit fly problems on cucurbits, solanaceous vegetables and fruit simultaneously.

3. Small resources and linguistic isolation from neighbouring countries in adopting joint approaches

4. Lack of standardised SPS legislation and practices between neighbouring countries and inadequate numbers and training of SPS personnel at borders. A draft phytosanitary law was prepared with FAO assistance from FAO in 1997, but has never been presented to Parliament. The lapse of time and new developments in WTO SPS regulations in the last ten years will require that the State Dept of Agriculture review and revise the draft law before submission to Parliament[5].

5. Lack of access to best information on taxonomy and identification of fly samples

6. Lack of exposure to latest methodologies for luring fruit flies for monitoring and pest management (e.g. MAT) including current use of sub-optimal attractants as an economy measure.

7. Farmers lacking good extension advice to stop using inappropriate chemical control methods on vegetables. Pesticides are imported from Senegal without permits and no training is provided to farmers by APMU.

5.2.13 Proposals for National Action Plan: The Gambia

The Gambia is a small country with limited resources and a small horticultural industry. However it is facing a wide range of fruit fly pest problems which need to be addressed.

1 Strengthening coordination between government and industry. There is a need to establish a joint consultative and planning body for fruit fly control, bringing together the main government departments: NARI, Agricultural Pest Management Unit (APMU) (Department of Agricultural Services), NADA, National Environmental Agency (NEA), with the main horticultural exporting companies (GHE, Radville) and representatives of fruit and vegetable farmers and related organizations (e.g. National Women Farmers' Association (NAWFA)). Tasks of this group should be to develop a unified National Strategy for Fruit fly Management, assigning roles and duties and monitoring progress.

2. Review of status of production statistics and economic value of fruit fly problems on mango, papaya, water melon and solanaceous and cucurbitaceous crops, and set priorities for pest management.

3. Review of international experiences, past research efforts and recent (COLEACP-PIP and other) trials on pest management for fruit flies and their results, especially in relation to application for homologation of new chemical agents under PSC of CILSS and preparing extension advice to farmers.

4. Capacity building on crop pest management methodologies for all actors.

5. Capacity-building on SPS methodology including certification, inspection, identification of quarantine pests and diseases and liaison with opposite numbers in Senegal.

6. Obtain correct identification of all questionable samples of fruit flies, preferably in the context of a tailored training programme for one or two representatives of NARDI and another organization with specific responsibilities for providing Identifications in the future, to be undertaken at MRAC, Tervuren (in English language medium).

[5] See Humado, 2006, Section 3.3.

5.2.14 References

Catherine Dolan and John Humphrey, 2001. Governance and Trade in Fresh Vegetables: The Impact of UK Supermarkets on the African Horticulture Industry

5.3 National Situation Synopsis: GUINEA

The Republic of Guinea covers an area of 245,857 km^2 with a population of 9.3 million inhabitants. It is situated on the Atlantic coast between Guinea Bissau and Sierra Leone, and bounded to the north by Senegal and Mali. The country has four main natural regions, running from west to east: Maritime Guinea or Lower Guinea on the coast, Middle Guinea, Upper Guinea and in the south east, Forest Guinea. Rural people constitute 80% of the population and derive 79% of their income from agriculture which represents 17 per cent of the country's GDP and employs two thirds of the population, the majority of whom are women.

However, most agriculture is traditional, low intensity, smallholder agriculture. Market-oriented agriculture represents only 10 per cent of the production. Today, of the 6 million hectares of arable land, only an estimated 1.5 million ha are under cultivation. Consequently, a significant amount of food products are imported into the country. The declining trend continues until today, fruit exports to Europe (pineapples, bananas, mangoes) generally not exceeding a thousand tons. Pineapple production, which reached around 6,000 tonnes in 2000/2001, is now down to around 3,000 tonnes. Exports amounted to slightly more than 300 tonnes in 2004. Mango exports to Europe (mainly to France, the key destination market), amount to approximately 550 tonnes, most of it transported by boat.

Guinea has a strong potential in terms of fruit production and more particularly in terms of mango production. Mango is a specific element of the Guinean diet. Fruit is considered a very important food constituent. Its production period occurs before the harvest of the staple food crop in a time of critical food need and thanks to its numerous culinary applications (stew, soup etc) it considerably reduces the need to resort to rice and *fonio* for feeding urban populations. Guineans admit willingly that the beginning of the mango campaign enables them to significantly reduce their food costs and mango can represent up to 40% of their diet at this time.

5.3.1 The main crops produced in Guinea

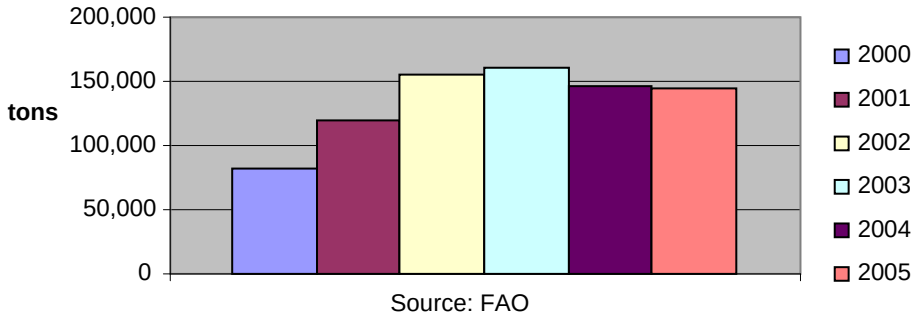
Major crops are oil palm and potatoes (2000 tons exported annually within the region). Apart from these, the principal crops are mangos, cashew nuts, bananas, citrus, pineapples, guavas. Crop zonation priorities in Guinea follow the agro-ecological zones which in sequence from west to east are as follows:

- Basse Guinée/Guinée maritime is characterised by fruits such as bananas, pineapples and mangoes. A Belgian-funded mango project planted 26-30 ha of mango orchards at correct spacing in Fanye (Forecariah Prefecture) a few kilometres east of Conakry around 1999. This was intended as a pilot project but was abandoned and the subsequent fate of the plantation is unknown.
- Moyen Guinée consists largely of the upland Fouta Djallon, is the main centre for potato production (exported to Senegal and Gambia) and also the main *fonio* area. It also has some mango production, though with a very serious fly problem currently. It is also described as having a problem of caterpillars ("chenilles").
- In Haute Guinée upland rice and mango are the key crops, though mango producers are turning to cashew and no mango orchards under five years old exist.
- Guinée Forestière in the SE of the country has a few mangoes but is mainly devoted to production of coffee, cocoa, rubber, banana, plantain and palm wine. Upland rice and cassava are produced in all areas, with maize in the drier parts and groundnuts in the north and west.

5.3.2 Mango production in Guinea

Although Guinea has a fertile soil particularly favourable to the establishment of a diversified agriculture, mangos occupy a predominant position with respect to cultivated land. The mango harvest season lasts from March to August. In the absence of national data concerning production, we have relied on information provided by the FAO. According to FAO data, mango production in Guinea has enjoyed steady growth. Estimated around 83,000 tons in 2000, it has increased by 74% to over 144,000 tons in 2005 (**Figure 18**).

Figure 18. Mango production in Guinea (2000 – 2005)



Source: FAO

5.3.2.1 The main mango production areas in Guinea

Guinea is divided into four horticultural production zones, all of which produce mangos at varying scales. The four production regions are:

- Maritime Guinea (or lower Guinea), about 30% of the country's mango production.
- Middle Guinea (Fouta Djalon area)
- Upper Guinea (Kankan area), about 50% of the Guinean mango production
- Forest Guinea

Upper and Lower Guinea are the most important regions in terms of mango production. They are also the ones which produce the majority of fruit intended for export. These two regions alone account for over 80% of the country's mango production. Seasonality of production is indicated in **Table 25**.

There are two main mango growing areas in Guinea. These are Kindia in Basse Guinée and Kankan in Haute Guinée. The latter area has younger orchards and being in the drier savannah zone (1500 mm rainfall) does not suffer from anthracnose which is problematic in the southern forest zone. The mangos here are better quality (sweeter and better colour) and the harvest campaign season continues later because of later rains. Kankan has considerable export potential if the fly problem could be addressed. There is little investment in orchards and basic hygiene standards are not met. Mali and Cote d'Ivoire currently import mangos from Kankan. It is estimated that of the 2000 tons exported from Sikasso by Tropical Expression Mali in 2006, 2-300 tons at least was from Kankan.

Table 25. Seasonal nature of mango production in Guinea

Month Region	Mar	Apr	May	June	July	Aug
Lower Guinea	X	X	X	X		
Middle Guinea	X	X	X	X	X	
Upper Guinea		X	X	X	X	
Forest Guinea		X	X	X	X	X

5.3.2.2 Types of orchards

Mango production has a singular importance in Guinea. Since the 1960's the establishment of a government-owned juice processing factory in Kankan has greatly influenced the types of orchards.. However this was closed under pressure from the World Bank in the late 1980s and the local mango market collapsed, leading to neglect or abandonment of orchards. The varieties grown had larger fruits, ideal for pulp or juice, but not suitable for transportation as fresh produce. Today one can distinguish:

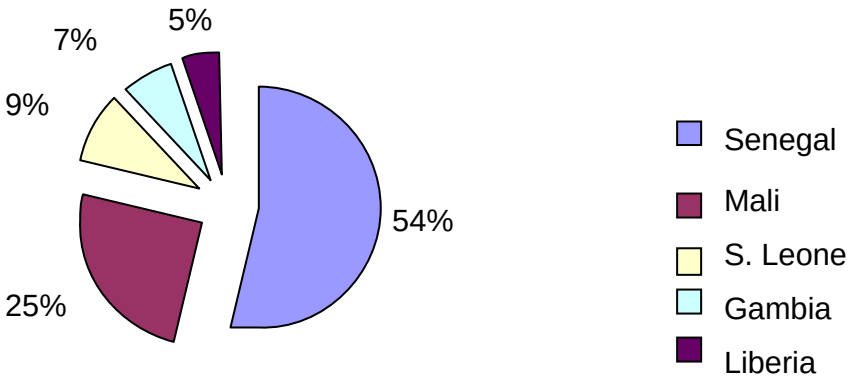
- The old "industrial" orchards. Characteristic of the 2 main production areas (Maritime Guinea and Upper Guinea), these are orchards which were planted in the 60's to supply raw material to the processing centres. Mainly planted with several varieties whose particularity is to produce pulpy, juicy fruit suited to processing, these orchards are generally very old, the average tree being 30 to 40 years old. They are subject to a very high pest pressure with losses estimated, according to the people met, between 50 and 80%.
- The improved orchards. This group includes orchards of 2-10 ha each of mixed varieties established because of the processing factory. However many are planted with mangos intended for export (Kent, Keitt, Amélie, Palmer etc). On average between 25 and 30 years old, they are situated close to "industrial" orchards and due to this are subject to a high pest pressure. Closely monitored during the export campaigns this pressure is all the higher and orchards of this type were said to suffer losses varying according to the seasons between 60% and sometimes over 80%.
- Small family orchards of mixed local varieties planted everywhere across Middle Guinea and Forest Guinea. These old orchards (average tree age above 50 years) supply a dietary supplement and are not the object of any particular maintenance. Losses, estimated between 60 and sometimes 100%, and representing a serious risk with respect to food security, were in the past attributed to "wasps". The plant protection department has identified *Bactrocera invadens* as the main cause.

5.3.3 The national and sub regional market

The mango offer on the local market is often overabundant and prices are consequently low (6 mangos sold for about 100 GNF). At markets, damaged or unsold fruit may be thrown away, favouring the development and spread of the fruit flies. The agents of the ACA (Agence pour la Commercialisation Agricole / Agency for Agricultural Trade), enabled us to assess the commercial flows inside Guinea and from Guinea to the other countries in the sub-region (**Figure 19**). The ACA is a national NGO, established with USAID assistance, to organise and support agricultural operators, collect and distribute information concerning the prices of over 22 agricultural products[1]. Through regional offices in the four producing regions, it collects data on prices and tonnage in local administrative centres and markets.

[1] groundnut, maize, sesame, pineapple, mango, ginger, plantain, onion, banana, potato, shea butter, fonio, cola nut, palm oil, coffee, small dried pepper, cocoa, local steamed rice, yam, dried cassava, nere grain.

Figure 19. Destination of Guinean mango exports in 2002



Source: ACA

Mango production figures are estimated at 65,000 t of which 30,000 is sold within the subregion, primarily neighbouring countries (**Figure 19**). In 2002 the main recipient of these exports was Senegal, but for exports originating from Upper Guinea, the Ivory Coast now occupies the first position (about 1200 tons exported to the Ivory Coast). Several reasons appear to explain this situation:

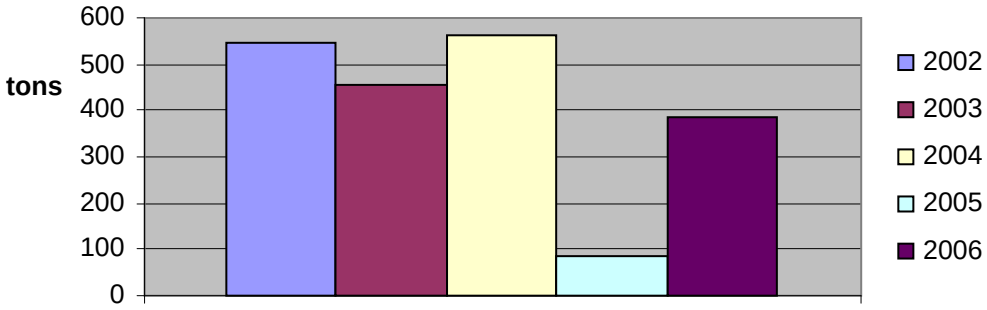
- Financial weakness of national fruit and vegetable exporters prevents them, with the exception of a single company, from obtaining EUREPGAP/GLOBALGAP certification.
- Poor condition of the road network results in discouraging exporters from Lower Guinea sourcing fruit in Upper Guinea.
- The price paid by operators from neighbouring countries such as Senegal which are profitable mainly thanks to favourable rates of exchange.

5.3.4 Guinean exports to Europe

Guinea has quite low mango exports but potential for growth. Only small amounts of mangos are exported to Europe because operators cannot comply with the traceability conditions required to export to EU markets. Only SIPEF, whose headquarters are in Belgium, exports mainly to Belgium (**Figure 20**). Although we have been informed of a trade in organic fruit to Europe, we have not found any trace of these exports. The mango export market is rather irregular. Although between 2002 and 2004, exports have increased by 2%, In 2005 rains came early in May and exports fell by over 84% passing from 562 tons to 85 tons (with a consequent increase in price). In 2006, exports picked up again from 85 tons to 388 tons and in 2007 the rains were late so 700 tons were harvested.

Asked about the strong decrease in 2005, the agents of the Plant Protection Department as well as the operators of the main exporting company suggested that early heavy rainfall led to increased fungal problems such as anthracnose, and the devastating arrival of *B invadens* caused losses exceeding 80% in some orchards. Although Guinea offers a large choice of varieties suitable for export, only a few varieties such as the Kent, Keitt and sometimes Palmer are actually exported. In the last three years, exports by air have been dominated by SIPEF and those by sea by Malick Condé, exporting varieties Kent and Keitt. Costs of export by sea are given in **Table 26**.

Figure 20. Mango exports from Guinea to Belgium (2002 – 2006)



Source: EUROSTAT

Table 26. Costs of mango exportation by boat from Guinea to Europe for a 40 foot container (in 2001)

Item	**GUINEA**	
	(GNF/Kg)	Euro/Kg
Mango purchase	135	0,0675
Transport and collection	127	0,0635
Boxes and supplies	243	0,1215
Packing	63	0,0315
Transport to port (Sikasso – Ferkéssédougou for Mali)	57	0,0285
Various road expenses	6	0,003
Genset/Clipton rental	18	0,009
Transport SITARAIL		0
Transit costs	36	0,018
Quality control	2	0,001
Total putting in FOB	687	0,3435
Freight	494	0,247
Commission	3	0,0015
Other expenses	50	0,025
Sub total	547	0,2735
Gross CAF	1234	0,617
Sale	1400	0,7
Gross margin for exporter	166	0,083

Sources: SIPEF Guinea * 1 Euro = 10 500 GNF (check)

5.3.5 Processing of mangos in Guinea

Since the closure of the factory at Kankan in 1991, there has been no substantial processing for export. A company SAIG at Mamou in middle Guinea refurbished an old processing factory to produce fruit pulp. However this ceased operation due to the withdrawl of the French partners. One company NABEKAM Bio which produced dried mango, ceased trading in 2002 because of the high cost of electricity for drying. Local womens' groups produce sun-dried mango for the local market. Processing is now largely artisanal and domestic.

5.3.6 Mango producer and exporter groups and associated companies

There are no specific associations of planters for mangos or for fruit generally. There are federations of agricultural producers which focus on general production in specific areas or particular crops, notably potatoes, coffee, cotton. Lack of producer representation is a handicap for development of the subsector. The main force is SIPEF – an exporting company. There are regional groupings of agricultural producers in Fouta (Federation des Paysans de Fouta) and Haute Guinée (Fédération de planteurs de Haute Guinée) which could be a model. FPF helps with input supply and training and ensuring marketing. It charges a cess for services received. In relation to processing there is a womens' group "Kania Nema" but much more is needed.

The exporters' have an association (REFLEG – Regroupement des Exportateurs des fruits et legumes). However many exporters have withdrawn from the market and the association is inactive. Credit access is a major problem for producers. Banks are purely commercial with 130% annual interest. Micro-credit agencies serve traders only, not growers who need to pay for labour as well as inputs. Lists of producer groups and exporters are annexed to the Country Report (**Annex 5)**.

5.3.6.1 SIPEF Guinée[2]

The largest exporter of mangos from Guinea by boat, SIPEF Guinée is a subsidiary of the Belgian SIPEF conglomerate (with interests in Cote d'Ivoire, South America, Indonesia etc) which has been operating since 2000 in Guinea as a fruit exporter. Originally based on the coast it opened its packhouse at Kindia in 2003. SIPEF does not have its own plantations but instead contracts pisteurs who use the company's equipment and materials to collect fruit from producers. The company works with a detailed manual of importers' quality requirements ("Cahier de Charge") setting out the criteria for purchase. Six classes of fruit between calibre 6 and 12[3] are selected and any fruit not meeting standards for whatever reason are returned to the *pisteur* and must be removed from the pack-house site. Fruit spend 30 days in transit in sealed refrigerated containers so must be picked before maturity. Inspection is carried out at Kindia before sealing of containers. Shipping is carried out by Maersk. Shipping times should be 17 days from Conakry but may be delayed up to a duration of 30 days due to delays at Algeciras due to high traffic volumes.

Since 2005 M. Touré has been aware of a new type of damage, characterised by punctures causing sap flows, mainly on coloured fruit, which is attributed to *Bactrocera invadens*. Such fruit are rejected. The campaign in 2007 lasted from 18 April to 30 May. The end of the campaign is signalled by rejections rising to 60% and time taken to fill a container with exportable fruit rising to 4-5 days. On 30 May an entire load was rejected because of the high proportion of struck fruit and the campaign was halted. Keitt fruit should still be seen on the trees into September but in 2007 all fruit had fallen by the end of June, as a result of fly damage.

A container holds 21.5 tons of mangoes and the recent figures (2003-2007) exported from Kindia have been: 2007, 33 containers; 2006, 18 containers; 2005, 4 containers; 2004 25 containers; 2003, 17 containers. This year about 80% of fruit received was exported. At the start of the season 90-95% of mangoes arriving at the packhouse are exportable but by the end of the campaign this has fallen to 70% on average.

[2] The mission met with Yaya Touré, SIPEF Quality Manager, who has been working at Kindia since 2004.
[3] SIPEX supplies Utopia UK Ltd Enterprise Way, Pinchbeck, Spalding, Lincs PE11 3YR, UK Tel: +44(0)1775 716800. Fax: +44(0)1775 716808. Their size categories range from Grade 5 (mean 840g, range 785-850g) to Grade 14 (mean 300g, range 285-325g).

However it must be noted that pisteurs never bring in more than 20% of the crop from the orchards visited. There are three reasons for this:

- Only Kent and Keitt are accepted at SIPEF
- Size, colour, maturity and damage criteria are applied
- Much of the crop is inaccessible due to the large size of the trees

In addition pisteurs avoid remote areas completely because the roads are so bad.

M. Touré has suggested that SIPEF should become involved upstream in the value chain (vertical coordination). It has already established its own nursery to supply high quality grafted mango plants. They are also looking for an agronomist to guide planters who are regarded as reliable. SIPEF uses COLEACP PIP's Itineraire Technique Mangier and is looking for farmers suitable to be certified under EurepGAP. M. Toure has never had any containers rejected. However SIPEF Belgium has had containers destroyed[4].

5.3.6.2 AGRIMEX

Marcel Condé of AGRIMEX was interviewed. He indicated that the company is involved in agricultural consultancy. Currently he is conducting a (*post hoc*) financial analysis of the World Bank PNIR II Plateformes (potato and mango) for CAFEX. The mango value chain is much more risk-prone than that for potatoes. It relies on a short (90-120 day) season, with variable yields and sensitive to climatic factors. Pest problems introduce a further uncertainty. The creation of adequate infrastructure is essential before other issues can be handled. Now adequate standards and inspection will be needed in addition to the enhanced storage created by PNIR II. The potential exportation is as high as 30,000 tons per annum. At present only 600 tons are exported through other countries in 20 ton lorries. Of this an estimated 20-30 % is lost on arrival in Mali and other recipient countries. The internal market handles about 2000 tons going to large towns and mines. M. Condé noted the lack of national statistics on mango production, which necessitated data collection at grass-roots level for his study.

5.3.7 Other export crops which could serve as hosts to fruit flies

The plant protection department confirmed that the following crops have also been identified as possible hosts for fruit flies, without however indicating that specific incubation trials had recently been conducted :

- mangos: *Bactrocera invadens, Ceratitis cosyra,*
- Orange, guava, papaya, cashew nut: *Dacus spp.*
- Cucumber: *B. cucurbitae*

According to the plant protection agents we met, neither premises or means are put at their disposal to enable them to undertake incubation trials to either identify pests or transmit the results of their research for identification.

Citrus are the second type of crop likely to be attacked by fruit flies after mango. They are mainly consumed inside the country and in the sub-region. Unfortunately, although we suspect the sub-regional flows of being important, we have not been able to obtain information concerning the trade in citrus. According to FAO data, citrus production in Guinea in 2005 was estimated around 209,360 tons. Before the arrival of cercosporiosis, citrus exports to countries in the sub-region were estimated between 2000 and 4000 tons. No current data for these sub-regional exports exist. Sales to fruit collectors are done by 18kg boxes with prices increasing recently as a result of phytosanitary problems (anthracnose,

[4] Contacts in SIPEF Belgium are as follows: Mr Frank Deams, Tel 0032 36 41 97 19; 0032 01 08 14 035; email fdeams@sipef.be; SIPEF Service Qualite, Tel: 0032 36419719; Email: fruits@sipef.be. Mr Thomas Hildenbrand, Manager, + 33 1212555 1212; Portable: 0032 4789 29 256 ; Email: thildenbrand@sipef.be

fruit flies). Depending on the export varieties concerned, the price of a box varies between 5000 and 7500 GNF.

5.3.8 Estimates of fruit fly damage

No precise estimates of damage caused by each fruit fly species have been made in Guinea either before or after the arrival of *Bactrocera invadens* around 2005. This needs to be accomplished by random picking of fruit, counting the proportion with fly oviposition holes (*piqures)* and incubation of the infested fruit to rear the adult flies and identify them to species. However estimates of damage made by producers and researchers suggest that 50 – 60% of the harvest is infested. Taking into account the fruit which are not harvested because of evident damage the figure is probably 60-80% overall. Published results of trapping before 2005 did not clearly show the most important damage-causing species, with C. cosyra, *C. flaviventris* (then mistakenly called *rosa*), and *C. punctata* being the most frequently trapped (Vayssières and Kalabane, 2000). The advent of *B. invadens* has probably displaced all of these species to some extent, but no data have been collected in Guinea.

5.3.9 Research activities on fruit flies

The history of work on fruit flies in Guinea begins with J.-F. Vayssiere's studies in the late 1970s. Early work was funded by the French government and the FAO programme based in the Laboratoire National de Protection de Vegetaux where Dr Traore was an entomologist. During this period *Dacus bivittatus* was found on Cucurbitaceae in Guinea (identified by Ian White, but not cited in his 1992 book).

From 1992-1995 a survey of fruit flies attacking mango (and some other fruit trees) was conducted at Foulaya by Dr Vayssière and M. Seni Kalabane, entomologist and now Head of the Section Zoologie Agricole, in the LNPV (M. Diallo also worked with M. Vayssières in 1995). The study included not only an inventory of the species found, but also data on their seasonal occurrence, distribution, host range and attraction to specific types of lures (trimedlure and buminal). One observation was that traps suspended at 4 metres above ground caught more flies than those set at 2 metres. *Ceratitis rosa* and *C. cosyra* were the most important of five species which were significantly damaging out of a total of 7 identified *Ceratitis* species on mango (Vayssières and Kalabane, 2000). The work also detected four species of Dacini including *Dacus ciliatus*, a pest of Cucurbitaceae. Subsequently Dr Vayssières has listed 9 species from mango at Kankan, caught in 1995[5].

The other main pest of concern on mango in this period was *Rastrococcus invadens* (the mango mealybug). FAO paid for a consultation on IPM of mango and Dr Traore conducted a national survey in 2002. Working with J.-Y. Rey 200-2003 *Bactrocera* sp. was found on cucumbers. No funding for fruitfly research or development work in Guinea has been available since the Vayssières study. IRAG has sent an application for funds in response to the Call for proposals received from PIP for pesticide trials related to mango but has not heard the result. See also the proposal being prepared by CFC (below).

In 2005, with assistance from Dr Vayssières, Dr Traore maintained two tephritraps with methyl eugenol at Foulaya (Kindia) from 21 June to 12 September. The results showed a peak population of *Bactrocera invadens* in August, with numbers starting to decline in September. He also conducted 24 hours of trapping using methyl eugenol traps in the Prefectures of Kankan (28-29 June 2006) and Kindia (Foulaya) (1-2 July 2006) for Dr Hanna

[5] *Ceratitis cosyra, C, silvestrii, C. quinaria, C. fasciventris* (previously identified as *C. rosa), C. anonae, C. ditissima, C. pedestris, C. acicularis, C. flava.* Source: email of J.-F. Vayssieres to Moustapha Donzo, 18 May 2004.

of IITA. The results showed huge catches (>1000) of *Bactrocera invadens* in the north (Kankan) and lower numbers (<100) in the south (Foulaya). However it is clear that *B. invadens* is now probably present throughout the country.

Key research needs were seen as being pest identification, control strategies and suitable pesticides. It was stressed that the fly problem cannot be tackled by any single method in isolation. Orchard sanitation was seen as crucial and a key role of the public service would be in providing information and awareness raising among farmers. Key problems are a lack of understanding by farmers of why *pisteurs* leave behind much of the fruit crop and the importance of rejuvenating the orchards through replanting and pruning of larger trees. A key strategy would be to work with lead farmers to implement GAP.

5.3.10 Official support structures for farmers and exporters in the horticulture industry

5.3.10.1 Laboratoire National de Protection des Végétaux et des Denrées Stockées, of the Direction National de l'Agriculture (DNA), Foulaya[6]

The Laboratoire national de protection des végétaux et des denrées stockées (LNPV) of the Direction National de l'Agriculture (DNA), is situated on the IRAG site at the Station de Recherche de Foulaya. The LNPV at Foulaya is effectively the technical section of the DPVC and only carries out plant protection research, while IRAG has a general research mandate. The LNPV, headed by entomologist Dr Lanciné Traore, is housed in a tall single-storey structure (which actually belongs to the IRAG) right next to the CRAF building. The LNPV building is quite unsuited to modern needs for plant protection research, with very large spaces and almost no equipment. The building is in worse condition than the CRAF building itself and the DNA does not supply any funds for repairs or maintenance. The original Institut des Sciences Agronomiques de Foulaya (ISAF) was closed in 1989-90. The present laboratory was developed by UNDP and FAP in the 1980s and taken over by government in 1988.

The LNPV has the task of conducting pest surveys and identification, developing pest management strategies and conducting pest monitoring and pest alerts. It is structured on paper as five sections: phytopharmacie (pesticides etc), petit vertebres (rats, mice, bird pests), phytopathologie, weed science (*malherbologie*) and zoology agricole. The phytopharmacy section has no equipment and no analytical capacity. The agricultural zoology section covers, insect and mite pests, molluscs, nematodes and stored products pests. The LNPV has a small room for seminars but its microscopes are in poor condition, left unhoused, and insect specimens are kept in a few loose boxes on a table.

The laboratory would like to have collection cabinets but the very poor quality of specimen preparation and maintenance and the absence of any visible taxonomic activity would (in the opinion of this reviewer) not justify such an expense except as part of a clearly targeted research programme serving the needs of producers with a substantial input of training and some assurance that a basic cadre of technical staff would remain in place to conduct taxonomic and curatorial activities.

The DNA needs facilities for analysis of pesticide residues including high-pressure liquid chromatography (HPLC) equipment. Currently analyses can be performed at LOCUSTOX in

[6] The laboratory is headed by Dr Lanciné Traoré, Chef de Service. Dr Traore organised all meetings and kindly devoted his time during the period of the team's visit to Guinea to facilitating access to informants. Without his unselfish assistance it would have been almost impossible to gain such free access to stakeholders in the mango value chain.

Senegal or in Mali at the CRSP West Africa Project funded by USAID. It is expected that some assistance will be provided by Canada in setting up facilities in the CERE laboratory. However they recognise the need to move from chemical control to IPM, and for this there is a need for capacity development. The current status in Guinea of chemical products permitted for use on mango was not clarified.

5.3.10.2 Institut National de Recherche Agricole (IRAG)[7]

IRAG has six research centres of which four are regional: Foulaya in Basse Cote, dealing with pineapple, banana, citrus and some mango (varietal breeding); Baring in Moyen Guinee, dealing with citrus, avocado and temperate fruits; Bordo (Kankan) in Haute Guinee dealing with mango (main programme), cashew and oranges (Dr Beavogui indicated that the juice factory in Kankan may be reopened, though this was unconfirmed); Seredou in Guinée Forestière. Two further specialist centres deal with mangroves and with rice maize and groundnuts. IRAG has some collaborative research on integrated pest management in potatoes and vegetables under CRISP at Bordo and Baring, funded by USAID and coordinated by Dr Amadou Diarra in Mali.

A survey of public agricultural research since the early 1990s using new data collected under the Agricultural Science and Technology Indicators (ASTI) initiative (IFPRI-ISNAR-CORAF/WECARD 2002-2003) was made in 2003 (Stads & Beavogui, 2003[8]). This revealed dependence of research in IRAG on donor funding (especially World Bank) throughout the 1990s with little government investment. Qualification levels of senior staff and availability of support staff are low by regional standards. Many support staff were retrenched in 2003 when research programmes were cut due to lack of funds. The report predicted further erosion of capacity in the absence of additional government funding. On the basis of the visit made to Foulaya by this mission, the 2003 report was prescient.

5.3.10.3 IRAG Centre de recherché de Foulaya (CRAF)

The mission visited the CRAF and met with its Director, Mustapha Donzo, and with a large group of staff. It was a shock to visit this centre and observe the reality of the situation after hearing the bland remarks of the minister who had been the Deputy Director of the IRAG until less than a year ago. Despite being well-constructed and with numerous offices and a large laboratory (occasionally used for training courses), there appeared to be little research happening. One major reason for this was indicated by the absence of electricity at the station during the last three years. The local electricity transformer broke down and subsequently the wiring has been stolen. The Centre had a generator for a while, but this also broke down and was never mended.

The lack of action had recently culminated in a visit from the Prime Minister himself with the promise that repairs would be effected “within weeks”. It is impossible to adequately express the seriousness of such official neglect of an institution which houses the national germplasm collection for Mango (with 100 named varieties - see list in **Annex 5**) and is the main centre for fruit research (though mango research was moved to Bordo in Kankan following a review of regional crop priorities by IRAG in 1995). Foulaya is the largest centre and has 10 programmes of which six relates to specific commodities or value chains (banana, pineapple, cassava, citrus, other fruits, vegetables). Four cross-cutting programmes (genetic resources, food technology, laboratories, systems research) also exist.

[7] The mission met with Dr Sékou Beavogui, Directeur Générale of IRAG.
[8] Agricultural Science and Technology Indicators. ASTI Country Brief No. 12 • November 2003. http://www.asti.cgiar.org/pdf/Guinea_CB12.pdf

Mango research was the first programme undertaken at Foulaya. The collection of mango varieties remains there as part of the genetic resources programme. Dr J.-Y. Rey conducted studies of varietal susceptibility to fruit flies based at Foulaya. However no results of this have been seen. There are no adequate statistics on the current fruitfly situation apart from those gathered by M. Traore in conjunction with M. Vayssières. Otherwise only visual reports have been made of the severe effects on production of the invasive species.

5.3.10.4 DNA and IRAG staffing issues and work programme needs

It was very evident that the staff of both DNA and CRAF at Foulaya (and also those at Bordo) are mainly in their 50s and many are soon to retire. No thought appears to have been given to succession planning. The Ecole National d'Agriculture et d'Elevage (ENAE) de Bordo at Kankan produces about 100 graduates per year (50 for agriculture) from a three-year course (Diplome de technician d'Agriculture / d'Elevage). Another similar college exists at Tolo in Moyen Guinee. In the past top students "laureates" were selected to enter the public service. The mechanism for replacing ageing staff thus appears to exist. However the quality of the education received is not known and given the lack of resources is likely to be deficient in practical access to farmers and their fields and in exposure to new methods and good training materials. CRAF staff commented that the curriculum needs modernising to meet the needs of commodity value chains. There is little curriculum content on fruit. Students at Bordo can participate in programmes at the CRAB on a six month "stage" or attachment, and make short reports which are evaluated as part of their Diploma course.

5.3.10.5 Observatoire Régional des Fruits et légumes (ORFL/AOC)

The Observatoire Régional des Fruits et légumes (ORFL/AOC) was created by the Conférence des Ministres de l'Agriculture de l'Afrique de l'Ouest et du Centre (CMA/AOC) at its meeting of 29-30 Nov 2006. It is based in Conakry and its Directeur Executif is M. Mamy Keita, President of FICA. The aim of the Observatoire is to support the growth of the horticultural sector among the 20 member countries of CMA/AOC. On 1 December a one-day training workshop[9] was held by CMA/OC in Conakry on the subject of mango quality and fruit fly control which was addressed by Catherine Guichard, Deleguée Generale du COLEACP. In their Final Statement (Communique Final) participants noted the need for regional action to manage the fruitfly problem and requested that CMA/AOC should create a regional steering committee to develop a regional strategic plan for the short and medium term control of mango fruit flies. They also invited development partners to to assist this initiative to diversify and reinforce the competitiveness of African economies and develop the regional market.

5.3.10.6 Min. de l'Agriculture, de l'Elévage, de l'Environnement et des Eaux et Forets

The mission met briefly with the Minister, Dr Mahmoud Camara, who was formerly Directeur Adjoint of IRAG and is himself trained as a plant pathologist. Dr Camara was appointed to the government in early 2007 in the wake of civil disturbances expressing strong dissatisfaction with the previous administration. He is no doubt well aware both of the needs for mango production and export and the challenges facing his ministry in supporting this important value chain. He made brief remarks about the need for an integrated approach to fruit production, involving the crop, the soil and the pest complex. He referred to the quality focus of the current sectoral strategy and to Guinea's participation in a regional whitefly programme. He stressed the need for a sustainable pest management strategy based on bio-rationals and biological approaches. What he significantly failed to do was to make any comment on the state of LNPV and IRAG infrastructure or actions proposed by government.

[9] The advance publicity for this workshop on the CMA/AOC website confused "mouche blanche" and "mouche de la mangue". Source: http://www.cmaoc.org/fr/contenu/index.cfm?lang=fr&pageId=acc_59_633

5.3.10.7 Division Protection des Végetaux et des Denrées Stockées (DPVDS)[10], of the DNA

The Division has three sections:

- Section Défense des cultures, protection des stocks et reduction des perts apres recolte, DPV, DNA;
- Section Réglementation et homologation des pesticides, DPV, DNA;
- Section Prévention des Pathologies Végétales et Lutte contre les Grandes Fléaux (Service phytosanitaire), DPV, DNA.

The activities of the Service Phytosanitaire are considered under Government Phytosanitary Controls (Section 5.3.13.2, below).

The DPV does not undertake spraying itself, but has staff in the prefectures who can draw on private operators ("agents privés de traitement phytosanitaires") who have been trained in short courses at Kindia. For example each of five prefectures in Kankan region (Siguiri, Mondiana, Kouroussa, Kankan and Kerouane) has a member of the Protection de Végétaux staff, usually a Technicien Specialisé en Protection des Végétaux (TSPV), the equivalent of an ingenieur agronome, assisted by 2-3 junior technical assistants. Staff provide advice and training to farmers. There is also a rural radio station based in Kankan which can provide extension training messages for farmers.

The last training of spray operators appears to have taken place under the Projet National de Service Agricole (PNSA) in 2000. Trained staff were given equipment and received an official authorization ("agrément"). They were supposed to be monitored subsequently by DPV staff. There is a need for further training and better access to materials for both DPV staff and private operators. M. Pivi feels that there is a need for a phytosanitary risk analysis and he is in favour of forming a national committee for fruit fly management.

5.3.10.8 CFC[11] / Ministère de l'Industrie, du Commerce, du Tourisme et de l'Artisanat

The Common Fund for Commodities is an inter-governmental financial institution established within the framework of the United Nations, with 109 member countries. The CFC headquarters is located in Amsterdam. The Fund's specific mandate is to support developing countries that are commodity dependent to improve and diversify commodities production and trade. The Fund's supports development of commodities-based economies upon which the producers and exporters depend for their livelihoods. This is achieved by grants or loans targeted at projects typically having a market development and poverty alleviation orientation; and through a variety of project-based initiatives, usually with a multi-country coverage. Target beneficiaries are small producers-exporters, smallholders and small enterprises in developing countries, particularly the Least Developed Countries (LDCs). All projects that are financed must demonstrate a spin-off effect factor to address general and common problems of each commodity12. CFC has previously financed projects on mango value chain development in South America (Ecuador and Venezuela).

[10] The mission met with M. Moriba Pivi, Chef de Division Protection des Vegetaux which is scheduled to be rebranded as the national plant protection service at some point in the future.

[11] The mission met with Mme Hadja Zénab Diallo, Governor of the Common Fund for Commodities (CFC) in Guinea (Coordinatrice Generale des Projets du CFC en Guinee, Gouverneur du CFC pour le Guinee. Chef de Service de Développement et de Promotion des Exportations des Produits de bases (SEDEP)), based in the Ministère de l'industrie, du commerce, du tourisme et de l'artisanat.

[12] Projects must meet criteria set out in a manual available in french and English from the CFC website at http://www.common-fund.org/download/content/CFC-Manual_projects.pdf and http://www.common-fund.org/download/content/French.pdf

Since 1999 Mme Diallo, CFC Governor for Guinea worked with ICIPE on a proposal for Mango fruit fly control, but no agreement was reached on which should be the executing agency and much of the funding was proposed for ICIPE. Despite FAO approval, this proposal was never finalised or funded. A new proposal is to be submitted to the CFC Administrative Council in January 2008. This requires that final papers be submitted to FAO one month earlier. The executing agency will be IITA (Director, Dr James Braima) and CIRAD will also become a partner (though not a member of CFC) through the involvement of Dr Vayssières. A feasibility study would need to be conducted before final approval.

The proposed project aims to promote access to the EC market through commercialisation of mango, involving quality assurance, traceability, HACCP, EurepGAP certification and the eventual development of an "AfricaGAP" or "GuineeGAP" standard. The project will use the Centre d'Etudes et de Recherche en Environnement (CERE) of the Université Gamal Abdel Nasser de Conakry (UC) funded by Canadian Aid. Three Guinean staff (one each from IRAG Baring, Laboratorire de Contrôle de Qualité and CERE) have been selected to attend a potato quality certification course in Geneva in September 2007. The national standing committee will be chaired by Mme Diallo and include all the main actors in the mango value chain. A French language version of the CFC proposal was provided to the mission and a more recent English draft exists.

5.3.11 Post harvest practices and quality management in packing stations

Among the fruits subject to attack by fruit flies, only mangos for export via ports or airports pass through packing stations. According to the people we met, there are only four packing stations in Guinea, belonging to four more or less regular exporters. The old pineapple packing station at Daboya was rehabilitated by Project Cadre de Promotion des Exportations Agricoles (PCPEA) in 2002 and is now operated by SIPEF Guinea. Among these four stations, only the one operated by SIPEF has been certified by EUREPGAP/GLOBALGAP (thanks to assistance from PIP). It is also equipped with three cold rooms and a hot water bath for thermal treatment against anthracnose attacks. Unfortunately, this station ceases its activities quite early during the mango campaign due to the high pest pressure on the fruit. This is the only packing station to really operate according to the procedures described in Section 4.7.1, above. For the three other stations, the procedures are generally more traditional, without mechanised production-lines or soaking trays which can be used for thermal baths. Indeed, these packing stations deal mainly with organic mangos (which do not undergo any treatment) which are exported by plane.

The "Agro-industrial Complex" is a private company based at Foulaya, inaugurated in April 2005, which combines an abattoir and butchery with premises for fruit export. There is an electronic packing line for mangos in two large hangers, as well as cold storage. Unfortunately this has never worked properly due to lack of qualified management. The owners would like to link with an NGO and develop a juice processing plant.

5.3.11.1 The main phytosanitary constraints managed in packing stations

Mango exports in Guinea are constrained mainly by fungal problems (anthracnose and stem end rot: *pourritures pédonculaires*) or problems caused by insects (fruit flies, mealybug). In all packing stations, management of fruit fly is undertaken exclusively through inspection by personnel specially trained to detect traces of fly punctures. ECOCERT (organic) certification was also mentioned in the case of two companies. The SIPEF operates an equipped packing station but it is underused owing to the premature termination of its export campaign due to pest pressure, despite the thermal treatments put in place.

5.3.12 Supply of Plant Protection Products

Notwithstanding the existence of an industry association (Association des Producteurs, Importateurs et Distributeurs d'Intrants Agricoles – APIDIA) there is almost no agro-chemicals market in Guinea. This is partly due to access to credit for importation and high inflation of the currency.

5.3.13 Government Phytosanitary control

5.3.13.1 Centre d'Appui aux formalités d'Exportation (CAFEX)[13]

CAFEX is described as a "one-stop shop" for assistance in achieving both phytosanitary and quality certification for export produce. Mme Natalie Konan and M. Aly Sylla are seconded from the DPV to work as phytosanitary specialists within CAFEX, based at the airport in Conakry. CAFEX carries out inspections and gives certificates for both quality and phytosanitary purposes. Inspectors in the production areas certify harvested fruit (Certificat de Base) and this paperwork is verified at the port or airport before export.

5.3.13.2 Section Prévention des Pathologies Végétales et Lutte contre les Grandes Fléaux (Service phytosanitaires) of DPVDS of the DNA

The phytosanitary service of the DNA follows FAO guidelines. Services at the port and airport are made available through CAFEX. However SPS offices at frontier posts are not working yet. A recent review of SPS Capacity in Guinea (Humado and Traore, 2006) funded by USAID found that the lack of SPS personnel and facilities at border posts exposed Guinea to high risk of importation of pests and diseases. The risk posed by informal cross-border land trade and travel was also of concern to staff. No action had been taken more than a year after the report was issued.

The Service has poor record keeping (no database of volumes of specific plant materials imported or exported). There is no pest risk analysis and there are no lists of pests believed to be present or absent from the country. The review noted the need to improve phytosanitary inspection equipment and facilities at all inspection points as well as communications between them. A wide range of training needs were identified, including quarantine pest identification. The legislation needs to be brought into line with international Standards for Phytosanitary Measures.

The Phytosanitary Service delivers the phytosanitary certificates for exports and its agents are also in charge of the management of quarantine pests. They expressed their needs for training and resources (human and material) to undertake their tasks correctly. The need to centralise information has also been mentioned and more importantly the need to reinforce capacity to adequately police the flow of goods subject to phytosanitary certificates across land borders. Agents met also expressed a need to exchange with their colleagues from neighbouring countries to harmonise phytosanitary inspection procedures.

5.3.14 Guinean responses to the fruit fly problem

For the moment, no response has really been offered to the production crisis in the mango sector, neither by its operators nor by government authorities. The country is handicapped by:

- the disorganisation of its export sector
- the lack of resources of the operators

[13] Ousmane Bah, Coordonnateur National, and Mamadou Condé, Directeur

- government neglect of its agricultural infrastructure and services
- the fact that mango is mainly consumed locally and that people imagine that the resources are practically unlimited. It is difficult for a Guinean to imagine for example that because of pests such as *B. invadens*, all the Guinean mango production could be threatened, bringing about a food shortage.

5.3.15 Activities of International donors

5.3.15.1 Project National d'Infrastructure Rurale (PNIR II)

The World Bank-funded Projet Cadre Promotion des Exports Agricoles (which finished in 2002) helped with logistics of mango export, including pack-houses (stations de conditionment). Currently a packing station, referred to as a "plate-forme logistique" is being developed by CAFEX at Kankan with assistance from World Bank (WB) through the Project National d'Infrastructure Rurale (PNIR II) (Composante C). This is a "hard" project, mostly (90%) devoted to rural road construction with 5% for the packing station. Cold storage (3˚C) is being built at Kankan in a pilot programme which will be functioning by the end of 2008 and will have running costs financed completely for one year thereafter (including cartons for packing). This project has a poverty alleviation aim. The capacity will be 3000 t/yr. The PNIR II is also supporting the potato value chain at Timbi Madina in Pita Prefecture (Moyenne Guinée), which is less problematic than fresh mangos. Ousmane Bah of CAFEX is also Coordonnateur de la Composante C, PNIR II[14].

The presence of this facility at Kankan may significantly alter the pattern of mango export movements in Mali, Cote d'Ivoire and Guinea, since Conakry is only 650 km and 24 hours away from Kankan. Currently Malian produce is sent to Abidjan (900 kms and 48 hours away). Even Senegalese companies may extend their market campaign by using Kankan rather than sending to Dakar 1050 kms and 72 hours away). SIPEF, a subsidiary of a Belgian multi-national, is already exporting from Kindia (700 tons in 2007). A remaining issue apart from fruit fly will be ship schedules which do not currently prioritise Guinean freight because of low volumes. There is no plant protection element in the WB project and the USAID Commercialization Programme ended a year ago. Chemonix produced several reports. M. Condé offered to send us the project document but never did so. USAID is now concentrating exclusively on governance and health.

5.3.15.2 Appui au Renforcement de Commercialisation de l'Agriculture (ARCA)

The USAID-funded project: Appui au Renforcement de Commercialisation de l'Agriculture (ARCA), assisted small producers (1 ha average) of Kent and Keitt. It encouraged GAP including IPM for anthracnose and flies. The main strategy appears to have been orchard hygiene. The project ended in 2006.

5.3.15.3 COLEACP/PIP

There is no "Task Force" group in Guinea where different actors of the public and private sectors can exchange ideas. It is necessary to establish an environment that enables the few private operators to raise the state's interest in defending the mango sector. Considering the history of the mango sector in Guinea (abandoned processing factories), this will not be easy. Nevertheless, the creation of such a meeting space is essential if one wants to reach the operators and coordinate pest management at a regional level. Following this logic, the

[14] See article "Lutter contre la pauvrete en Guinee". Source : http://go.worldbank.org/2ME5WIS410

COLEACP/PIP works with professionals of the sector and several actions are already being developed (trapping system trials in orchards).

5.3.16 Difficulties and constraints in fruit fly management

This list is not exhaustive, but focuses narrowly on issues specific to fruit flies. For a more detailed assessment of the problems of the mango export industry, see **Annex 5**.

1. There is no national participatory planning and support group to manage the phytosanitary issues of the industry for pest management on mango or for management of fruit flies on fruit and vegetable crops.

2. There is currently no agreed fruit fly pest management strategy applied at orchard level, which would enable farmers themselves to reduce the impact of the pest.

3. Orchards are semi-natural parklands. They are usually small and very widely distributed with no clear boundaries to production areas. Many trees are very large and senescent. Varieties are usually mixed. There is little or no maintenance and access for removal of fallen fruit (or for bait applications) is difficult.

4. Farmers, many illiterate, are either not organized into groups or are members of groups with diverse interests.

5. There is no forum for information exchange and consultation between different actors in the value chain in relation to managing pest problems during production.

6. The National research body currently has no effective research programme for fruit fly management and progress is hampered by the remoteness of the research station at Kankan, poor communications, and lack of equipment, consumable supplies, funding, review and accountability to the industry for the activities of researchers.

7. There has been no recent survey (by rearing from damaged fruit) of fruit fly species incidence in different zones, on different varieties, and at different times of the year, to determine the current relative impact of the main fruit fly species after the arrival of *Bactrocera invadens*.

8. There is no access to supplies of materials needed for IPM in fruit trees (traps, lures, baits, pesticides, instruction manuals).

9. There is limited national capacity for identification of fruit flies of economic importance with reliance on occasional external interventions by CIRAD. Some flies are still referred to obsolete taxonomic categories. There is also no agreed national reference collection facility for these pests.

10. There is a lack of adequate training and equipping of phytosanitary inspectors for checking of fruit consignments and in carrying out surveillance to prevent importation of exotic pests.

11. There is no information sharing mechanism to ensure rapid dissemination of new information within the subsector and to collect feedback for planning.

12. There is a lack of training and capacity-building for farmers in integrated pest management for fruit trees as opposed to delegating responsibility to external service providers.

13. There is no scientific information on the impact of fruit flies on other crops apart from mango (e.g. cucurbitaceous and solanaceous vegetable fruits), nor the species responsible for the damage.

14. The eventual scope and activities of the CFC project are as yet unclear[15]. It will be important to avoid duplication of effort in planning any new EC intervention related to fruit flies.

5.3.17 Proposals for a National Action Plan: Guinea

A Regional Action Plan (Section 7) has been developed in parallel with National Plans, to ensure effective division of responsibilities and work. Some items in a National Plan need to be in place in all countries (see item 1, for example).

1. Creation of a National Fruit Fly Planning Body

Government and the horticultural industry need to establish a joint planning and consultative body (Comité National de Lutte contre les Mouches des Fruits) which will oversee the development and implementation of a National Action Plan for Management of Fruit Flies. Ideally the National Committee should have co-chairs from the public and private sectors. Members should be representative of all main types of stakeholders in the value chain (growers and exporters, SPS regulators, LNPVDS, universities, IRAG, donors, projects, government agencies).

2. Research

The research community in Guinea (IRAG, LNPVDS, University) needs to be perceived as a service provider to the horticulture industry. The implications of this are that funding should be by grants for specific work based on preparation of a concept note, followed by a detailed plan of the research with clear time frame and quantified outputs. Results of research should be reported rapidly to the National Planning Group and should be externally assessed before release of further funds. The list of research topics below is not exhaustive but deals with pressing concerns.

(a) Assessing damage to mango by individual fruit fly species

A monitoring activity should be carried out by rearing larvae from fallen fruits collected in the orchards, which is the sole method of quantifying the proportional levels of damage attributable to the different species. Since the MAT/TEM technique is likely to play a major role in future control programmes against *B. invadens*, and because the MAT attractant methyl eugenol (ME) is highly attractive to this species, but not at all attractive to the *Ceratitis* species, information on relative damage levels of *Ceratitis* and *Bactrocera* is essential for planning future campaigns. The aim should be to take samples of infested fruit at intervals throughout the season (e.g. monthly) in several different areas, representative of the range of temperature and humidity across all the mango-growing zones. The only materials needed are plastic containers, sand, infested fruit and mosquito gauze.

(b) Evaluation of control methods

A programme of evaluation of control methods (*méthodes de lutte*) should be started, assessing several methods, including spot spraying with baits (including GF-120) and MAT (technique d'eradication des Males - TEM). Fibre board or wooden blocks (plaquettes) impregnated with parapheromones (in particular methyl eugenol) and a toxicant, are effective against males of species closely related to *B invadens* in Asia, but their effectiveness needs to be demonstrated against *B invadens* in West Africa. See Annex 5 for a detailed

[15] This seems likely to be a regional project including Guinea, Ivory Coast, Burkina Faso, and Sierra Leone.

description and costing for a complete pilot programme of integrated pest management which should be put in place and monitored by researchers with the participation of DNA local field agents.

All of these research activities will benefit from regional cooperation.

(c) Assessing varietal resistance to fruit fly attack in mango
Develop protocols for assessing the degree of susceptibility of different varieties to fruit flies with a view to improve germplasm or to popularise less susceptible cultivars. (resistance or tolerance to mealybug should also be sought at the same time). Work previously done in Guinea by Rey and others should be reviewed as a starting point for this work. It will be necessary to link with researchers from other countries in the region.

(d) Surveying fruit fly species composition and damage levels on vegetables
Surveys of cucurbitaceous and solanaceous vegetable fruits are needed to determine which species are present and the level of losses they inflict. Again this needs to involve sampling of produce and rearing of flies for identification.

3. Procurement of supplies for pest management and IPM capacity building
If it is necessary to promote control methods using baits (*appâts*) and para-pheromones, it will also be essential (1) to find sources of supply of these inputs so that producers can buy them and (2) to devise financial instruments to allow them to purchase them (for example financial guarantees for loans to purchase inputs before the start of the mango season). It is therefore also necessary that the physical inputs and the necessary instructions for using them (extension, training) should arrive at the same time, so as to link together the inputs and the information. Ideally a training of trainers (ToT) approach should be used to equip a cadre of trainers from the industry associations to ensure that their farmers are fully capable of applying the methods in their orchards.

4. Fruit fly identification capacity and reference collection
Guinea needs to be able to identify all likely fruit fly species which may be found on fruit and vegetables, especially in view of imminent quarantine threats to the country (see Section 4.5). This will be best achieved by training representatives of IRAG and agencies, provision of information and manuals and the designation of a single national clearing house for identification which will maintain a reference collection on behalf of the horticulture industry. Such facilities must not be seen as an end in themselves but as a practical service provider to the industry. Basic storage facilities are needed including a room which can be kept air-conditioned as a collection room and laboratory to prevent deterioration of insect reference collections. Airtight insect pinning boxes are also essential.

5. Capacity building for the quarantine service
Specialised training, part theoretical and part practical needs to be designed and delivered to inspectors of the Phytosanitary Service of the SNPV, to enable them to meet their obligations in pre-export inspection of fruit, especially mangoes. A quite separate module of training is needed to enable inspectors to assess incoming fruit and also to operate a system of sentinel traps at border posts and fruit markets. Their working conditions will also need to be improved with better equipment and facilities for SPS inspection and diagnosis, both at exit/entry points and at the post-entry centre. SNPV staff also need access to current literature and manuals, including internet access.

Regional Issues:

6. Pesticide Registration

Registration of pesticides and other inputs for IPM is an important regional issue. If there will be any changes in the requirements of importing countries (e.g. the pesticides specified for MAT/TEM or baits (appâts)), a rapid response will be needed. At present GF-120 is undergoing registration for spot treatment, but MAT/TEM blocks with malathion, fipronil or spinosad also need to be registered as a specific use. Since Guinea is not a member of CILSS or of UEMOA there is a need to conduct its own registration process while pursuing harmonization at the level of CMAOC and ECOWAS/CEDEAO.

7. Traceability

The requirement of traceability for imported fruit which is beginning to be demanded by the importers, underlines the need for a unified “audit trail” of responsibility and documentation for phytosanitary certification of produce destined for export. CAFEX is well-placed to ensure this, given adequate record-keeping.

8. Upgrading inward quarantine surveillance

Quarantine and phytosanitary defence against the arrival of further exotic fruit fly pests such as *Bactrocera zonata*, which has already reached Libya and Egypt, are issues probably better managed at regional level. See Section 4.5 and Tables 5 and 6 for an indication of the importance of this issue. However, at national level, as noted by Bonfour (2006), it is important to develop pest risk assessments for specific quarantine threats (such as the species of *Bactrocera* currently present in North East Africa and Arabia). This is a requirement of the WTO and IPPC as is the development of national lists of pests present and not present in the country.

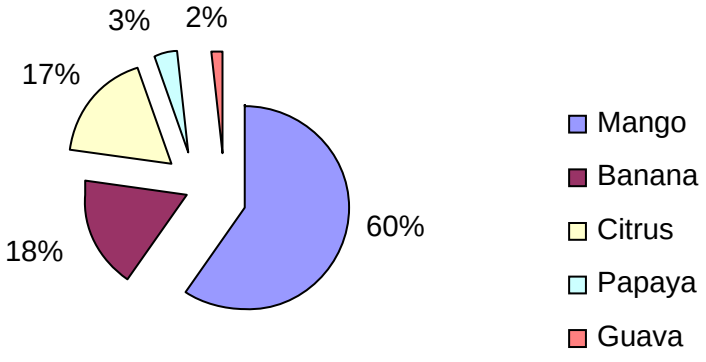
5.4 National Situation Synopsis: MALI

The fruit subsector plays an important role in the economy, as a source of income for rural people. The main fruit crops in Mali are mango, banana, citrus, guava and papaya (**Figure 21**), of which mango is the most important, accounting for about 60% of production. The mango harvest lasts from February to August. The temperature ranges between 23 and 32°C in the South and from 25 à 40°C at Bamako. The rainy season lasts from May until September, with occasional rain in October. In all the production zones, mango producers are organised in cooperatives.

The main fruit production regions in Mali are Kayes (Prefecture of Kita); Koulikoro (Prefectures of Kati, Dioïla, Koulikoro, Kangaba); Sikasso (Prefectures of Kolondieba, Yanfolila, Bougouni, Sikasso, Koutiala, Yorosso), distributed between the South, the South-West and the Centre of the country. There are four main areas of mango production:

- Sikasso Region: the Prefecture of Kolondièba is the main production area of the Amélie mango in Mali but it also grows other varieties destined for export (Kent and Keitt). This production zone appears to be the most affected by fruit flies. Many late varieties are harvested here during the rainy season when pests exert the strongest pressure.
- The area of Yanfolia (Sikasso), close to the Ivory Coast, from where collectors come to buy mangos, has used grafting to adapt existing orchards to the needs of the European market. Although it harbours several varieties within the same orchard, Kent and Keitt varieties dominate.
- Koulikoro Region: The municipality of Siby is the main supplier of mangos consumed locally. Planted with varieties which are not sought for on the European market (the Noukourouni variety is the most common), besides the national market, it supplies other countries in the sub-region (Mauritania in particular). Practically every adult land owner owns a few trees. Pest pressure is extremely high with losses to various insects (fruit flies and ants) which can exceed 90% in the worst cases.
- Kayes Region. The area of Kassaro is mainly planted with the Amélie variety it is trying to develop a little more export varieties but due to difficulties of access, the production of this area continues to supply the local market.

Figure 21. Fruit production in Mali in 2005

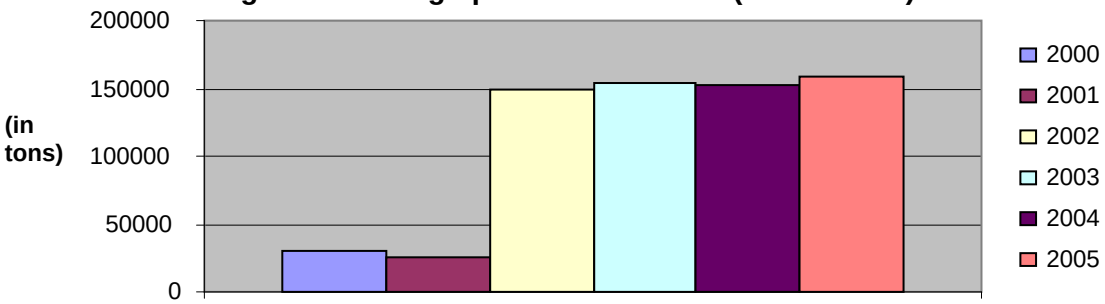


Source: DNA

5.4.1 Mango production in Mali

According to production data obtained from the DNA, production has progressed very strongly in the last 5 years. Estimated slightly above 30,000 tons in 2000, it has increased to 160,000 tons in 2005 (**Figure 22**), although FAO suggests a figure close to 200,000 tons , of which 25% are grafted varieties. However the PCDA estimates national production as high as 550,000 tons, from a growing area of around 28,400 ha, of which export potential is seen as 60,000 t.

Figure 22. Mango production in Mali (2000 – 2005).



Source: DNA

There are more than 100 mango varieties in Mali, amongst which the main cultivars are: Amelie, Kent, Keitt, Brooks, Valencia, Smith, Irwin, Bewerly, Musca, and some other local varieties. The most frequently traded varieties are: Amélie, Irwin, Zill, Kent, Valencia, Palmer, Aden, Smid and Keitt. The seasonal cycle is shown in **Table 27**. Average yields are estimated to be around 6 t/ha (2005) in Mali. (PCDA).

Table 27. Seasonal cycle of principal mango varieties in Mali.

Varieties	*Flowering*	*Nouaison*	*Fruiting*	*Maturation*	*Harvest*
Amélie	October - November	January	March - April	April	End of April
Irwin	November - December	February	March - April	April	April - May
Zill	November - December	January - February	End of February	February	End of February - March
Kent	November - December	February	March - April	May	May - June
Valencia	November - December	February	March - April	April	April - May
Palmer	November - December	February	March - April	April	April - May
Aden	November - December	February	March - April	April	April - May
Smid	November - December	February	March - April	May	May – June
Keitt	November - December	February	March - April	June	June - July

5.4.1.1 Types of orchards

The initial purpose of mango orchards in Mali was not to produce fruit for export. Very often the first orchards planted served essentially to demarcate a plot of land or a property. Subsequently they became linked to social status. Rich people with land planted mango trees to occupy land that they did not want to leave in a state of neglect. The tree left to itself grew and in its time produced fruit. Moreover, in this Muslim country, it was also considered as a way of giving alms. One can thus distinguish between three types of orchards in Mali.

- The so-called traditional orchards planted with several mango varieties. They represent 75% of the country's orchards. They were neglected until mango exports began to develop, benefitting only from a superficial clearing of the undergrowth to prevent bush fires which are quite important in this part of Africa. The lack of maintenance and difficulty of access in orchards with several fruit varieties (sometimes over 15) mainly intended for local consumption or sub-regional trade have turned these areas into real incubators for the different fruit fly species found in the country. In the last three years (2004/2005 campaign), several measures have been established to ensure their upkeep. The prime objective is to turn these orchards into regular sources of profit for mango exporters. In this type of orchard, losses to the various fruit fly species vary between 60% and over 90%.

- Improved traditional orchards are orchards which have been gradually transformed by grafting to obtain a higher proportion of fruit varieties adapted to export (Kent, Keitt, Amélie, Palmer, etc). At present, they represent about 20% of Malian orchards and are also the main suppliers of export mangos (over 80% of fruit sent to Europe come from this type of orchard). According to the season, losses in this type of orchard can amount to over 60%.

- Modern orchards are rare. They are planted with one or two varieties in rows to facilitate mechanised maintenance. They require financial capital for irrigation, treatments, regular pruning. Their produce is intended to satisfy European customers who are more demanding with respect to certain aspects of quality. They barely represent 5% of Malian orchards. Losses to fruit flies in this type of orchard are said to fluctuate between 40% and 60% depending on the period of the campaign.

Table 28. Seasonal nature of mango production in Mali.

Varieties	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
Variety/Vernacular name									
Zill /Télima									
Amélie/ Grafted									
Irwin/ Blémani									
Valencia / Diema									
Haden									
Palmer									
Smith									
Kent /Kogninakun									
Julie / Muscat									
Maya									
Victoria/ Apple									
Keitt Sumalè									
Springfield/Papaya mango									

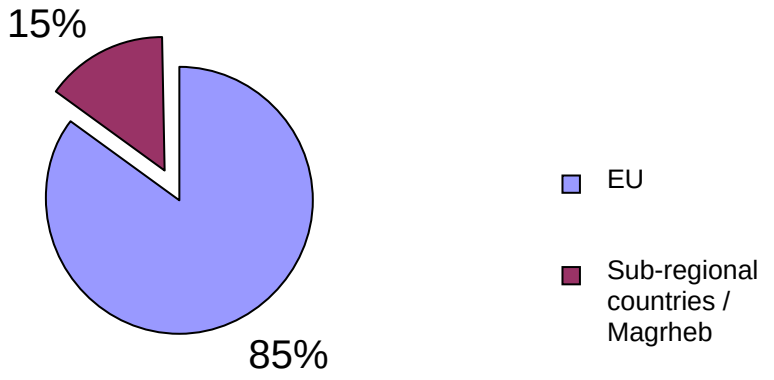
5.4.2 Farm-gate prices for mango (2007)

Prices vary from region to region. Around Bamako the farm-gate price is: 85 à 105 FCFA/Kg, and at the market: 150 FCFA/Kg. At Sikasso: the mean farm-gate price is: 95 FCFA, and at the market: 150 FCFA. At Bougouni: farm-gate price is: 66 to 85 FCFA/Kg.

5.4.2.1 The national and sub regional market

Amongst the varieties listed in **Table 28**, all are sold on local markets and only four are not exported to Europe (Springfield, Victoria, Julie and Haden). Quantities consumed on the national market as well as those exported to sub regional markets are the object of important exchanges. These are not always registered as they are made by land. Besides, it seems that some of the exchanges occur without phytosanitary certificates. Organisation of fruit collectors into associations has contributed to the export of over five tons of mangos during the 2007 campaign. However, figures concerning sub regional trade must be revised upwards since they do not take into account flows to the Ivory Coast. A rough estimate of percentages exported to all destinations is given in **Table 29** for 2007.

Figure 23. Main destinations for Malian mango exports in 2007



Source: EUROSTAT

Table 29. Estimated export destinations and modes of transport, 2007

Destination	% of exports	Mode of transport
France	46	Air
Belgique	3	Belgique : avion
Espagne	3	Air
Côte-d'Ivoire	18	Surface transport
Burkina	10	Surface transport
Sénégal	10	Surface transport
Libye	5	Air
Gabon	2	Air
Mauritanie	3	Surface transport

Source: S. Tchibozo (2007) modified

Table 30. Calendar of exportation, by variety

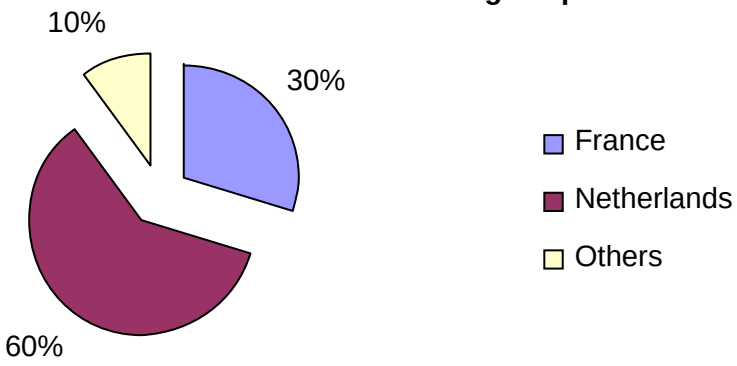
Variétés	*Exportations*
Amélie	April
Irwin	April-May
Zill	Feb-March
Kent	May-June
Valencia	April-May
Palmer	April-May
Aden	April-May
Smid	May-June
Keitt	June

Source: S. Tchibozo (2007)

5.4.2.2 Malian exports to Europe

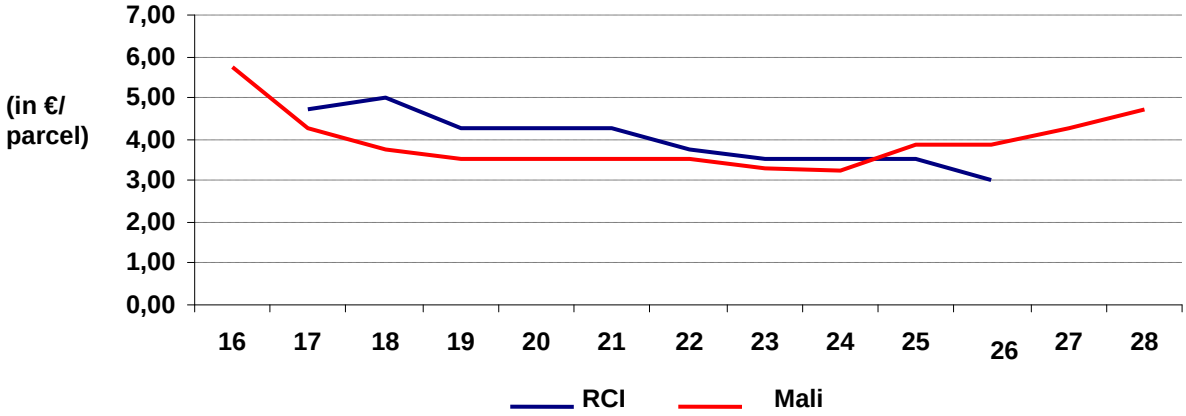
The export value chain is said to involve about ten exporters, 22 collectors (pisteurs) and 33,000 producers. Malian exports are predominantly to Europe with a significant trade with the Magrheb countries (**Figure 23**). Although Mali has a large variety of mangos, its export campaign to Europe only takes place from mid March to mid July. Exports to countries in the sub region start earlier (February) and finish later (beginning of August). Malian mango exports to Europe progressed from 708 tons in 2002 to over 3,400 tons in 2006 when they represented 11% of volumes received by Europe from ACP countries. The main European markets for Malian mangos during the 2006 campaign were the Netherlands with 60%, followed by France (30%) (**Figure 24**). During the latest campaign, over 60% of Malian mango exports by boat were made to the Netherlands where Mali was in competition with the Ivory Coast (**Figure 25**). On the airfreight market where seizures for pest causes are more frequent, Mali must confront stronger competition from other West African countries. The end of its campaign overlaps with the beginning of that in Senegal (Figure KK).

Figure 24. Main destinations for Malian mango exports to Europe in 2006



Source: EUROSTAT

Figure 25. Price of "Kent" mangos (by boat) from the Ivory Coast and from Mali on the Dutch market in 2007.



Source: Pierre Gerbaud

5.4.3 Main export constraints for mangoes and other fruit tree crops

- These are tied to the poor mastery of logistics (availability of containers, boxes and inputs, loading bays)
- Requirements of the receiving markets,
- Financing of the campaign and
- Lack of communication between actors in the value chain linked to poor management.

5.4.4 Pest problems on fruit trees

Losses caused by fruit flies to mango are estimated to reach 90 to 95 % of production on occasions. IER estimate losses at a more conservative 50%[1]. In addition to fruit flies (**Table 31**), Kadidiatou Touré Gamby and Moussa Noussourou also spoke of serious attacks of mango mealybug on mango trees in the dry season. The mealybug problem is said to be more serious in Sikasso than the fruit fly damage. There are also attacks on mango trees by termites which have caused the death of some trees.

Table 31. Incidence of fruit flies on mango (according to local informants).

Espèce mouche - Espèce hôte \	Bactrocera invadens	Ceratitis cosyra	Ceratitis quinaria	Ceratitis silvestrii
Mangue	1* (1)	4*** (1)	3*** (1)	3***(1)

Damage codes: ? = unknown species; 0 = not found (0% fruit loss); 1 = minor damage (0-15% fruit loss); 2 = medium damage (16-30% fruit loss); 3 = severe damage (31-45% fruit loss); 4 = Very severe damage (> 46%). **Distribution codes:** * = Limited distribution; ** = Moderately widespread distribution; *** = Very widespread distribution. Information Sources: (1) Dr. Kadidiatou Touré Gamby & M. Moussa Noussourou.

[1] IER, undated. Les Mouches des Fruits au Mali. 3 pp.

5.4.5 Fruit fly host crops

Apart from mango, which we know is the object of fruit fly attacks, the agents of the Direction Nationale de l'Agriculture (DNA) have determined which fruits and vegetables are attacked by different species of Tephritidae. Results of the incubation work done by the DNA are shown in **Table 32**.

Table 32. Fruit flies reared and identified from fruit and vegetables in Mali by DNA.

	Ceratitis cosyra	*C. silvestrii*	*C. fasci-ventris*[2]	*Bactrocera invadens* (since 2005)	*C. capitata*	*Dacus ciliatus*	*Dacus vertebratus*
Mango (*Manguifera indica*)	+	+	+	+			
Guava (*Psidium guajava*)	+	+			+		
Melon (*Cucumis melo*), Cucumber (*Cucumis sativus*) Courgette (*Cucumis pepo*), and Watermelon (*Citrillus vulgaris*)						+	+
Chili pepper (*Capsicum frutescens* or *C. chinense)* and sweet pepper (*Capscum annuum*)					+		
Clementine (*Citrus reticulata*), Orange (*Citrus sinensis*), Mandarine (*Citrus deliciosa*), etc.	+	+		+	+		

Source: T. Paqui, from DNA

5.4.6 Research activities on fruit flies

The earliest studies on fruit flies in Mali were those of Yaro 1977 who made a study of what he considered to be *Ceratitis capitata* on mango[3], and Diarisso (1977)[4] who detected an unknown *Ceratitis* species which was later identified by Dr A. Freidberg (Israel) as *C. rosa*. However we now know that this should be referred to *C. fasciventris* (see Section 4.5 and Table 5 for taxonomy of West African *Ceratitis*).

5.4.6.1 The Institut d'Economie Rurale (IER)

IER is charged with carrying out research activities in support of national agricultural production. Studies have been published since the mid 1990s (Noussourou, 1995. In 1998 five fruit fly species were identified by IER staff with the assistance of Dr Vayssières (Noussourou, 2001). Finally in 2003, a substantial study appeared of the fruit flies

[2] known to workers in Mali as "*Ceratitis* sp. close to *rosa*"
[3] In fact the species he saw could have been one of a number of others species apart from *C. capitata*.
[4] Diarisso, N.T. 1977. Etudes de quelques aspects entomologiques des arbres fruitiers du domaine du Centre National de Recherche Fruitières. Mémoire de fin d'études de l'Ecole Normale Supérieure pour l'obtention d'un DER en Biologie.

associated with mango (Vayssières et al, 2004). This recognised 6 species of which *Ceratitis cosyra* was the most serious pest, making up more than 80% of flies on most varieties, apart from Kent (57%). *C. silvestrii* and *C. quinaria* were the second and third most important species, respectively, with highest numbers reared from Kent variety. Larvo-pupal parasitoids, comprising four Braconidae Opiinae, one species of Eulophidae Tetrastichinae and two species of Pteromalidae Pteromalinae were found to parasitise *C. cosyra*, and to some extent also *C. sylvestrii*, *C. quinaria* et *C. fasciventris*.

More recent research activities carried out have concerned identification of the species of flies collected by trapping, economic evaluation of fly damage, population dynamics, plant hosts and the parasitoids of *Ceratitis cosyra*. The 11 fruit fly species now recognised or identified are: *Ceratitis cosyra*, *C. sylvestrii*, *C. anonae*, *C. quinaria*, *C. fasciventris*, *C. ditissima, Ceratitis (Pterandus) flava*, *C. (Pterandrus*) sp, *C. pedestris*, *C. (Ceratalopsis) connexa and Bactrocera invadens.* Economic assessment showed that the mango varieties most susceptible to damage are: Brooks, 36,1%; Alphonse de Goa, 32%; Miami late, 25%; Eldon, 15,7%; Bewerly, 14,4%, and Smith, 11,1%.

Plant hosts of fruit flies inventoried include: *Psidium guajava, Citrus aurantium, Persea americana, Annona senegalensis, Citrus reticulata, Citrus sinensis, Butyrospermum parkii, Nauclea latifolia, Landolphia senegalensis, Cordyla pinnata, Saba sengalensis, Landolphia beudolotii* et *Calotropis procera*. Larvo-pupal parasitoids, comprising four Braconidae Opiinae, one species of Eulophidae Tetrastichinae and two species of Pteromalidae Pteromalinae were found to parasitise *C. cosyra*, and to some extent also *C. sylvestrii*, *C. quinaria* et *C. fasciventris*.

The Institut d'Economie Rurale (IER) has three research stations, at Baguineda, 30 kms from Bamako, Sotuba, 7 kms from Bamako and at Sikasso. IER has 9 researchers. The Programme Fruits et Legumes is based at Sotuba but works in all regions. The Head of the programme is Mme Kadija Toure. Mme Toure presented some results of pesticides research with COLEACP (2003-4) in the World Bank videoconference. There are small reference collections of fruit flies at Sikasso and at Baguineda. Some work was done on a US-funded project Centre Agro-Entreprises (CAE) from 2000-2001 to develop trap monitoring with baits and pheromones and set a threshold of 25 flies per trap for intervention with deltamethrin sprays on the lower foliage of trees (0-1 metre only). IER worked on *Ceratitis capitata* on vegetables in the past but chemical control was unsustainable. The team would now like to use local attractant materials but have little experience with *Bactrocera invadens*[5].

Monitoring of fruit flies is carried out by the IER, the Projet Cadre Intégré and the Office de la Protection des Végétaux (OPV), using plastic « Addis » traps (CIRAD model) with pheromone or alimentary baits. CIRAD has provided some traps and attractants free of charge to IER for these studies. Attractants used are terpinyl acetate, trimedlure, methyl eugenol, cuelure, buminal, or buminal with borax. Experimental control sprays utilise five different products: bifenthrine, imidacloprid, lambda-cyhalothrin, malathion and spinosad. Incubation of infested fruit is done using screened wooden cages at IER.

The population dynamics of *Ceratitis cosyra*, were studied using food-baited traps between the end of May and end of August 2004. The population peaked during the period 20 - 25 June, then declined almost to extinction in August. This pattern varies from region to region. For example in the area of Baguineda, fruit flies are present in the mango orchards between

[5] In the opinion of this consultant it would be better to use the cheapest standard treatments using commercially prepared attractants and toxicants to avoid problems of quality variation and poor availability with locally produced preparations. Prices will reduce once economies of scale begin to operate. MAT blocks can certainly be made from locally sourced material but with commercial attractant chemicals. Baits may be prepared from brewery waste following recipes from other countries that have done this.

January and August, reaching their peak population at the end of June and beginning of July, whereas in the Sikasso region, catches start at the end of May and the maximum population is attained between the middle and end of July.

For the future it will be important to repeat the careful work of Vayssieres et al (2004) to establish the pattern of seasonal and spatial damage by different species on mangoes in Mali. This is because all previous research was carried out before the arrival of *Bactrocera invadens*. The extent to which *B. invadens* has displaced the *Ceratitis* species individually and as a group is unknown. *B. invadens* is originally a humid forest zone species. There are suggestions that *B. invadens* in Mali has not displaced *Ceratitis* to the same extent as has occurred further south in some other countries of ECOWAS/CEDEAO.

5.4.7 Mango producer and exporter organizations

Three associations of mango producers are found in Bamako, Sikasso and Yanfolila: Coopérative des Producteurs de Mangues de Bamako (Copromang), Union Régionale des Producteurs de Mangues de Sikasso, Union des Coopératives de Producteurs de Mangue de Yanfolila. These three associations bring together almost all the mango farmers in the producing region. Their role is to facilitate information exchange among producers to enhance their productivity.

At Bamako there are four companies which export by air: Association Malienne des Exportateurs de Légumes et Fruits (AMELEF) ; Association des Professionnelles de l'Exportation de Fruits et Légumes (APEFEL) ; Association des Jeunes Exportateurs (AJEX) ; Cie Fruilema. Three large independent companies are based at Sikasso which export by boat: Tropical Expression Mali (TEM); Agrumes et Oléagineux du Mali (AOM) ; Fruitières Lotio. Professional organizations bring together all the small and large exporters for fruits and legumes. They exchange information on improving exports and defending their common interests. Names and contact details for these organizations are given in **Annex 6**. Two companies (IB-Négoce and FLEX MALI) are EUREPGAP certified and three cooperatives are certified as organic.

5.4.8 Control methods utilised by farmers

The only control methods which are used are the collection and burial of fallen fruits and occasional blanket chemical treatments with insecticides. Collection and burial is very time-consuming but more environmentally benign than blanket spraying. Chemical control is more expensive and producers lack the financial means to treat their orchards regularly.

5.4.9 Post harvest practices and quality management in packing stations

Only mangos intended for export via ports or airports pass through packing stations. Those exported to Middle Eastern and Maghreb countries are subject to packing. but not necessarily in modern packing stations. It is necessary to distinguish between three types of packing stations. The description of the essential elements of a packing station (Section 4.7.1, above) mainly corresponds to the only mechanised station we encountered, the private station operated by the AOM company.

- There is only one modern packing station, established in the Sikasso region, belonging to the AOM company. It has a mechanised chain, an electronic grading system and cold stores (pre cooling room and cold rooms). The new PLAZA (Périmètre Logistique Aménagé en Zone Agricole) station, set up near Bamako airport could aspire to this status. Unfortunately, it was not yet finished at the time of our visits, its mechanised chain having not yet been delivered. The Plaza packing centre has been offered to Mali by the

Dutch Cooperation Service. Although it has not been officially inaugurated, during the latest campaign, the Plaza has functioned and provided free services (with expertise from the Ivory Coast with respect to inspection and packing). Eventually, this centre is meant to operate as a service provider. The question of the management of this station as well as the cost of its services is crucial and must be dealt with by the sector in view of future campaigns. Until its completion, this station had better be classified as an improved packing station.

- "Packing premises" consist of any premise used to manually package fruit. There are a few of these. Two of them are equipped with mechanised inspection chains (that of Mali-Primeurs and that of Flex-Mali) but on the other hand they have no real cold facility. Mali-Primeurs has a refrigerated container which can hold about 8/10 tons.

- Finally, there are what we will qualify as "packing points". They are the most widespread and consist of open spaces with rather rudimentary shelter to protect the people undertaking the inspection as well as the mangos from direct sunlight or from the rain.

With the exception of the « packing points », in most cases and with few variations, the work in packing stations can be broken down as already detailed in Section 4.7.1, above. The Plaza station has provided the help of a few inspectors from the Ivory Coast. This operation appears to have been a success as there were no interceptions amongst the exports which left the Plaza. When the station is equipped with cold rooms, fruit pallets are immediately stocked (pre cooling operation with cold air to reduce the temperature of mangos before being stocked in the proper cold room) before being dispatched.

Table 33. Number and description of packing stations

No.	*Zones*	*Stations*	*Capacity*
1	Bamako	Flex-mali	No information
2	Bamako	Ib-négoce	No information
3	Bamako	Elias	No information
4	Bamako	Mali-primeur	No information
5	Bamako	Yaffa et frères	No information
6	Bamako	Plaza	20 tonnes/jour
7	Sikasso	Entreprise Lotio	No information
8	Sikasso	TEM	No information
9	Sikasso	AOEM	No information
10	Bougouni	-	No information
11	Yanfolila	-	No information

5.4.9.1 The main phytosanitary constraints managed in packing stations

The main phytosanitary constraints managed by packing stations are: the fruit fly, the mealybug and anthracnose. Several studies have been carried out on the seasonal fruit fly population dynamics. At present, nothing specific is done in packing stations to control fruit flies apart from inspection by trained inspectors who come from the Ivory Coast for the most part. Since the various conferences on the fruit fly, more and more detailed prophylactic measures have been developed. In Mali, where fruit collectors are more organised in associations than elsewhere, they are an essential protagonist with respect to fruit quality, in the sense that they do the first selection.

5.4.10 The role of the DNA (Direction Nationale de l'Agriculture)

The Ministry of Agriculture has three central Divisions: The Direction National de l'Agriculture (DNA), The Direction Nationale du Genie Rural (DNGR) and the Office de Protection des Végétaux (OPV). The OPV is represented at Regional level by the Service Régional de Protection des Végétaux (SRPV) and at Cercle level by the Secteur de Protection des Végétaux (SPV).

The DNA is divided into four divisions:

- The Legislation and Phytosanitary Inspection Division
- The Crop and Plant Product Promotion and Development Division
- The Agricultural Extension, Training and Rural Animation Division
- The Promotion and Monitoring Division

As the official service in charge of plant protection, the DNA, via la Division Législation et Contrôle Phytosanitaire (DLCP), is responsible for:

- delivering phytosanitary certificates for export.
- Drawing up the legislation and regulations with respect to plant production, phytosanitary inspections, packing and inputs.
- Inspection of the quality of the packing of plant products and foodstuffs
- Regulation of the activities of operators in the sector
- Regulation and certification of pesticides (under the Law N0 02-014 of 3 June 2002 and Decree No 02-306 of 3 June 2002).

Mali is a member of CILSS and its pesticide legislation defers to the decisions of the CSP. La DLCP plays a role in devising protocols for experimentation with pesticides before their certification. The DNA is also in charge of the management and protection of the territory against the introduction of quarantine pests. The current Malian phytosanitary legislation dates from 2002 (Law No 02-013 and Decree No 02-305 of 3 June 2002). Further details of relevant legislation may be studied in the mali Country Report - **Annex 6**. The discussions we had with the various DNA services have revealed a need to update the knowledge of phytosanitary agents and to train them in sampling techniques. A need to harmonise control practices in West Africa was also mentioned.

The DNA (2007)[6] has issued a proposal setting out the financial needs for the construction and equipping of control posts and laboratories, training of inspectors for regulation and control activities, and for financing of the activities of the Comité National de Gestion des Pesticides(CNGP). Overall, DNA has estimated a sum of 2,500,000,000 (2.5 billion) FCFA. This budget fails to distinguish clearly between capital and recurrent expenditure, but nonetheless it provides an insight into the scale of the needs. At a lesser scale but with more closely argued justification, a proposal was prepared with the support of PCI for assistance from the STDF/FANDC to strengthen the function of SPS in Mali.

[6] Direction Nationale de l'Agriculture, 2007. Besoins Pour le Renforcement des Capacités de la Direction Nationale de L'agriculture en matière de legislation et de Contrôle Phytosanitaire. Stratégie de mise en œuvre du contrôle phytosanitaire et suivi de l'application de la législation. Division Législation et Contrôle Phytosanitaire / Direction Nationale de l'Agriculture. Bamako, Mai 2007.

5.4.11 The Programme Compétitivité et Diversification Agricoles (PCDA)

The PCDA is the largest programme of the Ministry of Agriculture financed by the International Development Association of the World Bank. It is endowed with 46 million USD over a six year duration. It has five components, covering 1) innovation in irrigation and intensification of production; 2) Improving value chain performance; 3) improved access to finance; 4) Improved infrastructure (rural roads, packing stations, cold stores); programme management. It operates partly through a system of competitive "matching grants" for new technology aimed enhancing production and processing, on the basis of submission of sub-project proposals from stakeholders.

PCDA is financing a two year programme on GIS for quantifying fruit production zones, including use of remote sensing to identify mango areas. Mango is a priority value chain for PCDA. In relation to fruit fly, PCDA was the focal point for the World Bank videoconference which brought together the main actors in Mali which was useful in sensitising stakeholders. Together with IER, PCDA has made a review of past activities in relation to fruit fly pest management[7]. This showed that strategies had been developed under the USAID funded CAE project, but there had been no dissemination of the methods developed. IER said that no further research was needed in their view. PCDA is not providing inputs for plant protection. The market for these is very small at present because 80% of producers are small family businesses. 1-2 ha is large here. Component 1 will include demonstrations and dissemination of IPM for fruit flies using monitoring traps and spot treatment with bait sprays.

At post-harvest level, the PCDA is interested in phytosanitary risks and developing norms (good practice guidelines) for product handling which would be complementary to the CODEX food safety norms. PCDA intends to provide post-harvest training for mango value chain stakeholders. Currently the production norms do not cover plant protection product active ingredients and withholding times. PCDA will work with the Agence Nationale de Securit**é** Sanitaire des Aliments (ANSSA) in relation to residues.

5.4.12 Projet Cadre Intégré (Integrated Framework) of the Direction Nationale du Commerce et de la Concurrence (DNCC)

The Projet Cadre Intégré (PCI)[8] was initiated by the Departement de l'Industrie et du Commerce in 2006. It is part of a six-country initiative (Guinea, Senegal, Burkina Faso, Niger, Mauritania, Mali) financed by a consortium of the World Bank, IMF, UNDP/PNUD, WTO (Organisation Mondiale du Commerce - OMC), UNCTAD (Conférence des Nations Unies sur le Commerce et le Développement - CNUCED) and the ICC (Centre du commerce International - CCI). The project is predicated on the premise that exports can be a motor to drive rural development and reduce poverty.

The Initiative selected the mango value chain as a subproject to improve the export quality of fruit. The PCI has engaged in EurepGAP Certification of growers and created a guarantee fund to assist the banks to provide credit (8% loans) to exporters (at a rate of about 5 million FCFA per exporter), to pay for purchase of fruit, transport, packing materials etc. It is also seeking to diversify Mali's export outlets, e,g, to Belgium and Germany. Pulp is seen as a promising processed product because it is less affected by fruit flies and less open to contamination than juice.

[7] Kouyaté, D., Bouaré, S., Touré, G.K. and Noussourou, M. 2007. Mouche des Fruits, Etat des lieux au Mali. Video conference II, 21 Mars 2007. Annexe. Etats des lieux des travaux de recherche sur la mouche des fruits de mague au Mali. Pp 9-17. PCDA.

[8] More correctly : « Le Cadre Intégré Pour L'assistance Technique Liée Au Commerce En Faveur Des Pays Les Moins Avancés »

One of the first actions of PCI was the blanket spraying of 611 orchards, with a combined area of 2000 hectares, in Sikasso, Bougouni, Yanfolila and Bamako. The farmers did not pay for these treatments. This exercise was repeated in 2007 on 4000 ha representing 840 orchards (twice, in March and June) at a total cost of 360,000 USD, paid for by UNDP and the government of Mali. The inputs were purchased from pesticide dealers who import them from France. The most commonly used insecticide is Dursban, for which the price varies between 10,000 and 12,500 FCFA per litre[9]. Decis (Deltamethrin) which is registered for use on mangoes in Ivory Coast is not registered in Mali.

The UNDP website maintains that spraying was essential to raise the quality of the produce destined for the export market, and that mangoes from the treated orchards enjoyed a price premium of 25-35,000 FCFA per tonne, compared to untreated orchards, based on a mean farm-gate price of 65,000 - 100,000 CFA per tonne[10]. The article lays sole claim to the credit for increasing the national mango export tonnage from 2927 in 2005 to 4521 t in 2006. The treatments were apparently conducted with the assistance of the Office de la Protection des Végétaux. However some commentators assert that the owners of the orchards are not informed in advance of the day of the treatment and do not know the service providers mandated by the Projet Cadre Intégré.

Some Malian researchers suggest that such treatments were not effective, and may have eliminated a good proportion of the natural enemies which suppress other pests, such as the mango mealybug. In the past no orchards were regularly sprayed with pesticides and mangoes were, in effect, produced organically. This was the case until 2006 when the Projet Cadre Intégré started chemical treatments. In addition such free spraying encourages dependency on the part of the growers and creates a poor precedent for the future. An assessment of the effectiveness of chemical spraying against fruit flies in March 2007[11] reported that it had not had any effect on fruit fly populations which start to rise after the first rains. However the PCI maintained that the June spray would permit the mango campaign to continue up to the end of July, instead of being terminated by fruit fly damage as occurs in Ivory Coast.

This difference of views highlights two issues: first, the need for clear plans and strategies which are communicated to, and command the confidence of all stakeholders (including research), and secondly, the need to monitor the condition of the orchards before and after spraying. This can be achieved using pheromone traps at a standard spacing (which has been established in previous years by IER). This would permit efficacy to be evaluated. In addition it is also important to evaluate the effect of blanket spraying on the mango mealybug and on non-target insects such as natural enemies of pests, including red ants. PCI's article describes the ants also as pests, despite their known value as biocontrol agents against fruit flies (see Section 4.6.6).

[9] However, it is not clear if this pesticides was actually used by PCI for their treatments.
[10] « Expérience réussie. Grand bond dans les exportations des mangues ».
http://www.ml.undp.org.html/mangues.html
[11] Projet Appui à l'Intégration du Commerce. 2007. Rapport de mission. Prospection et évaluation de l'impact du traitement des vergers de manguiers dans les zones de Sikasso, Bougouni, Kadiola et Yanfolila. 13 p.

5.4.13 Fonds pour l'application des normes et le développement du commerce (FANDC/STDF)[12]

The Standards and Trade Development Facility (STDF/FANDC) is a global programme in capacity building and technical co-operation established by the Food and Agriculture Organization of the United Nations (FAO), the World Organization for Animal Health (OIE), the World Bank, the World Health Organization (WHO) and the World Trade Organization (WTO). The strategic aims of the STDF are:

- to assist developing countries enhance their expertise and capacity to analyze and to implement international sanitary and phytosanitary (SPS) standards, improving their human, animal and plant health situation, and thus ability to gain and maintain market access; and
- to act as a vehicle for co-ordination among technical co-operation providers, the mobilization of funds, the exchange of experience and the dissemination of good practice in relation to the provision and receipt of SPS-related technical co-operation.

In Mali, FANDC has financed a project preparation mission in association with Projet Cadre Intégrée, to prepare a project valued at USD 585,800 over two years (of which 508,800 will be a grant from STDF/FANDC to improve application of phytosanitary measures for fruit and legumes in Mali. This was based on a consultancy report (Bonfour, 2006)[13] which reviewed the state of the phytosanitary system in Mali, using the mango value chain as a case study. The report identifies a major SPS constraint to production in the lack of any national capacity to identify fruit flies. However interestingly Bonfour cites red ants (presumably *Oecophylla*) as an operational hindrance in cultivation and harvesting of orchards. She notes that their biology is unstudied in Mali. There is in fact a pressing need to establish the biological role of these ants, since according to IITA/WARDA they have a considerable positive benefit in protecting fruit from fruit flies (see Section 4.6.6).

The Bonfour report documents the legislative basis of SPS in Mali and notes that there is no institutionalisation of SPS pest risk analysis, that points of entry and exit are not regulated and that there is no national list of quarantine pest organisms or prohibited products. There are no legal texts covering inspection and certification during production and post-harvest packing. Lastly Bonfour notes the lack of any system for information exchange between different actors, which makes interventions and rapid response difficult to accomplish. At the operational level, Bonfour notes the lack of training of producers, pisteurs, and SPS personnel in international SPS norms. She outlines the total lack of even the most basic facilities for the inspectors to carry out their duties (no table, no room, no quarantine station, no facility for destroying or treating infested produce). Finally she reiterates the absence of coordination and information sharing, citing little contact between producers, pickers, exporters and SPS staff. The recommendations of the report are highly pertinent and are reproduced in **Table 34**, below.

[12] The Standards and Trade Development Facility (STDF) http://www.standardsfacility.org/index.htm. The French language version of the website is not yet installed.

[13] Bonfour, M., 2006. Annex 3. Contraintes liées à l'application des SPS au Mali. Etude réalisée pour le secteur des fruits et légumes frais. In : Projet de coopération entre la République du Mali et le Fond pour l'Application des Normes et le Développement du Commerce. Projet Cadre Intégré. 19 pp.

Table 34. Objectives and activities for improvement of phytosanitary services in Mali. Source : Bonfour (2006).

Specific Objectives	Activities
Institutional capacity development of the SPS control system	Training of SPS control personnel in concepts and methods of inspection and relevant international norms.
	Review and overhaul of the SPS legislation and its harmonization with regional and international legislation.
	Development of manuals of standard operating procedures for SPS control, compliant with international standards.
	Reinforcement of controls on pesticide residues at packing stations.
	Assistance in field operations aimed at registration of pesticides.
	Development of a rational monitoring system to classify pest organisms logically and [produce a list of quarantine organisms.
Equipment	Install necessary infastructure for improving the quality of legumes and fruits in general and mangoes in particular.
	Reinforce laboratory capacity in terms of analysis and sampling equipment.
	Assist exporters and fruit collectors with transport and storage for fruits and legumes, especially purchase of refrigerated vehicles.
Training and information needs upstream of SPS inspections	Train mango producers in IPM
	Develop an information system on pests of plants and plant products.
	Develop databases and reference collections for pest organisms.
	Train producers, fruit collectors and exporters in phytosanitary measures.

5.4.14 The Task Force

The COLEACP/PIP took part in the establishment of a Task Force in Mali. The president of this Task Force is the President of the Association of Producers and Exporters of Mangos in Mali. The Task Force served to disseminate information concerning cultural practices which should be adopted to reduce the pest pressure in an orchard. The main activities concern the extension of cultural practices and encouraging operators to use chemical treatments.

Table 35. Official structures assisting producers

Organization	Personnel	Budget	
Programme Compétitivité Diversification Agricole (PCDA) (Ministry of Agriculture)	8	23 billion CFA over 6 yrs.	Project financed by the World Bank and the Malian Government to assist agricultural diversification: mango is a focus commodity. Djiguiba Kouyate, Specialiste Filière of PCDA is National focal point for fruit flies
Helvetas	2	?	Financed by the Swiss Government to organise agricultural value chains. Promotes organic mango production.
TradeMali	3	?	Financed by the US government to improve organization of agricultural value chains
Office de Protection des Végétaux (OPV)	10	?	Financed by the Malian government to oversee crop protection
Institut d'Economie Rurale (IER)	13	?	Financed by the Malian government to promote agricultural and forestry research
Direction Nationale du Commerce et de la Concurrence (DNCC)	7	>1 million USD	Financed by the Malian government to strengthen trade and competitiveness

5.4.15 International donor activities

Donor activities are concentrated on assisting the organization of the value chains, in research and in registration of pesticides. These are listed in **Table 36**.

Table 36. Donor-funded assistance project and programmes involving mango.

Project	Donor	Location	Actors	Nature of assistance
TRADE Mali	USAID	National	Local traders, transporters, exporters	Promote value chain
Mali Finance	USAID	National	Local traders, transporters, exporters	Access to credit
Project de développement des productions agricoles au Mali (PRODEPAM)	USAID	National	Producers	Enhance quality and productivity
PCDA (Ministry of Agriculture)	Govt + IDA	National	Producers, collectors, exporters	Enhance intensification and value chain performance
Programme Promotion des Filières (PRO-FIL)	HELVETAS	Pref. Bougouni, Yanfolila, Kolondieba	Producers	Advice, training on organic production
PCI	UNDP/PNUD	Bamako, Sikasso	Producers	Assistance and advice on quality
Programme Croissance Economique	Govt + IDA	National	Small and medium enterprises/industries (SME/I)	Develop and promote SME/I
Project Jèkassy	Coopération Suisse	Sikasso, Koutiala and Yorosso Prefectures	Producers, processors	Advice, assistance, commercial promotion
PASAOP	World Bank + Govt	National	Producers	Advice and organization of producers

5.4.16 Difficulties and constraints in fruit fly management

This list is not exhaustive, but focuses narrowly on issues specific to fruit flies.

1. There is no national participatory planning and support group to manage the phytosanitary issues of the industry for pest management on mango or for management of fruit flies on fruit and vegetable crops.

2. There is currently no agreed fruit fly pest management strategy applied at orchard level, which would enable farmers themselves to reduce the impact of the pest, and evident disagreement exists on appropriate control methods.

3. There is insufficient cooperation and consultation between different actors in the value chain (Projet Cadre intégré, OPV, IER, etc) in relation to managing pest problems during production.

4. The National research body IER has produced research recommendations which were never disseminated and are not well known to other actors. However the arrival of *Bactrocera invadens* means that those recommendations and approaches need to be critically reviewed, especially given the responsiveness of *Bactrocera* to ME (to which *Ceratitis* species are unresponsive). There is currently no effective research programme for fruit fly management and lack of funding, review and accountability to the industry of the activities of researchers.

5. There has been no recent survey (by rearing from damaged fruit) of fruit fly species incidence in different zones, on different varieties, and at different times of the year, to determine the current relative impact of the main fruit fly species after the arrival of *Bactrocera invadens*.

6. There has been inadequate monitoring of the populations of pests and their natural enemies in the orchards treated by Projet Cadre Integré.

7. Farmers have been habituated to receiving free spraying for fruit flies. What will happen when this is withdrawn?

8. There is no access to supplies of materials needed for IPM in fruit trees (traps, lures, baits, pesticides, instruction manuals).

9. In Mali it appears there is a need for surveys and damage estimates for *Rastrococcus invadens* (mango mealybug) to determine its economic impact and the infested zone as well as effects of pesticide treatments against fruit flies on populations of the pest and its natural enemies.

10. There is limited national capacity for identification of fruit flies of economic importance with reliance on occasional external interventions by CIRAD. Some flies are still referred to obsolete taxonomic categories. There is also no agreed national reference collection facility for these pests.

11. There is a lack of adequate training and equipping of phytosanitary inspectors for checking of fruit consignments (see **Table 34**).

12. Absence of an information sharing mechanism to ensure rapid dissemination of new information within the industry and to collect feedback for planning.

13. Lack of training and capacity-building for farmers in integrated pest management for fruit trees as opposed to delegating responsibility to external service providers.

14. There is no information on the importance of fruit flies in damaging other crops (e.g. cucurbitaceous and solanaceous vegetable fruits).

5.4.17 Proposals for a National Action Plan: Burkina Faso

A Regional Action Plan (**Section 7**) has been developed in parallel with National Plans, to ensure effective division of responsibilities and work. Some items in a National Plan need to be in place in all countries (see item 1, for example).

1. Creation of a National Fruit Fly Planning Body

Government and the horticultural industry need to establish a joint planning and consultative body which will oversee the development and implementation of a National Action Plan for Management of Fruit Flies. Ideally the National Committee should have co-chairs from the public and private sectors. Members should be representative of all main types of stakeholders in the value chain (grower and exporter associations, regulators, universities, IER, donors, projects, government agencies).

2. Research

The research community in Mali (IER, universities) needs to be perceived as a service provider to the horticulture industry. The implications of this are that funding should be by competitive grants for specific work based on submission of a concept note, followed by a detailed plan of the research with clear time frame and quantified outputs. Results of research should be reported rapidly to an oversight group (which should be centred in PCDA) and should be externally assessed before release of further funds. As a start, the field trials of 2007 with COLEACP-PIP should be critically evaluated to learn lessons on the efficacy of the process as much as on the technical results.

The list of research topics below is not exhaustive but deals with pressing concerns.

(a) Assessing damage to mango by individual fruit fly species

A monitoring activity should be carried out (updating the work of Vayssières et al., 2004) by rearing larvae from fallen fruits collected in the orchards, which is the sole method of quantifying the proportional levels of damage attributable to the different species. Since the MAT/TEM technique is likely to play a major role in future control programmes against *B. invadens*, and because the MAT attractant methyl eugenol (ME) is highly attractive to this species, but not at all attractive to the *Ceratitis* species, information on relative damage levels of *Ceratitis* and *Bactrocera* is essential for planning future campaigns. The aim should be to take samples of infested fruit at intervals throughout the season (e.g. monthly) in several different areas, representative of the range of temperature and humidity across all the mango-growing zones. The IER already has experience in this work and the only materials needed are plastic containers, infested fruit and mosquito gauze.

(b) Evaluation of control methods

A programme of evaluation of control methods (*méthodes de lutte*) should be started, assessing several methods, including spot spraying with baits (including GF-120) and MAT (technique d'eradication des Males - TEM). Impregnated fibre board or wooden blocks (plaquettes) using parapheromones (in particular methyl eugenol) and a toxicant, are effective against species closely related to *B invadens* in Asia, but their effectiveness cannot be guaranteed against *B invadens* in West Africa.

(c) Organic certification for control operations

To ensure that organic production of mango in Sikasso region can be, it is also important, as far as possible, to assess how to obtain an organic certification for control operations, such as spot bait applications and traps or parapheromone blocks (*plaquettes*) (methyl eugenol) which are useful against fruit flies and *Bactrocera invadens* in particular.

<u>All of these research activities will benefit from regional cooperation.</u>

(d) Simple biological control technology
The potential of weaver ants (known to be active in Malian orchards) for fly control has been shown in Benin (see Section 4.6.6). The level of natural control in orchards should be assessed using the methods pioneered by van Mele, with a view to disseminate this organic technology to organic producers in Mali.

(e) Assessing varietal resistance to fruit fly attack in mango
Develop protocols for assessing the degree of susceptibility of different varieties to fruit flies with a view to improve germplasm or to popularise less susceptible cultivars.

(f) Surveying fruit fly species composition and damage levels on vegetables
Surveys of cucurbitaceous and solanaceous vegetable fruits are needed to determine which species are present and the level of losses they inflict. Again this needs to involve sampling of produce and rearing of flies for identification.

3. Procurement of supplies for pest management and IPM capacity building
If it is necessary to promote control methods using baits (*appâts*) and para-pheromones, it will also be essential (1) to find sources of supply of these input so that producers can buy them and (2) to devise financial instruments to allow them to purchase them (for example financial guarantees for loans to purchase inputs before the start of the mango season). It is therefore also necessary that the physical inputs and the necessary instructions for using them (extension, training) should arrive at the same time, so as to link together the inputs and the information. Ideally a training of trainers (ToT) approach should be used to equip a cadre of trainers from the industry associations to ensure that their farmers are fully capable of applying the methods in their orchards.

4. Fruit fly identification capacity and reference collection
Mali needs to be able to identify all likely fruit fly species which may be found on fruit and vegetables, especially in view of imminent quarantine threats to the country (see Section 4.5). This will be best achieved by training representatives of several agencies, provision of information and manuals and the designation of a single national clearing house for identification which will maintain a reference collection on behalf of the horticulture industry. Such facilities must not be seen as an end in themselves but as a practical service provider to the industry.

5. Capacity building for the quarantine service
Specialised training, part theoretical and part practical needs to be designed and delivered to inspectors of the DLCP, to enable them to meet their obligations in pre-export inspection of fruit, especially mangoes. A quite separate module of training is needed to enable inspectors to assess incoming fruit and also to operate a system of sentinel traps at border posts and fruit markets. Their working conditions will also need to be improved with better equipment and facilities for SPS inspection and diagnosis, both at exit/entry points and at the post-entry centre. DLPC staff also need access to current literature and manuals, including internet access.

Regional Issues:

6. Pesticide Registration

Registration of pesticides and other inputs for IPM is an important regional issue. If there will be any changes in the requirements of importing countries (e.g. the pesticides specified for MAT/TEM or baits (appâts), a rapid response will be needed at the level of CILSS. At present GF-120 is undergoing registration for spot treatment, but MAT/TEM blocks with malathion, fipronil or spinosad also need to be registered as a specific use.

7. Traceability

The requirement of traceability for imported fruit which is beginning to be demanded by the importers, underlines the need for a unified “audit trail” of responsibility and documentation for phytosanitary certification of produce destined for export.

8. Upgrading inward quarantine surveillance

Quarantine and phytosanitary defence against the arrival of further exotic fruit fly pests such as *Bactrocera zonata*, which has already reached Libya and Egypt, are issues probably better managed at regional level. See Section 4.5 and Tables 5 and 6 for an indication of the importance of this issue. However, at national level, as noted by Bonfour (2006), it is important to develop pest risk assessments for specific quarantine threats (such as the species of *Bactrocera* currently present in North East Africa and Arabia). This is a requirement of the WTO and IPPC as is the development of national lists of pests present and not present in the country.

5.5 National Situation Synopsis: BURKINA FASO

5.5.1 Agro climatic zones with fruit production

The fruit growing area in the West of Burkina Faso consists of a single agro-climatic zone with rainfall between 900 and 1100 mm per year. The mean temperature varies between 24.9°C et 30.2°C. These conditions are favourable for fruit and especially mango production.

5.5.2 Fruit production 2000 to 2006

Fruits grown in Burkina Faso are listed in **Table 37** with their tonnage. Although citrus is the highest volume crop, mango is the main fruit product in Burkina Faso. Even though a large part of the production appears to be consumed locally, the mango sector is firmly directed to exports (Africa and Europe). Total fruit production is estimated between 100,000 and 120,000 tons.

Table 37. Fruit production in Burkina Faso (1999 – 2003).

Year	Fruit and nut crop production (tons)							
	Mango	Citrus	Guava	Banana	Pineapple	Avocado	Cashew	Papaya
1999	26,650	66,194	1,685	11,024	166	5	1,019	260
2000	26,502	66,380	1,701	11,130	168	5	1,029	262
2001	26,754	67,467	1,717	11,236	170	5	1,040	265
2002	27,007	68,03	1,733	11,342	171	5	1,049	268
2003	27,259	68,740	1,750	11,448	173	5	1,058	270

5.5.3 Mango production in Burkina

FAO data, which estimated production at only 7,200 tons, do not correspond to the data registered for trade. Local information indicates a mango production volume in Burkina of between 50,000 and 75,000 tons. The mango harvest in Burkina lasts from March to September. Fruit production in Burkina is concentrated in two areas:

- The South-West region is the main production area composed of two adjoining sub-regions (the waterfall region and that of the high ponds) which form a bloc. The South-West region alone represents over 75% of the country's fruit production (citrus, cashew, mango, banana and papaya). Mango contributes over 60% of this fruit production and citrus about 30%. Although there exist over 40 mango varieties across the country, the 7 principal ones in terms of trade both inside and outside the country are represented in the South-West (Amélie, Kent, Keitt, Valencia, Brooks, Springfield and Lippens). It is in this region that the Kénédougou Department is found, which is the first to have converted its old mango orchards to the Amélie and Kent varieties.
- The West-Central area which represents 20% of the country's fruit production. It grows mainly Amélie mangos as well as several other varieties for local consumption.

5.5.4 Types of orchards

Three main types of orchards can be distinguished:

- The so-called traditional orchards which still represent the majority of land dedicated to mangos. They are old orchards (average age between 35 and 65 years) of mixed varieties intended for the national and sub-regional markets. Predominant until the 1980's, they still represent over 23% of the country's mango production. They are not

maintained and constitute a reservoir of fruit flies, posing a hazard to other nearby orchards.

- The “intermediate” traditional orchards are between 10 and 25 years old and represent over 60% of the orchards in production. They are planted with several varieties mainly intended for export, initially Amélie, but gradually being converted to Kent and Keitt mangos. Often planted close to traditional orchards, they suffer from pest attacks but do not receive any protective measures (in terms of chemical control or prophylactic measures).
- Modern orchards are rare and estimated at less than 2% of the total. They are mainly orchards planted with a single variety (Kent or Keitt), at regular intervals and with a drip irrigation system. The main handicap to the development of this type of orchard is linked to land tenure (difficulty of access to land) and to the financial means necessary to establish such orchards. Although they are more easily and better maintained (fallen fruit are collected and buried), they nonetheless are subjected to strong pest pressure due mainly to their proximity to the other two types of orchards and to the weakness of the means for controlling fruit flies.

5.5.5 The national and sub-regional market

The national and sub-regional mango consumption mainly concerns the traditional varieties as well as the “second choice” fruit removed from export for non-compliance. So called ordinary mangos (green and fibrous) begin the campaign at the national level. The local prices indicated in **Table 39** vary according to the variety and the offer at a given moment in the campaign. Typical prices (2007) by variety: Amélie (50 - 60 F/kg), Kent (100 - 112 F/kg), Keitt (100 - 112 F/kg), Brooks (30 F/kg). Subregional trade is carried on by road transport (lorries, motor bicycles, bicycles) and on foot for the resource-poor. Phytosanitary control becomes very difficult, even non-existant in these circumstances. Although it is also possible that Burkina imports mangos from neighbouring countries (such as Guinea), it has not been possible for us to confirm the existence of these flows. Official services in charge of controlling flows have very few data concerning cross-border trade although it is very important. This is also due to the fact that a large part of this trade is informal without phytosanitary certificates. Moreover, records of phytosanitary certificates are not centralised.

Among the varieties mentioned in **Table 40**, below, only four (Amélie, Kent, Keitt and Valencia) are exported to Europe directly from Burkina Faso. For these four varieties, commercial channels also exist via the Ivory Coast, Mali and now Ghana which re-export them, often as produce of local origin. Other varieties are mainly subject to local or cross-border trade to countries such as Niger or Mauritania. In sub-regional markets there is less demand for specific varieties than with the European market. The varieties exported in this way travel in 10 ton trucks generally packed in 60 kg cardboard boxes. The global pattern of exports of mangos from Burkina Faso is indicated in **Figure 26**. In the last 10 years, exports from Burkina to the Maghreb and Middle-Eastern countries have developed. The operators that supply these markets admit that they chose not to be subjected to the requirements of markets such as those of the EU, not always as profitable as one could believe them to be. These markets look for mangos which are not infested but especially for mangos which taste good. The Lippens variety whose fruit can exceed 1.5 kg are appreciated. The calendar of mango exports of different varieties is as follows: Amélie, from February to April; Kent, from April to June; Keitt, from May to July. The pattern of seasonal development in different varieties is shown in Table FF.

Table 38. Seasonal succession of mango varieties in Burkina.

Variety / Vernacular names:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Green mango / Ordinary or Noukourni									
Amélie (Grafted / Governor)									
Springfield / Papaya									
Valencia Mademoiselle									
Lippens /Timi-Timi									
Kent / Kourba Kourba									
Keitt / Laban									
Brooks / Retard									

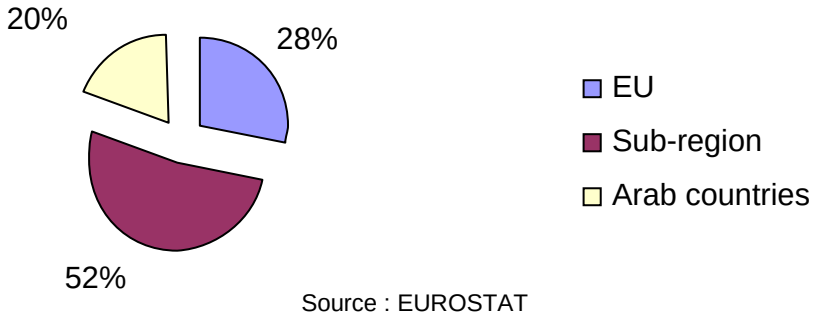
Table 39. Indication of mango prices on the Burkina Faso national market (FCFA/kg).

Marketing stage	Local varieties (Mango)	Improved varieties (2nd choice local market)	Improved varieties intended for export
Field side	20-35	50-75	190-275
Popular market wholesaler	70-80	100-175	
Urban wholesaler		200	300-350
Urban stalls and major roads		400	400-500

Table 40. Seasonal cycle of principal mango varieties in Burkina.

Variety	**Flowering**	**Fruiting**	**Maturity**	**Harvest**
Amélie:	From December	January – February	January - March	February to April
Kent:	January - February	February – April	February - April	March - June
Keitt:	February - March	March – April	April - May	May - July
Lippens:	January - February	February – April	February - April	March - June
Brooks:	February - March	March – April	April - May	May - July
Springfield:	January - February	February – Avril	February - April	March - June

Figure 26. Official mango exports from Burkina Faso



Source : EUROSTAT

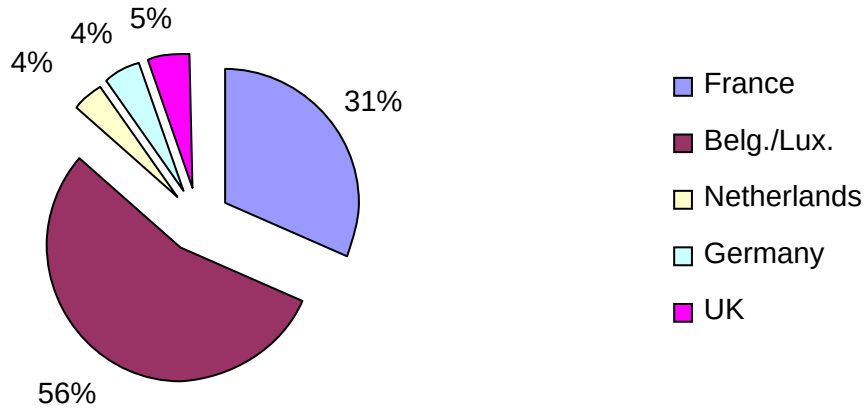
5.5.6 The export markets

Pest pressure depends on the fly variety and the season. Nevertheless, this pest pressure is felt differently by exporters, depending on the mango varieties and the markets targeted. For varieties sought by European markets (Kent Keitt and Valencia), operators (exporters from Burkina or importers from the sub-region intending to re-export the production) pay particular attention to the fruit due to the fact that fruit flies (whatever their species) are quarantine pests whose presence leads to the consignment's destruction. Concerning varieties which are less desired in Europe (such as Lippens and Brooks), the operators we met declare that they are more resistant to fly punctures. In addition the markets to which they are sent appear to judge them more from the point of view of their quality and taste.

5.5.6.1 Burkina Faso exports to Europe

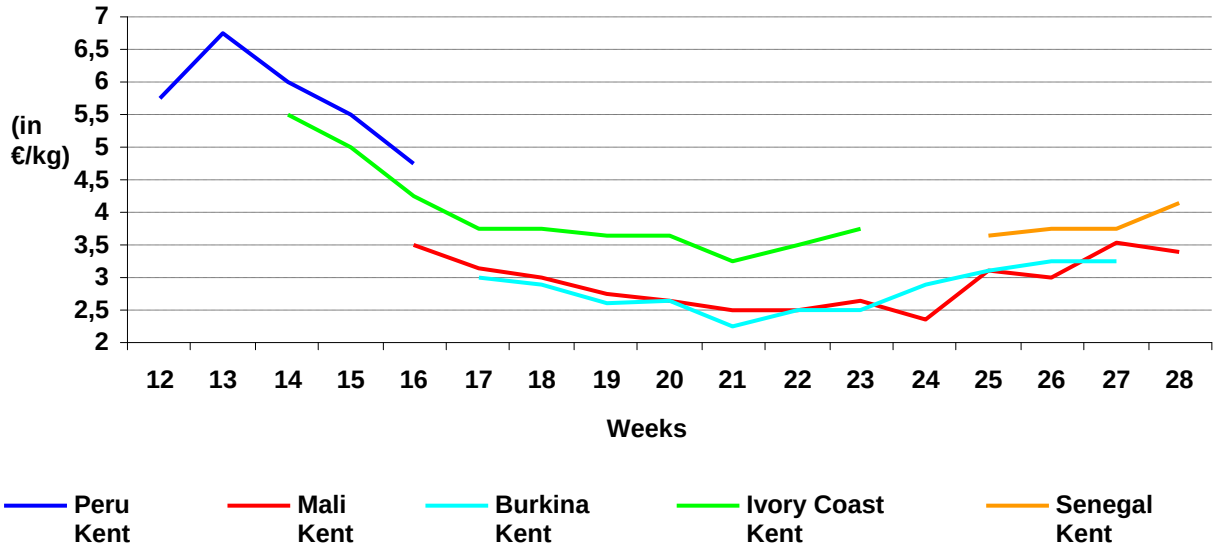
Exports from Burkina to Europe travel by boat (75%) and by airfreight (25%). The main fruit exports to Europe which can be affected by fruit flies are mangoes. The main market for mango exports from Burkina is the Benelux with 56%, followed by France with 31% (**Figure 27**). Exports increased from 260 tons in 2002 to over 2,100 tons. Whereas in 2002, mango exports from Burkina hardly represented 1% of quantities exported to the European Union by ACP countries, this had risen to 7% in 2006. In the case of mango exports to European markets or to destinations that re export to Europe, the campaign is halted well before the end of the production period, to avoid having to destroy two or even three consignments and thus lose the small profit gained during the campaign. The main reasons for this early interruption of the campaign are anthracnose and the fruit fly. As a landlocked country, initially Burkina Faso depended very much on air freight for dispatching its mango exports. The situation appears to have evolved with time and the development of maritime transport.

Figure 27. Main countries receiving mangos from Burkina in 2006



Source: EUROSTAT

Figure 28. Comparative price of mangos (airfreight) from Burkina Faso, Mali, Ivory Coast, Senegal and Peru on the French market – 2007.



Source: Pierre Gerbaud

During the 2007 campaign, Burkina exported mangos to Europe by plane and by boat. The Burkina label, due to the small amounts exchanged, was not particularly recognised on the market. **Figure 28** indicates a somewhat lower price than for Ivory Coast and Senegal mangos. However, this is evolving. The label was present on the market during 11 weeks. Although exports by boat continued during most of July, those by plane ceased as early as the beginning of July, pest pressure being too high and the losses in case of seizure of a consignment too important. The label is above all starting to make a name for itself as a source of high quality organic mangos. Unfortunately, it hasn't yet managed to fully exploit its potential. No doubt this will change with the increase in quantities exported and the work presently undertaken with respect to the quality of exported fruit. Costs of exportation from Burkina to Europe are shown in **Table 41**.

Table 41. Costs of mango exportation from Burkina to Europe by air and sea.

	Operation	Mangos by air Cfa/kg	Mangos by boat Cfa/kg
1	Producer price[1]	185-250	175-250
2	Picking costs	25	25
3	Transport and bulking	20	20
4	Grading and packing	95	95
5	Transport and container loading	20	20
6	Cardboard boxes	140	84
6	Putting in FOB	20	20
7	Commission & other costs	75	75
8	FOB price – CFA/Kg	550	550
9	Freight[2] - Destination	800-1000	190
10	Unloading - Storage	25	25
	Price in CFA/Kg	1.370	720
	Price in Euro /Kg (655 F Cfa=1€)	2.09	1.10
	Price in Euro /Mt (655 Fcfa=1€)	2.090	1.100

[1] According to the stage of the campaign and mango availability (more or less strong fruit fly attacks)
[2] According to place of departure (for example by plane departure can occur from Ouagadougou or Accra)

5.5.6.2 National production of citrus and other fruits 2000 à 2006

The other principal fruits produced are citrus (oranges, citrons, mandarines, clementines, etc.), cashew, papaya and bananas. Production figures are not available and are not considered in the statistics generated by the Direction Générale des Statistiques Agricoles du pays. There are almost no international exports and the amounts exported subregionally do not exceed 300 tonnes (mainly of cashew).

5.5.6.3 Volumes of mangoes sold for each type of processing

Drying is the principal form of processing of mango in Burkina. It represents three times the volume of fresh exports. The association Cercle Des Sécheurs (CDS) brings together all the actors in this field. For example, the association WOUOL, which is a member of CDS, exports 180 - 300 t of dried mangoes, equivalent to 2400 - 3600 t of fresh mangoes (it requires 15 to 20 kg of fresh mango to produce 1 kg of dried mango).

5.5.7 Main production constraints for mangoes and other fruit tree crops

The main constraints facing fruit producers can be summarised as follows[3]:

- High rate of loss in nurseries
- Poor understanding of nursery construction
- Lack of knowledge of production cycle
- Lack of knowledge of mango disease symptoms
- Pest and fruit fly attack
- Lack of protection of orchards against pests
- Poor accessibility of orchards
- Lack of extension support
- Senescence of orchards
- Difficulty of irrigating orchards
- Low yield of orchards
- Lack of specialist knowledge by producers
- Lack of knowledge of production standards (EUREPGAP, ECOCERT, FLO-CERT, etc.)
- Lack of knowledge of production statistics (area, production, value of yield sold)
- Lack of knowledge of calculation of production costs and recurrent costs
- Financial insecurity
- Poor organisation of the production chain
- High cost of certification of orchards
- Lack of knowledge of varietal diversity
- Unfavourable conditions of access to credit
- Lack of knowledge of market information
- Insufficient communication between actors in the value chain

5.5.7.1 Pest and disease problems on fruit trees

Gummosis and fruit flies are the principal plant protection problems of citrus, while fruit flies, termites, mango mealybug (*cochenille farineuse*) and anthracnose seriously affect mango production. Bad agricultural practices and senescent orchards also contribute to increased attacks by fruit flies on mango.

[3] Source: Dabire, 2007.

5.5.7.2 Fruit fly damage to fruit crops

In Burkina, fruitflies attack several fruit trees and also market garden crops. Unfortunately these species are not formally identified, apart from the four species from mango (collected by S. Ouedraogo which were identified by Dr Vayssieres in 2007: *Ceratitis cosyra, C. sylvestrii, C. quinaria* and *Bactrocera invadens.* The occurrence of fruit fly species on specific crops is shown in **Table 42**. *Ceratitis* species are abundant at the start of the mango campaign, followed by *Bactrocera invadens* towards the end. In SW Burkina, in Kénédougou mango orchards, losses to the fruit fly are estimated at between 50% and 80% of production. In the West Central zone we have been told that losses to *B. invadens* vary between 60% and over 80% at different stages of the campaign.

Apart from citrus on which fruit flies have been found, no specific research has been conducted on other host crops. It will be necessary, as is the case in other countries were these incubation trials have not yet been held, to determine precisely the level of pest damage on different crops and the species responsible for it. 50% of mangoes picked are rejected in the fields by the fruit pickers (*pisteurs*) because of fruit fly damage and a further 25-30% rejection takes place at the pack houses for the same reason. The incidence of damage to citrus is unknown but may be estimated as 10-25%

No specific measures are taken at present at the national level to control fruit flies, although the PAFASP has been launched and the Bobo Dioulasso fruit terminal has started to function. As an upsurge of fruit fly attacks mainly occurs in the rainy season, as a precaution most exports cease as early as the end of June, except through the Bobo Dioulasso centres in which personnel from the Ivory Coast help with fruit inspection. This interruption of exports occurs well before the campaign is finished (end of August), despite the reduced competition in the recipient markets.

Table 42. Incidence of fruit flies on different host plants.

Fruit fly species - Plant host \	*Bactrocera invadens*	*Ceratitis sp. (unidentified)*	*Ceratitis cosyra*	*Ceratitis quinaria*	*Ceratitis silvestrii*
Mango	4 ***	?	3 ***	3 ***	3 ***
Citrus	3 **	? **	3 **	3 **	3 **
Other fruits and vegetable fruits	?	?	?	?	?

Damage codes: ? = unknown species; 0 = not found (0% fruit loss); 1 = minor damage (0-15% fruit loss); 2 = medium damage (16-30% fruit loss); 3 = severe damage (31-45% fruit loss); 4 = Very severe damage (> 46%).
Distribution codes: * = Limited distribution; ** = Moderately widespread distribution; *** = Very widespread distribution. Source: Dabire, R.A., 2007.

5.5.7.3 Post harvest practices and quality management in packing stations

Only mangos intended for export via ports or airports pass through packing stations. So called local mangos or mangos of common consumption, as well as those sent to other ECOWAS countries for re exportation, do not pass by packing stations but are directly introduced to the marketing channel. A detail must be added though, those exported to Middle Eastern and Maghreb countries are subject to packing but not necessarily in what we qualify as modern packing stations. Three types of packing stations must be distinguished. The following description of the essential elements of a packing station refers mainly to the two first types.

- There are two modern packing stations in the Bobo Dioulasso region. One is owned and operated by Fruiteq and the other (Terminale Fruitière) is a "service provider" packing station established with World Bank funds, and managed by the SGTF society. SGTF only deals with batches of high added value intended for export to Europe. It consists of a 1040 m^2 building, a packing chain for round fruit (mango, melon, papaya), with three cold rooms of 75 m^2 each. It operates a traceability system which identifies the field of production and is certified (HACCP, EUREPGAP/GLOBALGAP and Organic Agriculture). It works as a service provider with charges which are recovered from the importers.

- There are improved packing stations which belong to specific operators. There are three of them: the UFMB's station, Fruiteq's Ranch du Koba and that of Burkinature. To these can be added the station of Ouagadougou airport which is not mechanised but equipped with cold rooms (which have been renewed). Of various sizes, these stations only package products for their importers. With the exception of the Ouagadougou airport station, they are equipped with more or less average mechanised packing chains and have cold rooms (generally two, one of which is dedicated to pre-cooling operations).

- We refer to the third type of packing station as "packing premises". This can mean any place used to manually package fruit. Everything is done manually. Even though they used to be many, their numbers tend to decrease mainly due to the numerous seizures and destructions operated in Europe which have demonstrated the limits of this type of facility.

With the exception of "packing premises", in most cases, work in a packing station can be broken down, with a few variations, to the stages already described in Section 5.5.7.3, above. In the Bobo Dioulasso station only the packaged export quality mangos are paid for. The packing station does not soak fruit in hot water anymore due to the defects observed on their skin when they are subsequently put through the polishing machine. The fruit inspectors (*trieuses*) of the Bobo Dioulasso station come from the Ivory Coast. To increase the inspection efficiency, their numbers were increased during the past campaign. Amongst the 15 40-foot containers dispatched from the station, there was no interception linked to fruit flies.

5.5.7.4 Main phytosanitary constraints managed in packing stations

The main phytosanitary constraints faced by mango exporters are the fruit fly and the mealybug (a recent problem we were told). It seems that late mangos (Kent, Keitt and Brooks) suffer most from pests, mainly due to the fact that harvest occurs during the rainy period when *B. invadens* is most active. Very few prophylactic measures are taken to reduce pest attacks on mango. Operators depend a lot on collectors in charge of organising the picking to operate a first important inspection and reduce the number of infested fruit brought to the station. The only post harvest control measures undertaken to manage the fruit fly problem are the inspections carried out by trained inspectors (*trieuses*). Those working in Burkina come from the Ivory Coast for the most part.

5.5.8 Government phytosanitary Controls

5.5.8.1 The Direction Générale des Productions Végétales (DGPV)

As the official government service in charge of plant protection, the DGPV (Direction Générale des Productions Végétales / General Directorate of Plant Products) is responsible, through its Service du Contrôle Phytosanitaire et des Pesticides (SCPP), under the Direction de la Protection des Végétaux et du Conditionnement (DPVC), for delivering phytosanitary certificates for exports. It is also the DGPV which is in charge of managing and protecting the territory against the introduction of quarantine pests. The DGPV has expressed a lack of personnel and capacity to adequately conduct the monitoring of agricultural product flows. The phytosanitary legislation presently in force in Burkina dates back to 1960. Since 1960 all plant material leaving or entering Burkina must be accompanied by a phytosanitary certificate.

A DPVC manual for a training course (13-17 June 2005) for phytosanitary inspectors and contollers was studied. Much of the material seems impractical for the conditions of work of inspectors (recognition of bacteria and viruses for example is unlikely to be possible without sophisticated laboratory facilities). However the section on insects deals at length with stored products pests, mainly beetles (Coleoptera). There is no material whatever relating to examination of fruit or recognition of fruit flies. In light of this it is perhaps not surprising that DPVC has not been able to prevent interception of consignments in France as a result of fruit fly presence.

A sea freight container holds 22 pallets, each pallet comprising 240 boxes weighing 4 Kg each. A container therefore holds 5,280 boxes. The DPVC phytosanitary inspectors check every tenth box per pallet by visual inspection and cutting if punctures are found. During 2006, five consignments of mangoes from Burkina were intercepted in France, of which three related specifically to the presence of fruitflies (Tephritidae). The remaining two interceptions related to absence of information or false information in the paperwork. Notifications were sent to the SCPP of the DPVC. The approach and methodology used by inspectors needs to be aligned with the methods used to examine fruit in France. Repeated failures of phytosanitary control in Burkina are likely to lead to more exhaustive searches of Burkina export produce by the SPS inspectorate in the EU.

The DPVC is also responsible for enforcement of the pesticide legislation of Burkina Faso and CILSS. Since 1992 a common law ("*La Reglementation Commune*") has been in force governing pesticide registration (homologation) in the member countries. Burkina ratified the *Reglementation Commune* on 20 July 2004. However the National Law No 041/96 ADP of 1996 instituting control of pesticides, and the Law No 006-98 of 26 March 1998 modifying the earlier law, stipulate that import, export and manufacture of pesticides are controlled in Burkina and that all import, export, manufacture, sale and services bearing on pesticides not authorized by the Comité Sahélien des Pesticides (CSP)[4] are forbidden. The Commission National de Contrôle des Pesticides was set up in 1998 to monitor pesticide issues and consider requests for registration (dossiers de demande d'agrément).

[4] The member countries of the CSP are Burkina Faso, Cape Verde, Gambia, Guinea Bissau, Mali, Mauritania, Niger, Senegal and Chad. The headquarters is in Bamako. Updated lists of permitted products are issued regularly. Malathion (925g/l) (suitable for MAT blocks) is registered against locusts and grasshoppers. Fipronil (an alternative) is not registered for any use by CSP.

5.5.9 Official Support Structures for farmers and exporters in the horticulture industry

5.5.9.1 Ministère de l'Agriculture et des Ressources Haleutiques (MAHRH). Programme d'Appui aux Filieres Agro-Sylvo-Pastorales (PAFASP).

The main official support for producers and exporters of mangos comes from the PAFASP which is a donor-funded project based within the MAHRH. PAFASP organised two planning workshops for the stakeholders of the value chain during 2007. These were enormously useful in bringing together the various actors and identifying targets for the coming year, including formally commissioning INERA to develop strategies for pest management for the fruit flies in mango (see Section 5.5.9.3, below). PAFASP aims to increase the competitiveness of selected value chains, of which one is mango. It works through strengthening the capacity of interprofessional organizations to develop and implement strategies which address the requirements of the market. It also facilitates access to export credit and works to enhance product quality and productivity. The project duration is six years from 2007-2012. This longevity makes PAFASP a good potential development partner in addressing the fruit fly problem on mango.

5.5.9.2 Projet d'Appui au Développement Local des Provinces de la Comoé, Léraba et Kénédougou (PADL/CLK) :

PADL/CLK is a State project, financed by the African Development Bank (ADB/BAD), which aims to promote local development in three provinces (Comoé, Léraba, Kénédougou) largely based on commercialisation of mango production.

5.5.9.3 l'Institut de l'Environnement et de Recherches Agricoles (INERA)

The l'Institut de l'Environnement et de Recherches Agricoles (INERA) carried out a diagnostic study on pest problems of mango and citrus in 2002[5] but was unable to identify fruit flies or to quantify their attacks. A second study examined the impact of fruit flies on different varieties of mango in 2006-2007. Two reports have been produced on fruit flies, one Ingénieur agronome dissertation and one DEA (Diplôme d'Etudes Approfondies) dissertation[6]. The latter identified the four main species which were present in Kénédougou (**Table 42**, above) and indicated that the variety Kent is heavily attacked (30%), while Amelie is only slightly attacked (4%).

There exists a mango Task Force in Burkina, created through a COLEACP/PIP initiative. In conjunction with PIP/COLEACP, INERA is in process of evaluating three new chemical products against fruit flies. These are the same trials being undertaken in Senegal and The Gambia, with Success Appat (GF-120) as a bait spray for spot application and two cover spray pyrethroid insecticides (bifenthrin and lambda cyhalothrin). In Burkina Faso there has been no special plan for monitoring and control of fruit flies. INERA is charged by PAFASP with developing a programme to reduce losses in the 2008 season by 10% and increasing the available marketable fruit production by 5%[7]. This is mainly seen as a programme of information and training for producers, but it will require the prior certification of the pesticides by CSP and their availability.

[5] Somda, I, Dabire A.R., Ouedraogo, S.K. and Ouedraogo, S., 2002.
[6] Ouedraogo, S. 2007. Etude des attaques de la mangue par les mouches de fruits dans la province du Kénédougou (Ouest du Burkina Faso).
[7] PAFASP, 2007. Programme Interimaire de la filière mangue, Septembre 2007 –Aout 2008. Ministère de l'Agriculture et des Ressources Haleutiques (MAHRH).

The lack of a monitoring plan and a pest management strategy for fruit flies in Burkina Faso has meant that stakeholders in the value chain are still ignorant of the cause of the damage, volumes of mangoes exported have fallen, fruit are harvested prematurely before the rains become established, and enormous losses are experienced in the orchards and in the pack-houses.

5.5.10 Methods of fruit fly management

Producers have no officially sanctioned pest management methods for fruit fly and have sometimes used inappropriate chemicals licensed for other purposes (e.g. cotton). The only strategies they know consist in early harvesting and in orchard sanitation which is difficult to achieve. At the research level, INERA has some experience with trapping (for monitoring purposes) utilising either Tephri-Traps or MacPhail traps with different protein baits (Torula or hydrolysed protein) or parapheromones (Terpinyl acetate, methyl eugenol) and DDVP strips as toxicant. During 2007 trials of pyrethroid insecticides and Success Appat were carried out (see above). These, together with improved orchard sanitation, will form the basis of the control strategy in the coming year. However there is a need to apply techniques which have been found to be successful elsewhere. These include MAT using fibreboard or wooden blocks impregnated with an attractant and a pesticide (see Section 4.6.3, above).

5.5.11 Input suppliers for fruit fly control

Up to now in Burkina Faso, there are no dealers supplying specific inputs or monitoring equipment for fruit fly management. However there are several agrochemical companies which could stock the necessary products given a sufficient market. For example, Saphyto, with its head office in Bobo Dioulasso and associated companies throughout West Africa would be well placed to supply inputs.

5.5.12 Producers' and Exporters' Professional Organisations in the fruit value chain

At least nine producer/exporters exist. Of these five are EurepGAP certified, three are certified as organic and three have fair-trade certification. FRUITEQ has the aim of grading and packing and export of mangoes, with organic (BIO) and EUREPGAP certification and observing FairTrade principles (principe du commerce equitable). FRUITEQ has its own packing station in Bob Dioulasso. SGTF provides services in quality control and packing of fruit for export, based at the new Terminal Fruitier at Bobo Dioulasso. APROMA-B is an inter-professional organization for the mango value chain in Burkina with the objective of bringing together all the actors of the value chain to achieve better performance and competitiveness on the regional and international markets.

FEDAF (500 members) and UPPFL/CO (200 members) are private companies involved in development of fruit trees in Burkina Faso and their principal activities are the production and marketing of fruit. BURKINATURE Sarl (c 300 members) is a company involved in improving quality and hygiene, certification and export of fruit. Its principal activities cover training, management, certification and organising harvesting and distribution. Producers' professional organizations are not well-structured and often engage in inappropriate rivalry among themselves which limits the international and regional competitiveness of the country

Wouol is a farmers' association with 1500 members, based in Bérégadoudou, in the southwest of Burkina Faso, producing dried mango for export. Organisation Néerlandaise de Développement (better known as SNV) a Dutch Development NGO which provides technical advice to build capacity in local institutions in developing countries, has been assisting Wouol in restructuring its activities to reduce dependance on donor funding and increase income from commercial production and export of mango and other commodiies. In 2004 Wouol

produced 35 tonnes of dried mangos, all of which were exported to Europe. Wouol is an organic producer certified by Ecocert International, and has applied for Fair Trade certification from the Fairtrade Labelling Organization (FLO).

5.5.13 Association des Professionnels de l'Irrigation Privée et des Activités Connexes (APIPAC)[8]

APIPAC is a professional association of smallholders using irrigation. Some of the Association's members have old mango orchards situated on poor, unfertilised acidic sandy and lateritic soils. They experience low yields and have no control of pests. They now have a drying factory with a capacity of 40 tons per day, situated at Orodara, 76 kms from Bobo Dioulasso, situated in a major growing area[9]. The drying unit needs between 12 and 15 tons of fresh mango to produce one ton of dried mango. 30% of mangoes received at the factory are rejected. This has meant losses of 2-3 tons of rotting fruit per day as a result of fly damage and other causes. Other problems include the need for expensive orchard renewal and irrigation and the limited market. However the situation is improving as exporters are getting access to credit.

Producers say that only one fifth of their mangoes are commercially viable. Of 60,000 mangoes which are harvested, about 15,000 are rejected in the orchard. 45,000 mangoes is about 10 tons. At drying another 3% are rejected. However, for fresh export mango producers can face up to 60% rejection. Many exporters buy non-organic mangoes. Before Interprofession became active prices were around 15-20 CFA/Kg at the farm gate. In 2007 Brookes and Keitt fetched 35 CFA at the farm gate and 149 CFA/Kg after sorting and grading (conditionnement). M. Ouattara wants to see a system of qualification for loans based on criteria such as minimum plot size and adherence to quality control procedures set out in an agreed "Cahier de charge" which would be developed by specialists with consultation within the industry.

5.5.14 Activities of International Donors

The main internationally funded initiatives in Burkina which have had some impact so far on the fruit fly problem are as follows:

- PAFASP (World Bank)
- The Fruitfly Initialtive launched by the World Bank
- FAO interventions on application of Good Agricultural Practice (des Bonnes Pratiques Agricoles)[10]
- Common Fund for Comodities (CFC) (Le Fond Commun pour les Produits de Bases)
- European Union (supporting COLEACP/PIP).

5.5.15 Difficulties and constraints in fruit fly management

This list is not exhaustive, but focuses narrowly on issues specific to fruit flies.

1. Lack of adequate checking and selection of fruit for export, leading to quarantine interceptions in Europe and consequent financial losses.

2. Lack of adequate training and equipping of phytosanitary inspectors for checking of fruit consignments.

[8] Source: Interview with M. Lamine OUATARA, Coordonnnateur Regional, Association des Professionnels de l'Irrigation Privee et des Activites Connexes (APIPAC), Bobo Dioulasso, 6 September 2007.
[9] Banfora in the south of Burkina is a less important mango growing area.
[10] http://www.fao.org/prods/GAP/DOCS/PDF/6-7-8-GAP.pdf

3. Absence of a clear pest management strategy for farmers to reduce the impact of fruit flies, especially after the start of the rains.

4. Absence of an information sharing mechanism to ensure rapid dissemination of new information within the industry and to collect feedback for planning.

5. Lack of a central participatory planning and support group to manage the phytosanitary issues of the industry

6. Lack of an effective research programme for fruit fly management and lack of funding, review and accountability of the activities of researchers.

7. Lack of training and capacity-building for farmers in integrated pest management for fruit trees.

8. Lack of accessible supplies of materials needed for IPM in fruit trees (traps, lures, baits, pesticides, instruction manuals).

9. Lack of processing capacity and clear market intelligence for alternative uses of lightly damaged fruit unsuitable for the fresh fruit export market.

10. There is no information on the importance of fruit flies in damaging other crops (e.g. cucurbitaceous and solanaceous vegetable fruits).

11. There is very limited capacity nationally for identification of fruit flies of economic importance, with some previous collections apparently still unidentified.

5.5.16 Proposals for a National Action Plan: Burkina Faso

A Regional Action Plan has been developed in parallel with National Plans, to ensure effective division of responsibilities and work. Some items in a National Plan need to be in place in all countries (see item 1, for example).

1. Creation of a National Fruit Fly Planning Body

Government and the horticultural industry need to establish a joint planning and consultative body which will oversee the development and implementation of a National Action Plan for Management of Fruit Flies. Ideally the National Committee should have co-chairs from the public and private sectors. Members should be representative of all main types of stakeholders in the value chain (grower and exporter associations, regulators, universities, INERA, donors, projects, government agencies).

2. Research

The research community in Burkina (INERA, universities) needs to be perceived as a service provider to the horticulture industry. The implications of this are that funding should be by competitive grants for specific work based on submission of a concept note, followed by a detailed plan of the research with clear time frame and quantified outputs. Most of the research needs are not highly complex or original. The methodologies for the most part exist and must be applied conscientiously to achieve results. However they cannot be left to inexperienced students with occasional inputs from supervisory staff. Results of research should be reported rapidly to the oversight group (which should be centred in PAFASP) and should be externally assessed before release of further funds. As a start, the field trials of 2007 with COLEACP-PIP should be critically evaluated to learn lessons on the efficacy of the process as much as on the technical results.

The list of research topics below is not exhaustive but deals with pressing concerns.

(a) Assessing damage to mango by individual fruit fly species
A monitoring activity should be carried out by rearing larvae from fallen fruits collected in the orchards, which is the sole method of quantifying the proportional levels of damage attributable to the different species. This is because trap samples are affected by the different degree of attraction of the different fly species to different lures (*attractifs*)).

(b) Evaluation of control methods
A programme of evaluation of control methods (*méthodes de lutte*) should be started, assessing several methods, including spot spraying with baits (including GF-120) and MAT/TEM (technique d'eradication des Males). MAT/TEM using parapheromones (in particular methyl eugenol) and an insecticide is effective against species closely related to *B invadens* in Asia, but its effectiveness cannot be guaranteed against *B invadens* in West Africa.

(c) Organic certification for control operations
To protect the organic certification of mangoes exported from Burkina Faso, it is also important, as far as possible, to assess how to obtain an organic certification for control operations, such as spot bait applications and traps or parapheromone blocks (plaquettes) (methyl eugenol) which are useful against fruit flies and *Bactrocera invadens* in particular.
All of these research activities will benefit from regional cooperation.

(d) Simple biological control technology
The potential of weaver ants (known to be active in Burkina orchards[11]) for fly control has been shown in Benin (see Section). The level of natural control in orchards should be assessed using the methods pioneered by van Mele, with a view to disseminate this organic technology to organic orchards in Burkina Faso.

(e) Assessing varietal resistance to fruit fly attack in mango
Develop protocols for assessing the degree of susceptibility of different varieties to fruit flies with a view to improve germplasm or to popularise less susceptible cultivars.

(f) Surveying fruit fly species composition and damage levels on vegetables
Surveys of cucurbitaceous and solanaceous vegetable fruits are needed to determine which species are present and the level of losses they inflict. Again this needs to involve sampling of produce and rearing of flies for identification.

3. Procurement of supplies for pest management and IPM capacity building
If it is necessary to promote control methods using baits (*appâts*) and parapheromones, it will also be essential (1) to find sources of supply of these input so that producers can buy them and (2) to devise financial instruments to allow them to purchase them (for example financial guarantees for loans to purchase inputs before the start of the mango season). It is therefore also necessary that the physical inputs and the necessary instructions for using them (extension, training) should arrive at the same time, so as to link together the inputs and the information. Ideally a training of trainers (ToT) approach should be used to equip a cadre of trainers from the industry associations to ensure that their farmers are fully capable of applying the methods in their orchards.

[11] See the report of et al. (2002), in which the ants were viewed as a pest!

4. Fruit fly identification capacity and reference collection

Burkina Faso needs to be able to identify all likely fruit fly species which may be found on fruit and vegetables, especially in view of imminent quarantine threats to the country (see Section 4.5). This will be best achieved by training representatives of several agencies, provision of information and manuals and the designation of a single national clearing house for identification which will maintain a reference collection on behalf of the horticulture industry. Such facilities must not be seen as an end in themselves but as a practical service provider to the industry.

5. Capacity building for the quarantine service

Specialised training, part theoretical and part practical needs to be designed and delivered to inspectors of the DPVC, to enable them to meet their obligations in pre-export inspection of fruit, especially mangoes. A quite separate module of training is needed to enable inspectors to assess incoming fruit and also to operate a system of sentinel traps at border posts and fruit markets. Their working conditions will also need to be improved with better equipment and facilities for SPS inspection and diagnosis, both at exit/entry points and at the post-entry centre. DPVC staff also need access to current literature and manuals, including internet access. If there has not been a thorough external review of SPS in Burkina Faso, this should be undertaken, using the format of the WATH SPS assessments of Gambia and Ghana as a template (Humado, 2006).

6. Alternative uses for fruit not suitable for the fresh fruit market

A study is needed to assess the economic viability of increasing the processing capacity in major production areas (e.g. Bobo Dioulasso) to utilize fruit rejected for export because of minor damage by fruitflies for preparation of pulp or juice as an alternative to the local fresh produce market. This study could be undertaken within the programme of PAFASP.

Regional Issues:

7. Capacity building in Research

It will be desirable to develop a system of mentoring of researchers (using expertise from within the region (e.g. IITA, ICIPE), and elsewhere, especially since similar experiments need to be conducted in several countries for validation and certification (homologation). A research network is needed to bring together all concerned research staff in West Africa and create a high quality peer group in this field across the region.

8. Upgrading inward quarantine surveillance

Quarantine and phytosanitary defence against the arrival of further exotic fruit fly pests such as *Bactrocera zonata*, which has already reached Libya and Egypt, are issues probably better managed at regional level. See Section 4.5 and Tables 5 and 6 for an indication of the importance of this issue.

9. Phytosanitary risk assessment and insurance

In the longer term, the system of certification of exports for phytosanitary protection of the importers could be reformed. At present it is not clear who carries the risk of refusal of entry to the destination country, and how to manage this risk properly. One possibility could be a formal and quantified system of risk analysis and risk management, which could make possible the quantification of risks and thus the purchase and sale of insurance to manage the risk effectively.

5.6 National Situation Synopsis: BENIN

Benin has 5 major vegetation zones, distributed from South to North. The potential fruit production areas are situated in the sudano-sahelian zone in the four Departments of the northern region of the country: Borgou, Alibori, Atakora andt Donga. The rainfall regime is bimodal, with rainy seasons lasting from May and from October to November. The temperature is between 23 and 32°C with 4 distinct seasons per year (rains from May to July, a dry period from August to September, rains from October to November and dry season from December to May). Temperatures rise with the coming of the dry season (less from June to October) progressing from south to north.

5.6.1 Mango production zones

Mango production takes place in the Southern Sudan and Northern Guinea savannah zones. Dr Vayssières stressed that mango is an important food crop during the hungry season (dry season and early rains) in the Sudan savannah zone of all West African countries. It is therefore important to improve quality for local consumption as well as export. Mango has not been a priority in Benin as the value chain has not yet been developed. The private sector in Benin appears relatively timid by comparison with neighbouring countries. Nonetheless there is potential for mango production in the Sudanian zone between 8 and 12 degrees north. Mangoes in the litoral zone are of poor quality with low sugar and heavy disease pressure.

5.6.2 Mango Varieties grown and production cycle

The main varieties in Benin are Amélie, Ifac, Gouverneur, Irwin, Zill, Tommy Atkins, Atakora, Eldon, Sabot, Ruby, Améliorée du Cameroun, Dabschar, Springfield, Miami late, Haden, Edwards, Alphonse, Sensation, Lippens, Bedami rouge, Smith, Kent, Valencia, Palmer, Davis Haden, Keitt, Julis, Jules et Brooks. Les variétés les plus commercialisées sont : Gouverneur, Kent, Valencia, Amélie, Keitt, Irwin, Zill, Eldon et Palmer. Peak fruiting was in May-June in 2005 and in June in 2006. There is 2-3 weeks difference in timing between north and south, but there are two fruiting season for local varieties in the south. The seasonal cycle for different varieties is shown in **Table 43**.

No data exist on the percentages of traditional or improved orchards, nor the varieties grown in them. It appears that most orchards are of mixed varieties, based on a rapid reconnaissance survey of five farms which showed the following arrangements in specific mango orchards:

- «Agrimucol de Guèmey» farm: 50 trees of Gouverneur,
- Orchard of Monsieur Pierre Adjamassouhon: 7 ha of mixed mango varieties
- Orchard of Fondation Georges: 74 ha of mixed mango varieties,
- Orchard at Kora: 2 ha of mixed mango varieties,
- Military citrus farm at Natitingou: 96 ha of mixed mango varieties.

5.6.3 Mango Prices at farm gate (prix bord de champs)

In southern Benin mangoes are sold at 50 FCFA/Kg to retailers and at 75 FCFA/Kg to direct consumers. In the north a plate of 5 mangoes (± 1250 grammes) is sold at 100 FCFA to all comers, but in some areas mangoes are sold at 50 to 100 FCFA/Kg. No information was available for citrus prices.

Table 43 Seasonal Cycle for mango varieties in Benin.

Varieties	Flowering	Nouaison	Fruiting	Maturation	Harveste
Gouverneur	Start March	End March	End March	End April – early May	May and June
Améliorée du Cameroun	Start March	End March	End March	End April – early May	May and June
Kent	February	March	April	End April	May
Eldon	December	January	January	avril-mai	May
Alphonse	December	January	January	avril-mai	May
Dabschar	December	January	January	avril-mai	May
Smith	January	March	April	May	June
Ifac	December	January	February - March	End April	May
Brooks	December - January	March - April	May	June to July	June to July
Julis	December - January	February	April	May	May and June
Jules	December	January - February	March	April	April

Source: Tchibozo (2007)

5.6.4 Fruit exports

There are no available production or export statistics and no staff in the Ministry of Agriculture for this purpose. Food security crops have production statistics but not fruit. Less than 20% of exports go by air, the rest by sea. Perhaps 10,000 t of pineapples are exported annually.

5.6.5 Producers and Exporters' Associations

5.6.5.1 Association de Developpement des Exportations (ADEx)

ADEx is an NGO formed in 1999 under the World Bank-funded Programme de Relance du Secteur Prove (PRSP) and Projet d'Appui au Développement du Secteur Privé (PADSP), which brings together representatives of the public and private sectors in the export value chain. ADEx is registered under the law 1901. It is funded by member contributions, charges from services rendered, and funding from the Benin government and the International Development Association (IDA). Its mission is to diversify and promote exportation of agricultural produce[1].

Moustaffa Abdoulahi (Responsible Service des Informations) indicated that cashew nuts and pineapples are the main fresh exports. Some juice is also produced for export. ADEx produces a monthly information newsletter for the industry. There is a Federation National des Organisations des Producteurs des Ananas de Benin for Pineapple, headed by M. Satola, President of "Fruits D'Or", a major pineapple producer and exporter. In January 2006, COLEACP provided training to exporters of pineapples exporting to Europe, affiliated to ADEx. There are no producers with EurepGAP or other certification.

[1] Source: ADEx Association de Developpement des Exportations. Presentation Generale. Objectifs, mission, Stratégie et Ressources, Organisation et Fonctionnnement, Structures et Activités. 11 pp. Mimeo.

5.6.5.2 The Federation des Associations Professionales des Fruits et Légumes (FAPFL)

FAPFL, based at Allada is an umbrella organization for associations representing other fruits and vegetables,. The team met briefly with M. Satola, President of the Federation at his house in Allada. M. Satola said that the Federation mainly represents growers in the south and centre of the country, mainly concerned with pineapple production. There are no members growing mangoes and he himself has no interest in mangoes. There is apparently no professional association specifically for producers and exporters of mangoes.

5.6.6 Fruit flies as a major constraint to fruit production

Research studies by IITA/CIRAD revealed 12 species of fruit-flies feeding on mango, of which four were of economic significance: *Ceratitis cosyra*, *C. quinaria*, *C. silvestrii* and *Bactrocera invadens* (**Table 44**). In the dry season *C. cosyra* was the most important species, feeding especially on early fruiting varieties. *B. invadens* became dominant at the start of the rainy season. Mean mango damage levels caused by fruit flies varied from 9% in early April to more than 60% in June 2006. Mango trees are being cut down in Northern Benin because of the fruitfly problem, with fruit losses reaching as high as 90-95% on late mangoes in the departments of Borgou and Atakora. Cultivars are Brooks, Alphonse de Goa, Amelie, with Kent and Keitt as the most important mid and late season varieties, respectively.

B. invadens is said to be commoner in southern Benin than the north and is present there all year round, because it is a humid forest species. For this reason, Dr Vayssieres believes that the MAT (using ME and insecticide impregnated blocks against *B. invadens*) will be more effective in the South than in the North of Benin, where *C. cosyra* (which does not respond to ME) is more numerous.

Table 44 Incidence and severity of fruit fly species on fruit hosts in Benin

Fruit fly species: Host species	*Bactrocera invadens*	*Ceratitis cosyra*	*Ceratitis quinaria*	*Ceratitis silvestrii*	*Ceratitis capitata*
Mango	4***(1)	4***(1)	3**(1)	3**(1)	3**(2)
Citrus					3** (2)
Guava	4**(2)				
Cucurbitaceae					3**(2)
Tomatoes/ peppers/chillis					3** (2)

Damage codes: ? = unknown species; 0 = not found (0% fruit loss); 1 = minor damage (0-15% fruit loss); 2 = medium damage (16-30% fruit loss); 3 = severe damage (31-45% fruit loss); 4 = Very severe damage (> 46%). **Distribution codes**: * = Limited distribution; ** = Moderately widespread distribution; *** = Very widespread distribution. **Information sources**: (1) = Dr. Jean-François Vayssieres ; (2) = Dr. Désiré Gnanvossou *et al.*

Plant hosts identified include *Annona senegalensis*, *Sarcocephalus latifolius*, *Sclerocarya birrea* et *Vitellaria paradoxa* for the species *Ceratitis cosyra* and *Bactrocera invadens.* Overall, the pest occurs predominantly on exotic hosts but with a roughly equal proportion on cultivated and wild plants. Preferred cultivated fruits are mangos, citrus, guava (*psidium guajava*) and soursop (*Annona muricata),* whereas among wild hosts incidence on tropical

almond *Terminalia catappa* (Combretaceae) (known locally as "colati" and in French as *Badamier*), bush mango (*Irvingia gabonensis)*, *citrus sinensis,* and sheanut (*Vitellaria paradoxa)* can be quite high[2]. Mango, guava and *Terminalia* are the most common hosts, with up to 45% of guava fruits affected. *T. catappa* trees fruit after the mango season and have the highest numbers of flies per kg of fruit, with a recorded infestation of 64.2 %. Fruit flies also lay eggs on lychee but the larvae are unable to develop.

Box B. Farmer perceptions of losses: Agrimucol de Guemey, N of Allada

The team met with Teothim Bognon, manager of a small fruit farm with an orchard producing mangoes and citrus for the local market. The orchard has two varieties, Gouverneur and Camerounaise. The Gouverneur trees are about 12-13 years old and start to bear from year 4 after planting. M. Bognon confirmed that fruit flies are a serious problem every year. This is countered by early harvesting, one week before maturity. In 2007 he harvested 2,750 Kg from 50 trees. He estimates that losses of Gouverneur at maturity are about 75%, but this can be reduced to 10% loss by early harvest. Mangoes become ripe within 1-2 days of maturity.

Camerounaise is less attacked than Gouverneur, but there are only 3 trees of this variety. Damage at maturity is estimated at 25%. Perceptions of fruitfly damage have been checked by cutting struck fruit to find maggots. Value of the fruit is 50 Francs CFA at farm gate for Gouverneur and 75 CFA in the local market. Buyers sell to local makers of juice and jam if they cannot sell the fresh fruit quickly. Flowering takes place in March, "noisson" at the end of March, first fruits by the end of April, harvesting is mainly in May and June and the season is over by the start of July. He would advise growing Camerounaise which is smaller, more perfumed and has less fly than Gouverneur. The citrus orchard produces fruit during May – July.

Asked about control measures, M. Bognon indicated that he had tried spraying mango trees with a knapsack sprayer using Dursban 4E (25 ml in 20 litres of water). This needed to be sprayed at maturity but the 10-day withholding period meant that this was too late for marketing fruit. Another pesticide product "Cypedico" (Dimethoate 250g/l and Cypermethrin 30g/l) was used on citrus. Fungicide ("alliette") was also sprayed on citrus foliage before flowering. The team placed an ME pheromone trap at the farm for a few hours and caught *Bactrocera invadens*, despite the absence of mango fruits. Presumably some citrus were still available at the time of our visit (21 July 2007).

2 Source: Abstract of presentation, 7th International Symposium on Fruit flies of Economic Importance. 6th Meeting of the Working Group on Fruit flies of the Western Hemisphere. Sept 10-15 2006. Salvador, Bahia, Brazil: *Bactrocera Invadens*, A New Fruit Fly Problem In The Afrotropics: Distribution And Host-Plant Range In West And Central Africa. Georg Goergen, Rachid Hanna, Jean-françois Vayssières, Desiré Gnanvossou and Maurice Tindo.

5.6.7 Research activities on fruit flies in Benin

5.6.7.1 International Institute of Tropical Agriculture (IITA), Benin Research Station.

The IITA station in Benin is based on a 50 ha site adjacent to the campus of the National University of Abomey-Calavi, 12 km north of Cotonou. The station was originally set up in 1985 as a base for agricultural research, training and technology transfer for francophone Africa. In 1988 it was expanded and insect rearing facilities were developed to serve a major biological control programme on cassava pests. The station includes experimental fields, greenhouses, secure insect rearing rooms and microbiological laboratories for production of pathogens that kill insects. A recent feature is the development of a separate insect museum and biodiversity study facility which houses reference material of pests and beneficial insects from the region.

In its 22 years of life, the IITA - Benin Centre has pioneered biological control campaigns against insect, mite and weed pests affecting mangoes, cassava and inland waterways among others, with an estimated value of production saved in excess of 20 billion dollars US. The current business plan for 2005-2015 focuses on integrated pest management, as a basis for safe and sustainable growth in crop production volume and quality. IITA-Benin already works with national plant protection programmes in ten countries in Africa, including Benin, Burkina Faso, Ghana, Mali and Senegal. It works closely with FAO, other CGIAR institutes and international and bilateral donor agencies. The four current work programmes cover: development of national IPM policy frameworks, development of eco-friendly IPM options, capacity strengthening for IPM implementation and evaluation of IPM impact on sustainable development. Within this overall framework 33 separate IPM projects are currently financed. The estimated budget for four work programmes over five years is 3.1 million dollars US per country[3].

Dr Jean-Francois Vayssières, fruit fly entomologist, has been working for CIRAD at IITA since July 2004 with a contract until 2008. He was previously working in Brazil and French Guyana with US support and before that he worked in West Africa and in Reunion. IITA has an MoU with CIRAD for cost sharing. CIRAD core funding is provided by the French Ministry of Research. During the last three years Dr Vayssières has made studies of *Bactrocera invadens* in Senegal and Mali (2004) and carried out studies of fruit fly population fluctuations and mango infestations and losses in Parakou, northern Benin (2005[4] and 2006[5]).

With CIRAD colleagues in Senegal (Dr Rey) and in Cameroon, Dr Vayssières hopes to develop a regional project focussed on integrated fruit production, involving Dr Van Mele (WARDA) (see below) and with external links to CIRAD Reunion, ICIPE and other CG centres. Dr Vayssières has also been working on the CFC fruit fly proposal (see Guinea country report) for a regional fruit fly project which will involve Benin, Mali and Guinea. The USAID West Africa Regional Programme (WARP) is not yet involved in fruit flies directly but is interested.

[3] Source: Integrated Pest Management: Towards 2015. A business plan. IITA (undated). 35 pp.
[4] Vayssières, J.-F., Goergen, G, Lokossou, O., Dossa, P. and Akponon, P. 2005. A new *Bactrocera* species in benin among mango fruitfly (Diptera: Tephritidae) species. *Fruits*, 2005, vol 60, pp. 371-377.
[5] Vayssières, J.-F., Lokossou, O., Ayegnon D., Boueyi S. and Akponon, C. 2006. Inventaire, fluctuations des populations et importance des dégâts des espèces de mouches des fruits (Diptera Tephritidae) inféodées au mangier dans le Département du Borgou (Bénin) en 2005 et 2006. Workshop Proceedings. Abomey-Calavi. 19-22 December 2006. Atelier Scientifique National de la Recherche Agronomique. In press.

Dr Desiré Gnanvossou who works with the African Fruit Fly Initiative (AFFI) based at ICIPE. Dr Rachid Hanna and Dr Georg Goergen (an insect taxonomist) also work with the AFFI but were not present on the day of our visit. Dr Goergen is responsible for the management of the IITA insect collection which in 12 years has grown to more than 500,000 specimens, including both dry pinned insects and slide-mounted specimens of Homoptera. The facility is air-conditioned with modern storage cabinets and has photo-microscopic equipment linked to computer software and hardware permitting the production of very high quality composite images of insect pests and natural enemies. The technician in day-to-day charge of collection maintenance is Mr Simon Ahlinui. This facility has a major potential regional role to play in building capacity for insect taxonomy and the curation of national reference collections and in keeping regionally important reference collection of fruit flies and providing routine identification of species for neighbouring countries.

Tree crops were recently added to the IITA mandate. Work on fruit flies at IITA started in 2003-2004. This includes pests of vegetable fruits as well as fruits. The research has focussed on faunistic and plant host surveys, biological and ecological studies (including natural enemy interactions) as well as development and testing of management options. A network of 58 trap sites is used for population monitoring of *Ceratitis* males using terpinyl acetate, ME for *B. invadens* males, cuelure for males of other species and food baits (nu lure, PTA and Torula yeast) for both sexes. Some studies of a new non-drying liquid bait spray GF-120 have been made by Dr Vayssières and these will continue.

INERAB based at Parakou has links with IITA, but mainly for work on cotton. It has also carried out some studies on pineapple and cashew. A student from Parakou University, Leon Hounou, is studying for his Ingenieur Agronome diploma, with specialisation on *Metarhizium anisopliae* applied to soil as a larval control method (developed by ICIPE). Dr Gnanvossou has received training in fruit fly taxonomy from Dr Marc De Meyer at the Musee Royale de l'Afrique Centrale, Tervuren, Belgium.

The IITA group has contacts with Francois Hala N'Klo in Cote d'Ivoire and Francois-Xavier Ndzama Abande at IRAD in Cameroon. Contacts are also maintained with Dr Tindo at IITA, Cameroon, Dr David Wilson in Ghana (Legon), with Dr Umeh in Nigeria and with SAGIC in Senegal as well as with the NARS and with University of Hawaii. IITA can contribute to developing capacity in West African countries. A new IITA/ICIPE joint project started in April 2007 and will run for three years. This is funded by BMZ and will deal with mango pests including the mealybugs *Rastrococcus invadens* and *R. iceryoides* in West and East Africa respectively. It will also cover fruit flies and the Mango Seed Weevil *Sternochetus mangiferae*[6].

Three papers are currently in preparation by IITA/CIRASD personnel, covering fruit flies on cucurbits and on citrus and host range of *B. invadens* in West Africa (Benin and Cameroon). Incubation of field-collected fruits has shown that in West and Central Africa *B. invadens* develops in fruits of at least 36 plant species from 19 families. Infested fruits are incubated in plastic pots for 2-3 days to obtain pupae which later hatch out as flies. Dr Ousmane Coulibaly works on the socio-economics of mango and value chain analysis. He has been joined by Ms Cathelijne Van Melle, a PhD student from Netherlands who started in early 2007 and will work at IITA for three years.

[6] Not a quarantine pest in Europe but likely to become one because of the development of mango production in the Mediterranean region.
http://www.eppo.org/QUARANTINE/insects/Sternochetus_mangiferae/CRYPMA_ds.pdf

5.6.7.2 The West African Rice Development Association (WARDA/ADRAO)

WARDA's Centre du riz pour l'Afrique is now co-located with IITA on the Benin campus. Dr Paul Van Mele, who has previously worked in Vietnam on weaver ants in fruit plantations, has worked with Dr Vayssières and colleagues at CIRAD to assess the potential of *Oecopgylla longinoda* weaver ants for protecting mangos against fruit fly damage[7]. In northern Benin in 2006 high levels (>8) of ant nests per tree were shown to greatly reduce fruit fly damage to mangos. Initial observations suggested that damage by fruit bats was also reduced (for further details see Section 4.6.6 and bibliography).

5.6.8 Plant Protection Products for fruit fly management

There are no local sellers of appropriate specialised plant protection products for fruit fly control and monitoring. CIRAD and IITA are still involved in experimental studies with traps and parapheromones, based in certain orchards in Borgou department in the North of Benin. Monitoring of fruit flies is carried out by CIRAD and IITA using plastic Tephritrap (modified McPhaill) traps. Three types of attractant are used: terpinyl acetate, methyl eugenol and trimedlure. The insecticide used in traps is dichlorvos (DDVP). Pesticides, lures, baits and traps are purchased overseas by IITA and CIRAD from specialist suppliers such as IPS in UK.

5.6.9 Official support structures for fruit farmers

5.6.9.1 Ministère de L'Agriculture de l'Elevage et de Pêche (MAEP)

In the time available and bearing in mind the August holiday pattern of many expatriate and also national researchers and civil servants, it was not possible to make contact with the main figures in the Ministry. Mango is not a priority crop for the Ministry which focuses more on market gardening vegetables. M. Euloge Videgla, Coordonnateur National due Projet d'Appui Institutionnel a la Modernisation de l'Agriculture Familiale (PAIMAF) provided a copy of the National Growth Strategy for Poverty Reduction[8]. This document covers the period 2007-2009 and stresses, economic diversification and growth with the aim of poverty reduction and contributing to meeting the Millennium Development Goals for Benin.

The report notes that national export performance is one of the weakest in the UEMOA and that the economy of Benin is overly reliant on a single commodity, cotton (40% of all exports). There is a strong desire to diversify the agricultural production, moving towards value-added and processed goods instead of basic commodities in which Benin is less competitive on the world market. Focus value chains include oil palm, cashew, rice, vegetables, pineapple, cassava and fish. Mango is not perceived as a value chain to be developed. However plans to strengthen irrigated cropping, producers' associations, collection of agricultural statistics etc, are all likely to contribute to creating a better enabling environment for mango growers.

[7] Van Mele, P., Vayssières, J.-F., Van Tellingen, E. and Vrolijks, J. 2007. Effects of Weaver Ant, *Oecophylla longinoda*, in controlling Mango Fruit Flies (Diptera Tephritidae) in Benin. Journal of Economic Entomology Vol. 100, no 3: 695-701.

[8] Stratégie de Croissance pour la Reduction de la Pauvreté (April, 2007).

5.6.9.2 Regional Agricultural Promotion Centres (Centres Régional de Promotion Agricole)(CERPA)

For the time being there is no organised system of support to farmers to manage fruit flies. No strategies are used by farmers to manage damage by fruit flies except early harvesting (1 week early) of fruits before maturity. Some extension services are provided by the Benin government through the CERPA which has six offices covering the 12 Departments of Benin:

- Cerpa Atlantique-Littoral : (+229) 21361798 / 1799
- Cerpa Ouémé-Plateau : (+229) 20224899
- Cerpa Zou-Collines : (+229) 22510134 / 0151
- Cerpa Mono-Couffo: (+229) 22411120 / 1121
- Cerpa Borgou-Alibori : (+229) 23610425 / 1094
- Cerpa Atacora-Donga : (+229) 23821423 / 2006

The CERPA branches conduct technical training of crop producers, animal raisers and fishers. HoweverNo specific crop protection methods are used against fruit flies and there is no farmer training in cultural techniques and plant protection.

5.6.9.3 Direction du Conseil Agricole et de la Formation Opérationelle

The team briefly met with M. Desiré Agoundote who is responsible for general agricultural training. There are some general training materials on mango culture but he does not cover pest problems. Such training should be provided by the Service de la Protection des Végétaux (SPV) at Porto Novo outside Cotonou. The telephone to Porto Novo was out of action during the visit so it was not possible to schedule a visit to the SPV.

5.6.10 Government Departments with responsibility for Phytosanitary Issues

5.6.10.1 Service Protection des Végétaux et Contrôle Phytosanitaire (SPVCP)

The SPVCP in the Direction de l'Agriculture of the Ministère de l'Agriculture, de l'Élévage, et de la Pêche (MAEP) is responsible for: phytosanitary certification of exports and inspection of imports, assisting exportation, and the process of registration of pesticides. The SPVCP lacks financial and human resources and capacity-building as well as laboratory facilities. M. Symphorien Saizonnou, Chef Service Phytosanitaire de Service Protection des Végétaux (DAGRI) was away from Cotonou during the team's visit.

5.6.10.2 Comité National de Controle Alimentaire

The Comité National de Contrôle Alimentaire oversees the Système national de Normalization de Qualité in the Direction de l'Alimentation National (DANA). There are four laboratories but the analysis laboratories are not accredited overseas. COLEACP visited in January 2007.

5.6.11 Regulatory framework

Pesticides are regulated under Arrete No 591 of 1995 promulgated by the Minister of Rural Development, regarding registration of dealers in plant protection chemicals, and under Arrete 593 of 1995 regarding requests for experimentation and registration of plant protection products (produits phytopharmaceutiques) under Law no 91-004 of 1991 dealing with phytosanitary regulations in Benin. Such registrations are approved by the Comité National d'Agrément et de Contrôle des Produits Phytopharmaceutiques (CNAC).

5.6.12 Activities of International donors

GTZ (German Cooperation) had a successful project to strengthen the Service Protection des Végétaux et Contrôle Phytosanitaire (SPVCP) from 1984 to 1998 for homologation of pesticides. The French Ministry of Research has assisted Benin through CIRAD in collaboration with IITA. The World Bank and the European Commission have provided assistance to producers through COLEACP. Other long-term assistance has been extended to the government through World Bank, French Cooperation and Danish Cooperation.

5.6.13 Difficulties and constraints in fruit fly management in Benin

- At present there is a lack of engagement with the fruit fly problem by SPV and NARS, partly because of other priorities and lack of resources.

- Mango is mainly grown in the northern region which is further from the capital and poorer than the south. There is a need to halt the decline in mango growing as a contribution to poverty alleviation.

- There is no forum for interaction between stakeholders of the mango value chain, who mostly remain unidentified and unknown to each other.

- There is more research information for pest management of fruit flies available in Benin than in most other countries in the region. However this is not is not yet well-disseminated to growers and the delivery of practical management programmes which growers can apply.

- Farmers lack training in maintenance of the orchards and in post-harvest matters, seeking markets etc.

- Farmers lack the necessary materials for fruit fly management (Traps, MAT blocks, baits, etc)

- Many farmers are unaware of the benefits of Biological control using weaver ants

- There is no market intelligence which indicates the potential for exporting mango regionally or internationally.

5.6.14 Proposals for National Action Plan: Benin

The cultivation of mango is not a national agricultural production priority for the Ministère de l'Agriculture, d'Élévage et de la Pêche. However mango exports could have a bright future if producers were assisted and the value chain was organised. This would enable the producers at least to export within the subregion, for example to Niger.

There is a need for an economic study of the current and potential market for Benin's mangoes in the region and beyond.

There is a need to convene an awareness raising workshop meeting of stakeholders in the mango value chain and the fruit fly problem in order to explore common interests and set national priorities. This should be developed into a stakeholder information network

Bearing in mind the statement of S. Quilici that no single technology can solve the fruit fly problem, researchers need to develop IPM programmes that integrate several compatible best-bet technologies - and test them for sustainability with farmers.

To the extent possible, stronger linkages should be built between IITA, SPV and NARS to test and transfer technologies to farmers.

Demonstration activities and ToT need to be designed by research and extension staff to assist the mango farmers in the North by scaling up recent experiments in baiting, MAT and weaver ant biocontrol.

Since vegetable crops are a priority for the MAEP, surveys of fruit fly damage on solanaceous and cucurbitaceous vegetables are needed to assess the role of fruit flies in smallholder vegetable production and the need for a response.

Researchers need to look for synergies between IPM for fruit flies on fruit and vegetable (some common pests, some common monitoring and control strategies, possibilities for co-location of traps and fruit/vegetable crops).

5.6.15 IITA potential for regional capacity-building in fruit fly management

Through IITA/CIRAD, Benin has considerable experience in mango pest management which could also benefit other countries of the subregion. The following topics, while not exhaustive, are indicative of the potential contribution to training of trainers at regional level which IITA could deliver[9].

5.6.15.1 Fruit fly trapping

Different uses of fruit fly trapping (for detection, surveillance or control) and their outcomes. techniques of setting up traps (different kinds of traps, positioning and density of traps) and types of attractants; different techniques for trap servicing (frequency of servicing, changing of attractants, collecting, storing and sorting of insect catches, avoiding cross-contamination, etc)

5.6.15.2 Taxonomy

Preparation of reference specimens of fruit flies and identification of main fruit fly species (sorting trap catches, collection and incubation of infested fruits, emergence of flies from infested fruits, specimen preparation, identification characters, use of keys, data recording, etc).

5.6.15.3 Bait application technique (BAT)

Protocol for controlling fruit flies with GF 120 = Success Appat (principles of action, variability of spreading, preparation of the mixture, timing of interventions, assessing success, data recording, basic analysis methods).

[9] This initial list is the outcome of an exploratory exchange of emails between the team and Dr J.-F. Vayssières.

5.6.15.4 Male Annihilation Technique (MAT) (technique eradication des males -TEM)

Protocol for controlling fruit flies with MAT (principles of action, variability of density per area, making blocks at the lowest cost, variability of suitable pesticides, assessing success, data recording, use of GPS tool, basic analysis methods, etc).

5.6.15.5 Biocontrol using Weaver Ants (Oecophylla longinoda)

Protocol for controlling fruit flies with Weaver Ants (WA) (public awareness campaign about weaver ants, optimal density of nests in the orchards, improving colonisation where nests are absent, conservation measures, avoidance of biting at harvest, etc).

5.7 National Situation Synopsis: GHANA

5.7.1 Agro-ecological zones and land-use in Ghana

The country is divided into six agro-ecological zones on the basis of climate. The natural vegetation is determined by the different climatic conditions and by different soil types. These agro-ecological zones (from north to south) are; the Sudan Savannah, Guinea Savannah, Transition, Semi-Deciduous Forest, Rain Forest and the Coastal Savannah zones (**Table 45**).

The mean annual rainfall ranges from 800 mm in the Coastal Savannah to 2200 mm in the Rain Forest. Two main regimes of rainfall distribution are found in Ghana. The first is the double maximum or bi-modal regime occurring from March to July/August and from September to October/November in the Transition, Semi-Deciduous Forest, Rain Forest and the Coastal Savannah zones. The single maximum or uni-modal regime is found in the north (the Sudan and Guinea Savannah zones), where there is only one rainy season from May to September followed by a long dry season from November to May. The land in Ghana is generally below 600 m. The soils are highly weathered with poor water holding capacity. Thus crop water stress is not uncommon during the growing season.

Table 45. Agro Ecological Zones of Ghana.

Agro-ecological Zone	Coverage Area (km^2)	Mean annual rainfall (mm)	Rainfall pattern	Major season	Minor season
Sudan Savannah	2,200	1000	Uni-modal	May-Sept	-
Guinea Savannah	147,900	1000	Uni-modal	May-Sept	-
Costal Savannah	4,500	800	Bi-modal	Mar-July	Sept-Oct
Transitional Zone	8,400	1300	Bi-modal	Mar-July	Sept-Oct
Deciduous Forest	66,000	1500	Bi-modal	Mar-July	Sept-Nov
Rain Forest	9,500	2200	Bi-modal	Mar-July	Sept-Nov

Source: Combined data from Meteorological Department and MoFA/HEII, Accra.

5.7.2 Agriculture in Ghana

Agriculture in Ghana is dominated by the smallholder sector with plots of less than 1.5 ha contributing 80% of the agricultural production of the country. Productivity is low and volatile due to variable rainfall and largely traditional production methods. About 22% of land area is under cultivation, but of this less than 0.5% is irrigated. Agriculture is the dominant sector of the Ghanaian economy, employing 60-70% of the labour force and contributes about 40% of the GDP, with agro-exports accounting for 57% of total foreign exchange earnings. The sector is made up of 5 sub-sectors; Cocoa, Non-Cocoa Crops, Livestock, Fisheries and Forestry. The non-cocoa crop sub-sector covers cereals, legumes and pulses, roots and tubers, Industrial crops and horticultural crops. Horticultural crops include pineapple, mango, papaya, and many other fruits and vegetables and other crops (plantain, banana, ginger, etc). The producer profile of horticultural crops is indicated in Table 3. The production calendar for pineapple and mango is given in **Table 46**.

Table 46. Production calendar for pineapple and mango in Ghana.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Pineapple												
Mango												

5.7.3 Fruit and Vegetable Cultivation in Ghana

Ghana produces a number of fruits and vegetables, mostly for domestic consumption. These include pineapple, papaya, avocado, mango, cashew, watermelon, plantain, tomato, eggplant, pepper/chilies, okra, onion, cabbage, lettuce, carrot. Though pineapple is the most important exported fruit, it has no major problem with fruit flies. Apart from pineapples, all other horticultural products are prone to fruit fly attack. Fruit flies are quarantine pests and detection in exports may lead to complete banning by importing nations.

Table 47. Producer profile of the main horticultural products.

Product	Producers	
Pineapple	Large and medium (60%)	Smallholders (40%)
Papaya	Large and medium (70%)	Smallholders (30%)
Mango	Medium (30%)	Smallholders (70%)
Banana	Large and medium	-
Vegetables	-	Smallholders

5.7.4 EurepGAP certification

There are a number of exporters/producers who have currently obtained EurepGAP Option 2 certifications in Ghana. These include companies such as Blue Skies Foods Ltd, ITFC and Farmapine, with a few more still undergoing the process. The GTZ, HEII and TIPCEE projects are actively involved in furthering the EurepGAP Option 2 smallholder framework in Ghana's horticultural export sector: GTZ has funded collaboration with EurepGAP's secretariat Foodplus GmBH to produce a Smallholder manual for the building up of an internal control system for certification to EurepGAP option 2 in the Horticultural sector. TIPCEE is concurrently working with individual pineapple exporters and their immediate outgrowers, providing them technical assistance for the implementation of the internal control system required by Option 2 EurepGAP and fair-trade certification. These recommended practices would be consolidated into practical implementation tools and trainer's guides which would serve as the basis for further dissemination by MOFA extension agents, business development service (BDS) providers and private exporters' field teams.

5.7.5 Mango production

5.7.5.1 Mango production zones

The Coastal (Greater Accra, Eastern and Volta), Transitional (Brong Ahafo and Ashanti), and Northern Savannah (Northern region) zones are ideal for cultivation of the crop. The mango industry is divided into two production zones - the southern and northern sectors. Average temperature is 24 °C (Southern sector: 21-34 °C and Northern sector 18-40 °C), with the lowest temperatures occurring between December and mid-February in the Northern sector. The Coastal and Transitional zones form the southern sector, while the Savannah zone forms the northern sector. In the southern sector, large businesses with huge acreages operate as producers and exporters at the same time.

The orchards of the Volta region are diverse and extensive, and have benefited from specific TIPCEE support. The orchards of the Dodowa and Somanya areas are almost all young with an average age below 4 years. They are orchards newly planted with varieties intended for export and which it is hoped will contribute to increase the volumes exported from Ghana. The Yilo Krobo District area is one of the old mango production zones whose production was mainly intended for local consumption. The Hoho District area, like the Yilo Krobo District area, is an old mango production zone. Its orchards are said to be over 30 years old.

5.7.5.2 National mango production area

Figures from 2005 (TIPCEE GIS Survey) estimated that about 6,937 acres are planted to mango in Ghana, with southern Ghana cultivating 5,637 acres to various varieties and 1,300 acres planted in the Northern sector. About 40% of the estimated planted acreage has started fruiting.

5.7.5.3 Types of mango orchards

At least at the beginning, mango production was not intended for export but for local consumption and possibly for certain sub regional markets. One can thus distinguish between three main types of orchards in Ghana:

- Modern orchards (those planted by operators monitored by the TIPCEE) are mainly planted with one or possibly two varieties. They are almost all recent and have not yet entered into full production. According to data in our possession, these orchards should start to produce significant quantities of fruit as from 2008/2009. They are reported to represent less than 10% of the country's orchards.
- Improved traditional orchards are all the orchards which have been gradually grafted to produce fruit adapted to export. They are reported to represent between 40 and 50% of the country's orchards. The conversion from old varieties to varieties mainly destined for export contributes to standardising the offer.
- Traditional orchards are the most important but it is nevertheless difficult to quantify them. We know that they represent over 60% of trees planted in the country. These trees are often old (over 40 years) and up to now only served for local consumption.

5.7.5.4 Mango production volume

Data concerning mango production in Ghana are very patchy. The orchards assisted by the TIPCEE are mapped by GPS. The varieties cultivated are also registered. For the rest of the sector, the situation remains unclear. Unfortunately, the TIPCEE is a recent program and the data it offers only concern orchards which are not yet in production. To remain coherent, we therefore based our analysis on FAO data. Unfortunately, they do not take into the account the diversity of the offer either and we believe they are well below the real quantities produced in Ghana. According to these data, mango production has progressed markedly during the last 5 years. Estimated slightly above 30,000 tons in 2000, it reached 160,000 tons in 2005

5.7.5.5 Varieties grown and production cycle

About 85% of mangoes produced in Ghana are Keitt and the remaining 15% made of Kent, Tommy Atkins, Julie, Palmer, Zill, Irwin, Haden, Springfield, Jaffna etc plus the local varieties. The major season in the Southern sector starts in November/December (especially for Hayden and Tommy Atkins), while Kent and Keitt start in January and February. Fruits from these 2 flowering periods are harvested between March/April and May/June, respectively. Fruits normally mature 3-3½ months after flowering and take 4-6 weeks to ripen for harvest. For the minor season, flower initiation starts in late July/August. The improved varieties are grown with the aim of exporting to foreign markets, but production difficulties, inadequate management skills coupled with pests and diseases have rendered that aim not fully achievable. Losses due to fruit flies in Ghana are estimated between 60-85 % depending on variety and season.

5.7.6 Mango exports

The European Union (EU) market has been the main market destination of Ghanaian fruit. Exports from Ghana account for 1% of African mango exports to Europe. Export of mangoes from Ghana to the EU began in 2004 with a total of 177 tonnes, making mangoes one of the country's largest fresh produce exports to the EU. Despite rather limited exports to Europe, the Ghanaian mango market remains a dynamic market with strong potential. Between 2004 and 2006, mango exports from Ghana to EU markets progressed from 177 tons to 293 tons (**Figure 29**).

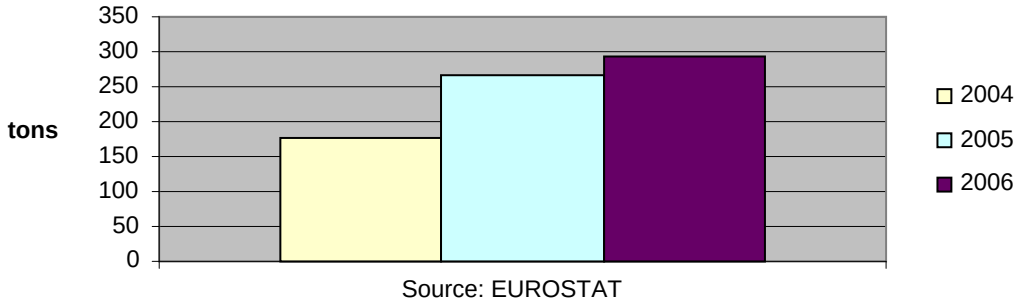
The Netherlands are the main recipients of Ghanaian mango exports, with a little over 51%, followed by the United Kingdom (26%) and the Benelux countries (15%) (**Figure 30**). Ghana's productivity is low and the highest export volume reached was about 400 tonnes in 2005 (GEPC, 2006). Nevertheless, Ghanaian stakeholders believe the recent restructuring of the horticultural sub sector such as HEII and EMQAP coupled with the presence of two harvest seasons (that may allow Ghana to supply the European market during times when competition is weaker) and its proximity to the EU and Middle East markets confer some geographic competitive advantages over other mango exporting countries. Last year the ECOWAS market, which is rapidly developing, accounted for 27% (GEPC, 2006). However, in 2005, a ban was placed on export of Ghanaian mangoes to South Africa (still in force) for fear of the potential invasion of the invasive fruit fly, *Bactrocera invadens*.

Table 48. Mango and citrus export figures for the period 2000-2006.

Year	Produce			
	Mango		Citrus*	
	Volume (MT)	Value (USD)	Volume (MT)	Value (USD)
2000	268.4	117,717	1,242	248,841
2001	231.7	78,475	1,335	126,378
2002	125.9	69,608	15,213	671,986
2003	234.4	108,084	4,307	329,000
2004	269.0	163,850	742	93,947
2005	407.2	134,559	5,846	3,865,853
2006	261.0	121,511	6,484	545,880

*Only Sweet Oranges (excluding limes and lemons)
Source: GEPC/MoFA-HEII

Figure 29. Mango exports from Ghana to the EU (2004-2006)



Source: EUROSTAT

Figure 30. Main European destinations for mango exports from Ghana in 2006

Source: EUROSTAT

Although exotic mango varieties target the export market, the domestic market is gradually becoming important. Of the estimated 4,860 MT produced annually, only 125-407 MT (2.6-8.4 %) are exported (GEPC, 2006; R. N. Attatsi, personal communication, 2007) (Table 5). Almost all mango produced are sold fresh (local and export markets), with a farm gate price of about $0.36/kg.

5.7.7 Pineapples

Over the last two decades or so, export of fruits and vegetables has been one of the most vibrant sources of foreign exchange to the Ghanaian economy, and placing Ghana as the fifth largest ACP exporter of fruits and vegetables to the European Union (EU), with pineapple being the leading product. In 2006, out of a total of 148,224.5 MT of horticultural products (worth USD 49,641,771), pineapples alone contributed 60,751 MT (worth USD 19,086,134), forming 40.99 % of the 32 products exported under the horticultural sub-sector in 2006. There was also a growth in export markets as follows; 13.8% EU, other Africa countries 34.5%, other Developed countries 33.6%, while those to all other countries combined increased by 47.2% from 2005-2006. Relocation of Golden Exotics Limited to Ghana from Cote D'Ivoire and the use of state-of-the art farming tools gave a percentage growth rate of 2.15 from 2005-2006 alone (GEPC, 2006). With export earnings valued at $22 million in 2004, Ghana's market share is estimated at 7% of world pineapple trade. Production has declined somewhat in recent years due to competition and introduction of a new variety (MD2) in Costa Rica. There are over 50 regular exporters of pineapples in Ghana, with about 10 exporting volumes above 1 000 tonnes per annum.

5.7.8 Papaya

Globally, Ghana is the 9th largest exporter with a market share of 2%. In Ghana papaya exports grew strongly during the late 1990s enabling Ghana to reach a second place in the ranks of EU suppliers. However, while the EU imports have continued to grow, Ghanaian exports reached a plateau in 1999 at around 1,800 tonnes. Though papaya exports are not as high as pineapples and mango, Ghana remains the largest ACP exporter of the crop to the EU (PIP, 2006). Local varieties have been cultivated for a long time in Ghana. The Hawaiian Solo types were introduced in the early 1990s and the export crop is built on this type. More recently, the Golden variety developed in Brazil, has become popular in the EU market and Ghanaian production is gradually switching to this variety. There are few major papaya producers. Six exporters send over 100 tonnes per year, with a farm gate price of about $1.00/kg.

5.7.9 Citrus

Citrus production is conservatively estimated between 200,000-245,000 metric tones (with about 80% being Late Valencia and 20% mixed varieties). The bulk of the citrus is consumed locally (about 90 % fresh and 10 % processed). Though citrus production far outweighs mango production, there is very little in terms of export mainly due to the high preference for citrus with orange-colour on international markets. Within the last seven years, the largest export volume (15,213 MT) was in 2002, which is only 6.2 % of the estimated production figure (**Table 48**). To offset this production glut, a few processing plants have been initiated (both private and community-based).

5.7.10 Other fruits and vegetables

Data was hard to come by with regard to the exact crop production figures of the other fruits and vegetables, with planted areas based on estimates. However, the volumes (and export earnings) of some selected produce exported between 2000 and 2006 are presented in the **Ghana Country Report - Annex 9**, **Table 6.**

5.7.11 Producer and exporter organizations

Small farmers (who make up the majority of fruit producers) are mostly organized in associations (**Table 49**), as it is very difficult to enter the business individually due to its capital-intensive nature. In the northern sector, the Integrated Tamale Fruit Company (ITFC) has created a mango out grower scheme with growers grouped into the Organic Mango Outgrowers Association (OMOA), that allows participating farmers to grow one acre of mango with input support on a credit basis. Due to the ITFC involvement in the mango sector, small farmers are able to grow mangoes in addition to their other farming activities. On the average, mango yields are estimated to be about 15 tons per hectare. However most of the outgrowers have not yet harvested so exporting has not begun and the sustainability of the scheme is not yet clear.

Table 49. Mango farmers and their professional organizations.

Association	Type of membership
Papaya and Mango Producers and Exporters Association of Ghana (PAMPEAG)	50% small scale farmers, 30% medium scale, producers and 20% large scale producers / exporters
Sea-Freight Pineapple Exporters of Ghana (SPEG); Ghana Vegetable Marketing Company Limited (GVMC); Horticulturists Association of Ghana (HAG); Vegetable Producers and Exporters Association of Ghana (VEPEAG);	Associations of producers / exporters
Tamale Fruit Company (ITFC) & Organic Mango Outgrowers association (OMOA)	Large scale producer operating an out grower scheme (targeting 2,000 small-scale farmers in the north) formed into association
Kintampo Mango Farmers Association, the Yilo-Krobo Mango Growers Association and the Mango Farmers Association of Dangbe West.	community-based and area-based associations of small-scale farmers
National Horticultural Task Force (NHTF) and the Federation of Associations of Ghanaian exporters (FAGE),	Professional groups which serve as platforms and facilitate other associations

Source: Billah, 2007.

5.7.12 Post harvest practices and Quality management in packing stations

Only mangos intended for export via ports or airports pass through packing stations. Mango exports are very recent in Ghana and as a result it is difficult to really categorise the export infrastructure, given that most mango exporters also produce pineapple and have at their disposal infrastructure specifically adapted to pineapple exports. One may nonetheless distinguish 2 types of stations:

- The stations that we could qualify as specific to mango exports. There does not appear to be a mechanised station specifically dedicated to mango. In the mango production zone, where the TIPCEE concentrates its efforts, we have identified an existing station which could be mechanised and improved. This station belongs to ECV (Equatorial Capital Ventures Ghana Limited). It is a station of about 580m^2 equipped with cold storage facilities (cold rooms and pre-cooling rooms). There is talk about modernising it by importing a packing chain from South Africa. The TIPCEE, following discussions with the owners of the station, is considering making it work as a service provider for the other products that will transit through it. The "Bomarts" station is also said to have cold rooms and equipment for grading round fruit.
- Existing stations oriented to other fruit but adapted or used for mango exports. This is the case of almost all mango exporters presently in Ghana. In fact, it appears that all present Ghanaian mango exports are despatched from this type of station.

In most cases, the work of the packing stations follows the sequence outlined above. Apart from the "Bomarts" station and the mechanised grading chain planned for the ECV station, size grading is done manually. The inspectors working in Ghana come from the Ivory Coast for the most part. As part of its activities, the TIPCEE calls on teams of women from the Ivory Coast to train and undertake inspection operations in packing stations. Several initiatives have also been undertaken to ensure the training of fruit pickers (*pisteurs*), the first links in the security chain.

5.7.13 Main phytosanitary constraints managed in packing stations

The main phytosanitary constraints managed in packing stations are fruit fly, mealybug and anthracnose. At the moment, apart from the inspection operations undertaken manually, nothing specific is done in packing stations to control fruit flies. In Ghana, there is the GAEC (Ghana Atomic Energy Commission) which attempts to develop techniques of fruit irradiation. The information in our possession attests that fruit irradiation trials (on pineapple) have been undertaken. According to the first results, the irradiation appears to have killed the nematodes and could also have increased the lifespan of the treated fruit. The pineapples treated in this way were exported to North America. For the time being, data and trials remain patchy concerning mangos.

5.7.14 Fruit processors

There are a limited number of processors in the country. The few registered processors are large-scale companies that employ wage labourers. A few of the major ones are Blue Skies Product Gh. Ltd. in the Greater Accra Region, which exports fresh-cut fruit salad containing mangoes to the EU by air. It is responsible for about 1% of Ghana's total exports, 25% of pineapple exports and 70% of mango exports, making it the market leader. It also supports a supplier base of over 130 EurepGAP certified small-holder farms in Ghana. Ebenut Gh. Ltd (also in the Greater Accra Region), produces dried mangoes, banana and pineapples, as well as sliced coconut, pawpaw and plantain chips. Its mango processing is concentrated on only 4 varieties namely, Kent, Palmer, Sunrise and Eldon.

A pulp processing company, AfriqueLink (in the Transitional zone at Wenchi in the Brong Ahafo Region), caters for farmers/producers from the Brong Ahafo, Ashanti and Northern regions with the bulk of its supplies coming from ITFC. It products include tomato pulp, tomato paste, chopped tomatoes, mango puree and mango concentrates. Mango supplies for the plant are usually not met and it and imports mangoes from Burkina Faso. Interestingly, AfriqueLink also uses local varieties for processing. Recently, there has been the establishment of a new processing plant in Asamankese in the Eastern Region, PINORA Ltd., with a processing capacity of 450 metric tones of citrus/day and 1200 metric tonnes of pineapple/week, making it the biggest in West Africa (S. Boateng, PINORA, personal communication). These are processed into juices and concentrate and exported mainly to the Europe. They therefore deal with a large number of producers (small and large) and purchase fruits from almost all production areas in the country, but there is no pest/orchard management scheme in place yet. There has also been a legitimate complaint from producers/farmers of undue delay at the plant gate before fruits are processed for payment. Additionally, the number of days spent at the plant gate leads to further fruit damage and farmers are not compensated for the waiting days of their trucks. There are also a large number of very dynamic small and medium enterprises which process and export fruits and vegetables.

5.7.15 Damage to fruit caused by fruit flies

Based on discussions with stakeholders, estimates of damage by fruit flies are given in **Table 51**. The different fruit fly species known from Ghana can be seen in **Table 50**.
The most severe damage to mango and citrus is caused by *Bactrocera invadens*. However in second place is *Ceratitis annonae*, damaging coffee and citrus, and *B. cucurbitae* on cucurbits. The third category includes *C. capitata* and *C. ditissima* on citrus and capsicum and *C. cosyra* on mango.

Table 50. Incidence of fruit flies on different hosts in Ghana. Source: Billah (2007).

	Fruit fly species							
Host species	***Bactrocera invadens***	***C. cosyra***	***C. anonae***	***C. capitata***	***C. fasciventris***	***B. cucurbitae***	***C. ditissima***	**Other fruit flies (specify)**
Mango	4ab****	2ab***			1b*			
Citrus sinensis (var. Late Valencia & Pineapple)	4ab****		2abceh**	2abceh**	1abd*		2abceh**	
Citrus reticulate (var. Satsuma and mandarin)	4ab***		2abceh**	2abd**	1abd*		2abceh**;	*Dacus* sp. 1b*
C. x nobilis (Tangor)	4b***		2abceh**					*Dacus bivittatus* 2b**; *Dacus* sp. 1b*
Papaya	4b***							
Cucurbits (Squash)						3b**		*D. bivittatus* 1b** *D. vertebratus* 1bc**
Capsicum frutescens				1e*				
Cola nitida								*C. colae* 3bc**
Coffea canephora			3abh***					*T. nigerrimum* 2abh*; *T. coffeae* 2abh*
Coffea arabica			3abh***					*T. nigerrimum*, 2abh*; *T. coffeae* 2abh*
Synsepalum dulcificum		1b*						*C. lentigera* 1b* (on fruit)
Terminalia catappa	4a****							
Unknown hosts								*D. punctatifrons* 1c*; *C. grahami* (on palm) 1e*; *C. guttiformis* (on leaf) 1e*; *C. melanopus* 1e*; *C. neostictica* 1e*; *C. punctata* 1e*

Damage codes: ? = unknown species; 0 = not found (0% fruit loss); 1 = minor damage (0-15% fruit loss); 2 = medium damage (16-30% fruit loss); 3 = severe damage (31-45% fruit loss); 4 = Very severe damage (> 46%).
Distribution codes: * = Limited distribution; ** = Moderately widespread distribution; *** = Very widespread distribution.
Information sources: a – D. Wilson, UG; b – MK Billah; c – White & Elson-Harris, 1992; d – Afreh-Nuamah, 1999; e – De Meyer, 1996, 1998; f. - Silvestri, 1918; g - Van Zwaluwenburg, 1937; h - Steck et al, 1986.

Table 51. Estimated losses in mango production due to fruit flies.

Level	% loss to fruit flies	Size of enterprise
Farmers	30-85 (mango) 10-35 (papaya)	Small, Medium and Large
Exporters	10-15	All levels
Processors	2-10	All levels
Nation	65	-

Source: Compiled from interviews from various stakeholders, 2007

5.7.16 Fruit fly research

Information on species composition, host range studies and natural enemies is scattered. A brief review of the history of fruit fly research in Ghana is given by Billah (2007) (**Ghana Country Report - Annex 9**). Recent collections in 2002 in the southern half of Ghana concentrated on coffee as the primary host plant, but yielded interesting fruit fly and parasitoid species, including first records of *Ceratitis fasciventris*, *Bactrocera cucurbitae* and a braconid parasitoid thought to be *Opius sulphureus.* With the recent invasion of *B. invadens* in Africa (Lux et al., 2003; Drew et al., 2005), a survey was conducted by Billah et al. (2006) in three major fruit-growing and trading regions, where the pest was detected in 29 out of 37 localities surveyed and immediately reported to the PPRSD in March 2005. Since then, collection exercises, host range studies, trapping and monitoring have been carried out by various organizations and groups but this information is not in the public domain for experts, producers/exporters to utilize in devising control strategies. About a dozen entomologists have some interest in fruit flies, of whom 5 are based at the University of Ghana, legon (See list in Billah, 2007).

5.7.17 Official support structures for farmers and exporters in the horticulture industry

5.7.17.1 The Ministry of Food and Agriculture (MOFA - Annex 9, Box 5)

The main support structures for farmers are organised under the MOFA structure, including those which deal with management of crops (pests and diseases), acquisition of inputs, market information, technology update and access to credit facilities, namely; Crops Services Directorate (HDU), PPRSD (Pests and Diseases Unit), Agricultural Extension Services and some of the cross-cutting projects like HEII, EMQAP, EDIF, GEPC etc. For imports/exports, the PPRSD, EPA and CEPS are the main players. The GSB and PPRSD ensure the safe use of pesticides, technical awareness, training stakeholders, inspectors and offer the necessary backstopping to issues relating to pesticides. MOFA is currently implementing various projects aimed at addressing specific needs along the horticulture supply chain as well as minimize the country's vulnerability to external price shocks as a result of over dependence on a few traditional commodities. In the forefront of this drive is:

- the **Horticulture Development Unit (HDU - Annex 9, Box 2)** of the Directorate of Crop Services, MOFA, was set up with the aim of providing technical support to farmers, Agriculture Extension Agents and all other stakeholders in the horticultural industry. This is done through; 1) Facilitation of stakeholder integration, interaction, backstopping services to farmer associations and commodity groups as well as academic and research institutions, 2) Provision of technical training on Good Agricultural practices, 3) Building networks for enhanced productivity and competitiveness, 4) Undertaking adaptive research and development, 5) Establishing demonstrations on improved agricultural technologies, and 6) Facilitating broad utilization and marketing of various horticultural produce. HDU is responsible for testing technologies developed at the various research

institutes for local adaptation and serves as a link between research institutions and extension, is providing technology and strategic information support to develop the Industry. Projects include the Horticulture Exports Industry Initiative (HEII) of the AgSSIP (funded by the World Bank), The Export marketing and Quality Awareness Project (EMQAP) and the Millennium Challenge Account (MCA), which augment the services of the HDU.

- **Export Marketing Awareness Project** (**EMQAP - Annex 9, Box 2**). This project is aimed at increasing incomes of horticulture crop farmers and exporters (and cassava producers) over a period of 5 years (starting from July 2006) in 4 regions. The main components being: i) Production and productivity enhancement, ii) Export marketing promotion and infrastructure improvement iii) Capacity building, and iv) Project coordination and management. Key outputs include: a) Four temperature controlled field pack houses to be constructed, b) 407 km of feeder roads to be upgraded to all-year-round access roads, c) Four demonstration farms (one in each of the selected regions) to be established to provide training on GAP, and d) Production of protocols and manuals of GAP and market requirements documented.

- The **Horticulture Exports Industry Initiative (HEII - Annex 9, Box 2)** is a 7-component 2-year programme (2006-2008) aimed at giving support to the Horticultural Industry. Components include: 1) Development of post harvest infrastructure at the field, airport and seaport. 2) to source and develop the new pineapple variety MD2 for farmers to meet challenges of the EU market by replacing the 'traditional' Smooth Cayene variety by October 2008. 3) Sustainable provision of high quality planting materials 4) Food safety and quality management (definitive pesticide list for all fresh produce export crops, certification of Ghana Standards Board lab to ISO 17025 and support to small farmer GAP. 5) Transfer of government investments to Industry ownership and operation. 6) Support to formation and strengthening of information sharing among stakeholders and 7) 50% matching grant and technical support to 2000 mango out-grower schemes to expand mango plantations in the N Region.

  Achievements of HEII have included development of designs for the construction of a perishable cargo centre for Kotoka International Airport and 2 pilot temperature-controlled field pack houses and near-completion of the ultra modern fruit terminal at the Tema Harbour (Shed 9); Support to EPA to fast-track the registration of 50 pesticides for use on horticultural crops and development and publication of a definite pesticide list for horticultural crops; collaborating with the Ghana Standards Board to set up a pesticide residue analysis laboratory; commencing EUREPGAP Option 2 certification process for 10 farmer groups and development of a geographic horticultural database management system to facilitate planning and integrating farmers into the global supply chain.

5.7.17.2 Other government structures supporting horticultural exports

A number of other organizations play different roles in the provision of support to the export sector. These include, among others:

- The **Ghana Export Promotion Council (GEPC - Annex 9, Box 9**), for trade development and facilitation, especially at the ECOWAS level.

- The **Ghana Standards Board** (**GSB - Annex 9, Box 8**) responsible for developing and publishing Ghanaian Standards in line with International Standards for all products and also for coordinating standardization and Conformity Assessment including Inspection, Testing, and Certification activities. GSB has set size standards for mangoes and

conducts pesticide residue testing in some produce. It is seeking accreditation for its analysis lab to ISO 17025, with assistance from HEII;

- The **Environmental Protection Agency** (**EPA - Annex 9, Box 7**), was set up in 1974 and subsequently transformed into an agency in December 1994 under Act 490, 1994. Under its mandate (Pesticides Control and Management Act, 1996 (Act 528)), EPA engages in: registration of pesticides, licensing of pesticides dealers and enforcement. The Chemicals Control and Management Centre (CCMC) of the EPA receives all applications, three PTC sub-committees evaluate applications and submit reports to a thirteen-member inter-sectoral Pesticides Technical Committee (PTC) which considers reports of sub-committees and makes recommendations to the EPA Board. The Board takes the final decision to register or deny registration of pesticides. EPA has published a guide to Pesticides for Horticulture Production under the HEII, with assistance from PPRSD (EPA, 2006)[1].

- The **Ghana Customs, Excise and Preventive Service** (**CEPS - Annex 9, Box 10**), responsible for collection of duties and enforcement of laws on import and export restrictions and prohibitions;

- The **Export Development and Investment Fund** (**EDIF - Annex 9, Box 11**), set up to support exporters with funds at concessionary rates in order to make Ghana's exports competitive on the international market and also give grants to strengthen public/private sector institutions and associations which provide service to the export sector;

- The **Private Sector Development/Presidential Initiative** (**PSI**).

5.7.18 Pest management strategies for fruit flies in Ghana

No specific methods or strategies are in place for the management of fruit flies in Ghana. Neither the Crops Services Directorate (CSD) nor the PPRSD of the Ministry of Agriculture (MOFA) had any specific control or management methods. Control strategies are based on general pest control methods, with heavy dependence on pesticides. Though farmers and producers are generally aware of the term integrated pest management (IPM), it was difficult listing any number of options that were used. However, most farmers/producers mentioned the use of orchard sanitation. The problem seemed to stem from the non-availability of any reliable menu of options to them. The use of baiting stations, attractants, lures (pheromones and/or para-pheromones and trapping were thought to be only for experimental purposes.

Horticultural research has been conducted in research institutes under the Council for Scientific and Industrial Research (CSIR) and in the Universities. Under the National Agricultural Research Project (NARP), research programs on plantain, pineapple, other fruit crops (citrus, mango), and vegetable crops (tomato, pepper, egg plant, okra, leafy vegetables and onion) are currently undertaken by multi-disciplinary scientists from the above-mentioned institutions. There has been no research programme specifically devoted to fruit flies. As a result understanding of fruit fly taxonomy and biology is limited.

A recent poster issued by MOFA's HEII, describing the threat posed by fruit flies, purports to show enlarged images of the male and female of *Bactrocera invadens*. However, instead of the two sexes of *B. invadens* the poster actually shows distorted images of a male of *B. invadens* and a female of a *Ceratitis* species. Under chemical control, the poster advocates "recommended pheromone traps" but gives no details of how these can be obtained nor what

[1] This lists 20 insecticides for fruit crops, including 13 for use on mango. These include fipronil and deltamethrin, but not malathion or spinosad. This has implications for the use of MAT blocks in Ghana, since the MAT blocks imported from India contain Malathion, which is not registered in Ghana for any purpose (EPA Revised Register of Pesticides, September 2007).

attractant to use. The advice for baiting (using molasses, hydrolysed protein or yeast extract) mixed with pesticides does not specify what pesticide to use.
A training workshop on *B. invadens* at the University of Ghana for staff of PPRSD, producer association members and farmers seems to have been the turning point where attention has been re-focused on fruit fly. Since late 2005, trapping with lures has been undertaken in eight of the ten regions of Ghana by PPRSD, USAID/TIPCEE project, ITFC and UG, Legon. This has shown the presence of *Bactrocera invadens* in all monitored regions[2].

5.7.19 Potential for sterile insect production for SIT

Ghana is host to one of the biggest irradiation facilities in West Africa. For the last decade or so, the Biotechnology and Nuclear Agriculture Research Institute (BNARI - see Box 4) of the Ghana Atomic Energy Commission (GAEC) has used irradiation in pest control, especially against Tsetse flies and stem borers and more recently on a limited (research) scale on fruit flies. Other areas have been use of irradiation for sprouting inhibition of '*Kponan*' yam variety exported to Côte d'Ivoire (IAEA, 2002) and in Ghanaian yam destined for the US market. The institute has also been instrumental in the supply of sterile male flies to the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC). A more detailed profile of the GAEC and BNARI is given in **Annex 9 -** Box 4. This facility could potentially be used to sterilise male fruit flies for release as part of an SIT programme. However see Section 4.6.7 for a critique of this technique in the West African context.

5.7.20 Plant Protection Products Dealers

In Ghana, there are a few large/wholesale suppliers. These include; DWA Dizengoff Ghana Limited, Agricultural Materials Limited (AGRI-MAT), WIENCO Ghana Limited, REISS & CO (Ghana) Limited, CALLI Ghana Limited, and CHEMICO Ghana Limited. Most of these are based in Accra with a few branches in the other regional capitals. There are also a large number of professional as well as unprofessional bulk breakers/retailers who reach out to the majority rural producers. Most of the chemicals sold are not exclusively for mangoes or fruit flies. For example, the only inputs and pesticides which were found during the study that were related to fruit fly control were methyl eugenol[3], Spinosad and a few yellow panel traps. No other lures/baits or traps were available. Only one supplier had methyl eugenol in stock which was re-packaged in various portable quantities.

The fruit fly control method recommended by these suppliers was basically part of the general insect pest control where a combination of 50 ml Deltapaz (Deltamethrin) and 25 ml Rimon[4]/15L knapsack was used as blanket spray (and as well as for the mango seed weevil, grasshoppers and stem borers). Since farmers/producers continually complain about fruit flies, all efforts are being made to get products and equipment into the country for their control, but these are not coordinated. The president of the PAMPEAG has also imported methyl eugenol (pre-mixed with killing agent and re-packaged in single, ready-to-use sachets) and small yellow plastic traps for their deployment. These are sold to members of the association (and any interested persons) for use in combination with orchard sanitation (plus any other options available to them). See Section 4.6.3.3 for a fuller discussion of this initiative.

[2] Sraha et al., 2006.
[3] AGRI-MAT Ltd had an insert in their 2007 catalogue offering a mixture of Deltamethrin EC 25% ("Plan D") with Methyl eugenol in a ratio of 1: 4 for fruit fly control. No instructions on how to deploy this mixture were provided.
[4] Novaluron (Rimon 0.83 EC) belongs to a class of insecticides called the benzoylphenyl ureas (insect growth regulators) and it affects chitin synthesis of immature insects, disrupting their normal growth and development. It has no action against adult insects (though if ingested it would probably lead to laying of sterile eggs).

5.7.21 Government Phytosanitary controls

The Ministry of Food and Agriculture's (MOFA - Annex 9, Box 5) Plant Protection and Regulatory Services Directorate (PPRSD - Annex 9, Box 6) is the agency charged with the responsibility for phytosanitary matters in Ghana, with technical support from the Environmental Protection Agency (EPA - Annex 9, Box 7) and the Ghana Standards Board (GSB - Annex 9, Box 8). The 3 bodies together constitute the National Codex Committee.

5.7.22 The Plant Protection and Regulatory Services Directorate (PPRSD)5

The PPRSD of the Ministry of Food and Agriculture (MOFA) is identified as the National Plant Protection Organization (NPPO) with the mandate and capacity to organize, regulate, implement and coordinate the plant protection services in support of sustainable growth of agriculture in Ghana. The legislative framework of the NPPO comprises a number of international conventions and agreements, as well as national legislation. These include the *Prevention and Control of Pests and Diseases of Plants Act (307)*, enacted by Parliament in 1965. In 1996, the Act was amended by *Act 528* to include *The Pesticide Control and Management Act*, giving PPRSD responsibility for post-registration monitoring of pesticides.

The draft Plant Quarantine Act was initially drafted under an FAO TCP initiated in 1996. It was reviewed in 1998 by Parliament to bring it into line with the standards of the WTO-International Plant Protection Convention. A draft law was submitted to the Attorney General (AG) for comments, but was later found to fall short in certain legal areas of the IPPC standards by the USAID funded West Africa Trade Hub (WATH) on Phytosanitary Capacity Evaluation (PCE) requirements - thus, resulting in its withdrawal for further review.

The PPRSD has four Divisions; Plant Quarantine, Pesticide Management, Seed Inspection and Certification and Crop Pests and Diseases Management Divisions:

- **Plant Quarantine Division** works with Customs, postal authorities and immigration staff at all official entry points. It is charged with keeping records of quarantine pests and diseases, training inspectors, and issuing phytosanitary certificates and permits. The PPRSD has 98 inspectors at 43 exit and entry points at the borders with Burkina Faso, Cote D'Ivoire and Togo, with the busiest being the Ghana-Togo border at Aflao. Collaborative complementary manning of the borders is undertaken by the Customs, Excise and Preventive Service (CEPS). The WATH Review of SPS Capacity in Ghana (2006) considered this satisfactory while proposing that more entry/exit points should be added on the western border.
- **Pesticide Management Division** works closely with the EPA in managing pesticides, training inspectors, training registering and inspecting pesticide dealers and applicators nationwide. It also provides extension training, technical backstopping and facilitates removal of obsolete chemicals.
- **Crop Pests and Diseases Management Divis**ion (CPMD) is responsible for containment of plant pests and diseases and promotion of IPM practices. It has a biological control unit which rears and releases natural enemies of cassava pests. The CPMD with other stakeholders has developed GAP manuals for 19 crops, including mango and papaya. It provides support and training for EurepGAP certification and technical backstopping on crop pest identification and control strategies.

[5] This section is mainly derived from WATH Technical Report No 18 (2006).

PPSRD Collaborates with local research institutions, the Universities, EPA, GSB, CEPS, Immigration Department, the Ghana Ports and Harbours Authority (GPHA), Air Cargo Operators, Trade Associations etc. It also collaborates with international institutions such as the International Institute for Tropical Agriculture (IITA). The USAID/USDA, GTZ, FAO, WATH, CILSS and ECOWAS play various roles from funding and training through reviews to consultancies.

The WATH Review of SPS Capacity in Ghana (2006) concluded that PPRSD documentation of surveillance systems and data on plants pests is inadequate for response to exotic pest and disease threats. The Directorate had no website at the time of the review. A list of regulated quarantine pests has been prepared but needs updating. *Bactrocera invadens* is noted as just one of ten insect pests believed to have been accidentally introduced into the country in the last ten years.

The CPMD was rated as having good capacity for pest risk assessment (PRA) overall. Eight draft PRAs were prepared in 2003-4 including okra, mango and eggplant. All of these must now need revision in the light of the recent and impending threats from exotic fruit flies (see Section 4.5 for details).

5.7.23 Fruit Fly Training

In the case of *Bactrocera invadens*, the PPRSD staff received training in 2005 at the Zoology Department, University of Ghana, which was organized by Dr. David Wilson and Ms Millicent Cobblah (Taxonomist) using keys and materials prepared by M. Billah (of ICIPE). After the training, PPRSD undertook a survey and confirmed the nationwide distribution of *B. invadens*. The PPRSD expressed interest to have biological control agents if there were any known from the ICIPE experience. Interest on the recognition and identification of fruit fly parasitoids was also expressed by the resident biological control entomologist (Ms. Angela Osei-Sarfoh).

5.7.24 The Ghana Standards Board (GSB)

GSB has begun to offer a crop protection residue analysis service but the service is limited and the laboratory is not yet accredited to ISO17025 standards. The PPRSD carries out phytosanitary checks on produce for export and monitors crop protection products together with the EPA to ensure that only authorized compounds of good quality are available in the country. The Soil and Water Research Institutes (SRI and WRI) of the Council for Scientific and Industrial Research (CSIR) provide soil and water testing services for export horticulture industry that have proved invaluable for getting EurepGAP certification although neither institution has internationally accredited laboratories.

5.7.25 Activities of international donors

1. **GTZ** (Annex 9, Box 12) - which is working on developing an integrated crop protection system through its **Market-Oriented Agriculture Programme (MOAP)**. This is jointly implemented by MOFA, GTZ and the German Development Service (DED). It was commissioned in 2004 by the German Federal Ministry for Economic co-operation and Development (BMZ). It is designed up to 2013. The programme aims at improving upon the competitiveness of agricultural producers, processors and traders on regional, national and international markets. MOAP provides training, e.g. in EurepGAP standards or quality management. The programme is open to all interested value chain operators, but does not specifically target the poor. In its core value chain component, MOAP has been focusing on five strategic commodities: pineapple, mango, chilli pepper, grass cutter, and aquaculture/fish (MOAP, 2005b).

2. **EU** - through its **Pesticide Initiative Programme (PIP)** (Annex 9, Box 13). The objective of which is to support horticultural production in African Caribbean and Pacific (ACP) countries by aligning their exports to meet European food safety and traceability requirements. PIP strives to strengthen the competitiveness of the private horticulture sector over the long-term in order to enable it to maintain its market share of imports into the EU. PIP activities in Ghana focus on raising awareness about EU legal and commercial food safety requirements, training staff of private companies in the various aspects of food safety and traceability, implementation of food safety and traceability systems, and building the capacity of support services to the horticultural export sector. PIP has organized sessions to train PPRSD staff in training delivery methods as well as in specialist pesticide application techniques for tree crops such as mango and papaya. PIP is working with Ghana and other neighbouring countries (Cameroon, Benin, Togo, and Ivory Coast) in promoting a harmonized system among the 5 coastal countries. PIP circulates printed publications such as presentation documents, posters, a monthly newsletter (PIP Info) and a quarterly magazine (PIP Magazine).

3. **USAID Millennium Challenge Account (MCA)**: Ghana was among the first countries deemed eligible in fiscal year 2004 to receive MCA funds and has remained eligible in each of the subsequent fiscal years --2005 and 2006. Ghana's MCA proposal aims to modernize agriculture and increase Ghana's non-traditional exports in three sub-regions; the southern horticultural belt, the Afram plains, and the northern savannah region. The program will support infrastructure development (roads, bridges, ports and irrigation); financial and business services to farmers and exporters, and policy reform, particularly land policy that will spur private sector investment in agri-business. The focus of the compact is closely aligned with the agribusiness export development and policy reform components of USAID/Ghana's Economic Growth Strategic Objective. The combined impacts of the MCA and USAID programs will accelerate growth through increased agricultural production and export and assist Ghana in achieving its millennium development goals. To avoid duplication and build on synergies in the two programs, USAID/Ghana provides administrative, procurement and technical support to the Millennium Challenge Corporation (MCC).

4. **USAID/TIPCEE** (Annex 9, Box 14): The **Trade and Investment Program for a Competitive Export Economy (TIPCEE)** is a USAID-sponsored 5-year project (starting from 2005) with the goal of increasing the competitiveness of Ghana's private sector in world markets through an improved enabling environment and a strengthened capacity of the private sector to respond to market demands. In this program, quality management is a cross-cutting issue which covers aspects linked to the physical and commercial characteristics of the products, as well as the implementation of management systems and production practices which aim to guarantee food safety and ensure consistency and reliability of supply. TIPCEE is currently addressing quality management concerns, and ultimately the EurepGAP certification issues, through several program activities. TIPCEE has Introduced geographic information systems (GIS) mapping of orchards, which is providing accurate data on the number of farms, sizes, and commodity distribution.

5. **USAID West African Trade Hub (WATH).** WATH has financed a study of SPS capacity in Ghana (WATH Technical Report 18, Humado, 2006) and two studies related to the Ghana Atomic Energy Commission, on Irradiation Quarantine (WATH Technical Report 11) and an engineering assessment of GAEC's gamma irradiation facility. (WATH Technical Report 16).

6. The World Bank, through its **Horticulture Export Industry Initiative** (**HEII** – see Box 2) under the Agricultural Sector Support Investment Project (AgSSIP).

7. African Development Bank (ADB) - through the **Export Marketing and Quality Awareness Project**. (**EMQAP**) (see Section KK, above and Annex 9, Box 2)

8. Department for International Development (DFID), supports food safety training and accreditation systems.

9. AHOLD Africa Sustainable Assistance Project.

5.7.26 Difficulties and constraints in fruit fly management

1. Lack of Plant Protection and SPS Facilities

Humado (2006) noted that the MOFA PQD is in need of better equipment and facilities for SPS inspection and diagnosis, both at entry/exit points and at the post-entry centre. There is a need for better accommodation, furniture, lighting, inspection tables, microscopes etc. WATH also drew attention to the need for better communication and transport between the different units and the central management to ensure rapid exchange of samples and instructions. PPRSD staff dealing with changing pest situations also need good access to current and up-to-date literature and teaching materials, including good internet access.

2. Need for regional harmonization of regulations

MOFA PPRSD management complains of shortage of resources and the problems of patrolling porous borders. Use of different phytosanitary regulations by neighbouring countries creates discrepancies which could be eliminated by harmonizing regulations across the sub region will help eliminate the problems.

3. Lack of farmer confidence in Extension

Agricultural Extension Agents face constraints in reaching out to remote areas, which makes it difficult for them to provide extension services to resource-poor farmers. Most (AEA) are still insufficiently skilled in mango production as the new exotic mango varieties require special knowledge. Extension delivery mostly uses a top-down approach. Feedback does not get back to decision makers thus making farmers lose confidence in agents.

4. Lack of a National Fruit fly Control Strategy

There is no proper national fruit fly control strategy in place. There is a clear lack of coordination between the agencies which are responsible for pest control. Training programmes and pest information are not coordinated to maximize impact to farmers and service delivery staff. Relaxed decision making between agencies leading to weak joint operations. Failure of stakeholders/implementing agencies to attend planning meetings (e.g. the last meeting was held in August 2006) does not augur well for planning control strategies and current information sharing.

5. Lack of agreed tools for fruit fly monitoring and control

No specific control strategies and tools (traps, baits/lures) have been nationally approved for fruit flies, though awareness of the pest is high. Monitoring of fruit flies done by various groups/agencies but results are not coordinated and there is a lack of pest information sharing. Current international best practice control strategies are unavailable and unregistered in Ghana.

6. Lack of clear leadership by PPRSD

Other organizations, agencies/bodies/institutions recognize PPRSD as the leader in the provision of phytosanitary services and look to it for initiation of policies and phytosanitary strategies. However PPRSD is failing to take initiatives on implementation of management/control strategies. When these initiatives are not forthcoming, individual organizations, farmer/exporter groups take their own initiatives and start control measures which they have heard of as working elsewhere, though these are not registered in Ghana.

5.7.27 Proposals for National Action Plan: Ghana

1. Strengthening the role of PPRSD

The PPRSD needs to act as an independent "watchdog" Directorate that should advise MOFA HQ on protection and regulatory issues on the ground. For a body tasked with the role of overseeing what goes out and comes into the country, the PPRSD HQ only has a small number of dedicated staff who are, normally overwhelmed with work. The provision of well-trained additional staff that can be deployed on emergency situations such as the fruit fly problem should therefore be a priority.

2. Strengthening of SPS legislative framework and capacity

As indicated by Humado (2006), the draft SPS law needs to be finalised and adopted. The facilities and equipment for inspection and diagnosis of quarantine pests need to be upgraded to avoid further accidental introductions which are costing the horticulture industry millions of dollars. This should include upgrading procedural manuals and pest risk assessments and training of inspectors in pest identification and monitoring.

3. International cooperation on SPS issues

GoG needs to exchange approved lists of plant protection chemicals with neighbouring countries and promote a common approach to homologation of new products and uses for control of fruit flies. There is also a need to pursue harmonization of SPS procedures, PRAs and lists of quarantine pests with neighbouring countries to address the common threat of further exotic pest and disease introductions.

4. Creation of a National Fruit Fly Planning Body

The government and the horticultural industry need to establish a joint planning and consultation body with membership from all types of stakeholders (grower and exporter association, regulators, universities, projects, government agencies) to ensure a coordinated response to fruit flies and other pests threatening fruit exports and domestic production. Such a body should be jointly chaired by senior representatives of PPRSD and the industry. This will have the effect of encouraging Information exchange between and among agencies, producers and exporters.

5. Production statistics

Production data in terms of quantities produced and land area per variety or cultivar on regional or national scale are not available. The need to asses the production levels of the different cultivars is imperative. Fortunately, the Trade and Investment Program for a Competitive Export Trade (TIPCEE) has embarked on a programme to map the production areas under mango cultivation. Good record keeping habits should be built into production systems for easy extraction for the records. Different stakeholders should agree on standardised record systems which can be used to derive national statistics as well as fulfilling traceability requirements necessary for EurepGAP etc.

6. Provision of Information and Relevant Literature

Non-availability of relevant and up-to-date literature and information sources. The need for relevant, accurate and timely information cannot be overemphasized. A number of printed

documents (handouts, brochures, posters and handbooks collected during the study – Annex 9, appendix 1) are available at the various institutions and agencies. Copies of the fruit fly manual 'A *Field Guide to the Management of Economically Important Tephritid Fruit Flies in Africa'* by Ekesi & Billah (2006) and posters on the fruit flies were donated by M. Billah to PPRSD, the Crop Science and Zoology Departments (University of Ghana), HEII/EMQAP and PAMPEAG. These scattered documents and sources of information should be pooled into the establishment of a central well-equipped horticultural library to enhance information sourcing by stakeholders.

7. Research and Capacity Building

Research and Development should be prioritized to address the numerous pests and diseases needs of the industry. For example, the University of Ghana at Legon hosts the West African sub regional branch of the Insect Science Programme of the African Regional Postgraduate Programme in Insect Science (ARPPIS), and the industry should take advantage of this to either enroll selected candidates for higher level training in specific subject areas or negotiate to submit special research topics which will address their needs. Ghana's horticultural stakeholders should seek active collaboration with well known international institutions like IITA and ICIPE, who have expertise in .their areas of operation. Annual reports of most of institutions show a good number of staff members on privately initiated study leave. Institutions should encourage staff members to pursue programmes which will address their research needs through provision of scholarships

8. Fruit tree nursery development

The nursery 'industry' should be addressed through training and establishment of a Nursery Act to ensure quality, regular and true-to-type supplies of commercially desirable varieties of fruit trees.

9. Enhanced storage and packing facilities and food safety skills

Need for improved cold storage and pack house facilities as well as proper transportation of produce. The provision of such facilities by HEII is a plus and should be extended to other mango producing regions. The increasing concern with food safety in the European Union has led to increasingly stringent requirements for horticulture products imported into the EU. Therefore professional and well trained teams should be assigned to the handling of fruits at the ports and in pack-houses. There should be a concerted effort at educating and training all stakeholders along the value chain on food safety and quality issues since losses as well as bad handling practices occur at all stages of the chain

10. Strengthening technology transfer to smallholder production

The application of existing technologies to smallholder systems would significantly increase unit area yields for all crops. A lot of effort is being put to ensure the production of good quality fruits and vegetables in Ghana, but the effort though complementary, are too fragmented i.e. undertaken by various individual organizations, which are not well-coordinated to have the desired bigger impact it could have achieved.

11. Attracting new entrants to the horticulture industry

FAGE, NHTF, GEPC, HEII etc should encourage young and enthusiastic prospective farmers into their folk. Awareness creation and encouraging prospective farmers into the industry can be done by posting graduates within the industry through the National Service Scheme.

12. Establishing a dynamic domestic fruit and vegetable market

A dynamic domestic market needs to be created for fruits and vegetables. This will easily absorb any excesses and also serve as a buffer should the export market fail to absorb production.

5.8 National Situation Synopsis: IVORY COAST

The horticultural sector is particularly dynamic in the Ivory Coast. It represents one of the main sources of revenue for the country (50% of GDP). Fruit production occupies an important place with respect to export crops, particularly due to banana, pineapple, mango and other fruits.

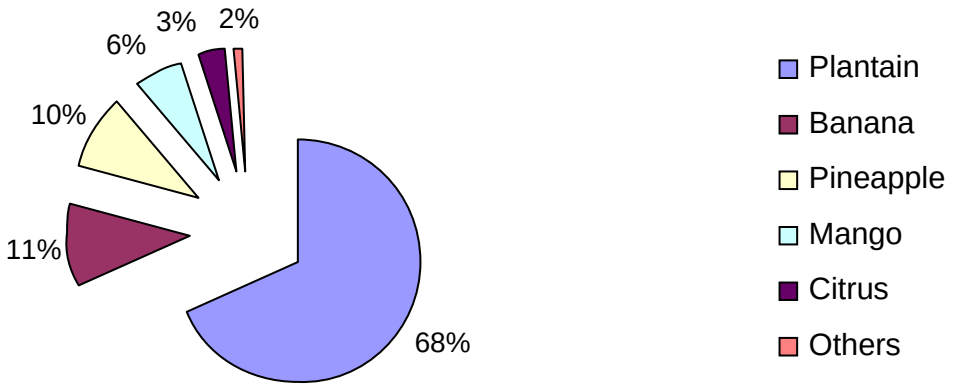
5.8.1 The main fruit crops in Ivory Coast

According to FAO, the fruit sector in the Ivory Coast produces about 2 million tons. The main crops are plantain (68% of production) (**Figure 32**) banana, pineapple, mango, citrus and papaya. The harvest season of mangos extends from March to July (**Table 52**).

Table 52. Seasonal availability of major crops in Ivory Coast.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Banana												
Pineapple												
Mango												

Figure 32. Fruit production in the Ivory Coast in 2005

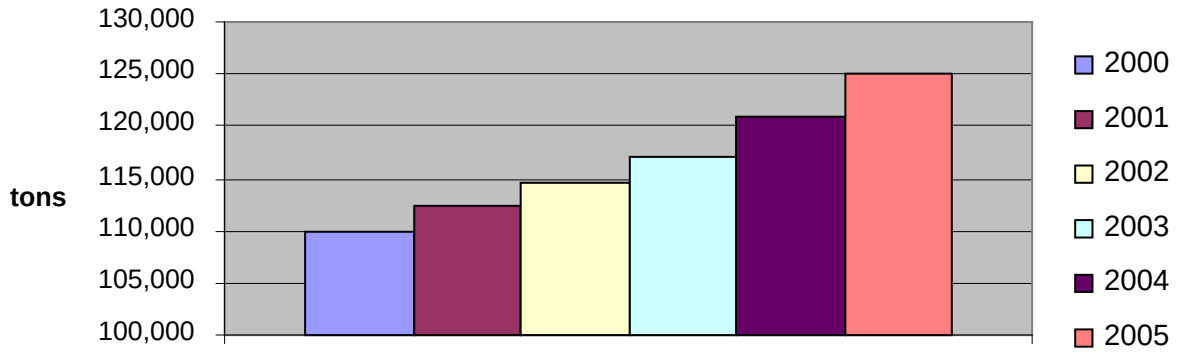


Source: FAO

5.8.2 Mango production in Ivory Coast

According to FAO data, mango production in the Ivory Coast has grown steadily, increasing from 110 000 tons in 2000 to 125 000 tons in 2005 (**Figure 33**). The main production area is in the north of the country, around Korhogo, In this humid savanna zone mangois the third most important cash crop after cotton and cashew.

Figure 33. Mango production in the Ivory Coast (2000-2005)



Source: FAO

5.8.2.1 Types of orchards

Oriented to the export market, mango production in the Ivory Coast rapidly led to the establishment of large orchards planted with varieties whose harvests follow each other. In the Northern zone which produces essentially for export, one can distinguish two types of orchards:

- There are the medium-sized orchards which belong to producers which are not also exporters. They represent over 90% of the region's orchards. In most cases, these producers work with an exporter which provides support (phytosanitary products, credit etc) in return for exclusive access to the production (which he doesn't always obtain). These orchards are maintained (pruning, weeding, tilling) and subject to frequent phytosanitary treatments not adapted to mangos (use of cotton products for example). Large orchards, between 200 and 2000 ha, are also found and are managed by large export structures. When this structure is certified, it can more easily develop a loyal partnership with its producers.

- One also encounters exporters which possess their own orchards. Most of these orchards are either certified or in the course of being certified. They represent 5% of the volumes produced.

- In the central zone, mango orchards are generally homestead orchards, with several varieties. Even though, one may find varieties such as Palmer amongst these orchards, the fruit are mainly consumed locally. The establishment of young orchards has also been observed in the region these last few years. Although these young orchards are planted with exportable varieties, consumption remains centred on the country with a certain increase in value for some varieties.

5.8.3 The national and sub regional market

Table 53. Seasonal nature of mango production in the Ivory Coast.

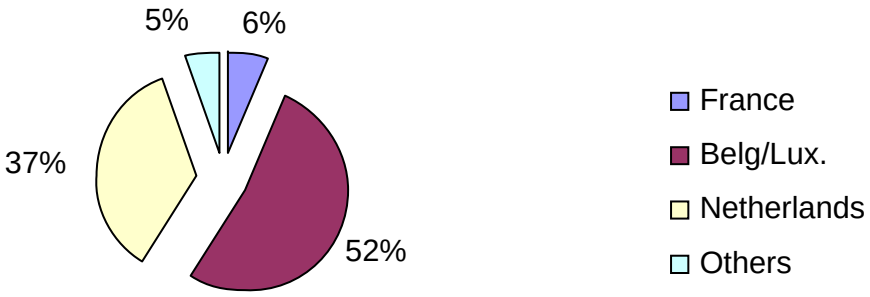
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Varieties/ Vernacular names									
Palmer									
Zill									
Amélie/ Gouverneur									
Brooks									
Kent									
Keitt									

All the varieties listed in **Table 53**, are sold and consumed on the local markets and five (Amélie and Zill, <20%; Kent, Keitt and Palmer, >80%) are mainly exported. During the field visits, it appeared that operators from the Ivory Coast must often go and buy mangos in neighbouring countries to fulfil all their orders. We have also been told of cases of mangos bought in the Ivory Coast and exported to Mali or Burkina overland, but we were not able to receive data on these transactions. The local market also receives fruit rejected for export for not complying with specifications (second choice).

5.8.4 Ivory Coast mango exports to Europe

The mango export campaign in the Ivory Coast occurs between the month of March (starting with the Amélie variety) and the month of June (ending with the Keitt variety). With over 144,000 tons exported to the European Union in 2006, the Ivory Coast is the third largest mango supplier to the European market and the principal African exporter. Ivory Coast alone represents over 46 % of ACP mango exports to Europe. Mango exports from the Ivory Coast have increased from 110,000 tons in 2002 to over 144,000 tons in 2006.

Figure 34. Main destinations of mango exports from the Ivory Coast to Europe (2006)



Data: EUROSTAT

The main recipient markets for exports from the Ivory Coast during the 2006 campaign are the Benelux (55%) followed by the Netherlands (37%) (**Figure 34**). Over the 2002/2006 period ports in Northern Europe, perceived as less protectionist by African exporters, particularly those from the Ivory Coast, have become the first points of entry to the European markets for mangos exported by boat from Ivory Coast. The airfreight campaign from the Ivory Coast starts during week 14 (end of March) to finish during week 23 (mid June). The Ivory Coast starts its airfreight campaign with Kent mangos when the Peruvian campaign is finishing. It remains the main supplier for buyers throughout its air campaign. The reason for this is mainly linked to the quality of the work done before export. During the 2007 campaign,

in France, airfreight exports from the Ivory Coast were subject to two interceptions due to the presence of fruit flies, one at the beginning of the campaign (start of April) and one in the middle (mid June). Interceptions have remained stable with respect to 2006 (when there were also two).

Present on the seafreight mango market more or less at the same time as Malian exports, mangos from the Ivory Coast were sold throughout the campaign at a slightly higher price due to the regularity of their quality. The end of the campaign in the Ivory Coast causes a decrease in the offer and coincides with higher prices for Malian fruit. No interceptions were signalled for maritime exports during the latest campaign.

5.8.5 Mango producer and exporter groups and associated companies

5.8.5.1 Organisation Centrale des Producteurs – Exportateurs d'Ananas et de Bananes (OCAB)

OCAB[1] is an inter-professional organization for the Ivorian fruit industry, founded in 1991 as a civil association. Its mission is to organize production, quality control, transport and marketing of fresh pineapples, bananas and mangos on behalf of its members. It publishes an instruction manual "Cahier de Charge" for quality control in Mango. It has 13 member and four user companies and cooperatives of whom 9 export mangos through OCAB. OCAB is the second largest exporter of mangos to the European market. It uses the services of Bureau Veritas for quality control. OCAB stresses the importance of mango in the north for halting desertification. Problems identified include fruit flies, anthracnose and mealybug. Some treatments are made using locally available pesticides against ants and mealybugs. There is a fear that if pesticides are used there will be residue problems. Anthracnose has got worse in the last two years. Smaller producers are not organised and there is no mapping of orchards. Census of producers and mapping of their orchards is seen as a priority need. There is a lack of processing capacity.

The highest proportion of risk of SPS rejection is for fruit fly. Exports could continue into August via Guinea, but stop in June, because of the onset of the rains causes the producers to cease supplying. This year the campaign started in March with Amelie and ended on May 20th. Brazil is extending its export campaign to June so there is direct competition. There are too many small pack-houses. Quality maintenance requires construction of larger facilities with good equipment (such as at Bobo Dioulassou) to be based at Ferkessedougou. Government inspectors and Bureau Veritas need common training materials. OCAB have stopped sending mangoes to Marseilles because they receive too many rejections. They use Anvers now only. Lack of working capital is a problem. They would like to find more markets outside France but currently have only one German importer and none in UK. OCAB look back to the COLEACP project (with Burkina and Mali) in the 1990s in which a "Cellule Mangue" was set up. This is no longer functioning but they would like to revive it.

5.8.5.2 Bureau Veritas (BV)

The Bureau Veritas Group is a global company network involved in certification and evaluation of conformity with international and local standards, in all sectors, including those for food quality, safety and phytosanitary security. It is active in the horticultural sector in certifying cashew, pineapple, bananas, mango and other fruits for export. It provides certification for HACCP, organic standards (Agriculture Biologique), EurepGAP, TESCO. The Abidjan office covers Benin, Burkina, and Ivory Coast. It undertakes qualitative and

[1] The team met with M. Emmanuel Dolly, Secrétaire Exécutif, OCAB

quantitative analysis of produce. BV is present in all countries of the region except Sierra Leone.

In relation to fruit fly, pack-house inspections require three times more staff than for other produce. The packing chain is sampled at three points. When the rains come the probability of fresh *piqures* rises. These are difficult to see in the first few hours after egg laying. The chain is slowed down and the number of samples inspected is doubled. When the detection rate rises production stops. Sanitation is strict and no waste is left near the packing station. Produce is cooled in storage while awaiting the boat. If two containers out of 50 are intercepted and destroyed, this destroys the profits of the export operation. BV operates by its good name. Its procedures for inspection are commercially sensitive and effective. The inspectors will reject a complete "lot" if they find fly damage. Trieuses are trained by BV for 1-2 weeks before the campaign. Some staff come back year after year and some move from country to country. BV also makes a programme of training for pisteurs and pickers at the pack-houses before the campaign. The SPS personnel check each pallet at the third stage in Ivory Coast, whereas in Burkina they only do spot checks. BV would like to set up a system for fruit fly quality conrol with the EU, based on an agreed "Cahier de Charge". They insist that it is unreasonable to destroy whole containers for a single infested pallet. BV confirmed that no fungicides are used on mangos in Cote d'Ivoire.

5.8.5.3 Alternative hosts of fruit flies

The incubation trials set up by the CNRA (Centre National de Recherche Agricole) since the 90's have enabled to identify 22 species of Tephritidae. The main host plants identified up to now apart from mango are:

- papaya
- citrus species
- cucurbitaceae
- coffee and various wild plants.

5.8.6 Estimates of fruit fly damage

The main fruit fly species causing damage are listed in **Table 54**. Until 2005, before the discovery of *B. invadens,* it was *Ceratitis* species which predominated in the Ivory Coast (with over 83% of the damage caused by *C. cosyra)*. However, since the arrival of *B. invadens*, CNRA observed a clear fall of *Ceratitis* populations with *B. invadens* which is a polyphagous and very aggressive species, now representing over 87% of mango infestations. CNRA estimates that damage is now around 43% of production.

Table 54. Incidence des mouches de fruits sur les différentes plantes hôtes

Espèce mouche - Espèce hôte \	*Bactrocera invadens*	*Ceratitis sp. (si pas identifiée)*	*Ceratitis cosyra*	*Ceratitis quinaria*	*Ceratitis silvestrii*	*Ceratitis fasciventris*	*Ceratitis capitata*	Autre espèce mouche fruit (spécifiées)
Mangue	4***	1*	4***	1 **	2**	2**		1 (*Dacus bivittatus, Ceratitis anonae*) *
Agrume	2*	0	0	0		2*		1*
Papaya	2 ***		3 ***	0	0	0		0
Autres fruits (spécifiés)	3*** (collection de Fruitiers divers)	0	4*** (collection de Fruitiers divers)					3 (*Dacus bivittatus, Ceratitis anonae*) ** (Anonaceae)
Cucurbitacées (spécifiées)	0		0					4 (*Bactrocera cucurbitae*) ***
Tomates/ poivrons/ piments (spécifiés)	0		0				2 *	
Autres légumes (spécifieées)	0		0				2**	
Hotes sauvages (spécifiés)	2 (Combava?) ***			0	0	0	2**	

Damage codes: ? = unknown species; 0 = not found (0% fruit loss); 1 = minor damage (0-15% fruit loss); 2 = medium damage (16-30% fruit loss); 3 = severe damage (31-45% fruit loss); 4 = Very severe damage (> 46%).
Distribution codes: * = Limited distribution; ** = Moderately widespread distribution; *** = Very widespread distribution.
Source: CNRA; Dabire, 2007

5.8.7 Research activities on fruit flies

Research on fruit flies (and mealybug) started in 1992-3 with the development of exportation of mangos. A biocontrol project with IITA released parasitoids for mealubug 1996-99. Inventory of fruit flies started in 1999. Twenty two species are recognised of which 7 species attack mango. The CNRA has mainly pursued studies of the host range and distribution of fruit flies through trapping with pheromone lures and baits (cuelure, TA, TML, and protein hydrolysate) and some rearing studies. This process began with the early efforts of the late Kwame Nguetta, who published the first report on the fruit flies of fruit crops in northern Cote d'Ivoire in 1994, and has continued with subsequent studies by Ouattara (1998), Barbet (2000), Hala N'klo (2000), Kehe, et al., 2001, and the recent DEA study by N'depo Ossey (2006).

In 1999 CNRA signed an MOU with ICIPE and from 2000 worked with them in testing the technique of localised spraying of baits against fruit flies at four localities in 2002 with materials provided by ICIPE. Torula yeast gave a 25-50% reduction in damage. Fruit fly specimens were sent for identification by Dr De Meyer at Tervuren by ICIPE. The disturbances in the country since 2002 have greatly disrupted research work and there appear to have been very limited resources available. Some work could be conducted at the former Bayer Experimental station at Yamousoukro which is now run independently by its former staff. The area has large blocks of mangos. The Ecole National de l'Agronomie (ESA) of the Institute National Polytechnique Houphouet Boigny, also at Yamousoukro, trains agronomists and does some research on fruit pests.

There was however a programme financed by French Cooperation with CIRAD from 2001-2005. Dr Hala N'klo was trained on taxonomy of fruit flies for one month in Belgium by Dr De Meyer in 2005 (see Section 4.5.6 and Table 8) and was provided by Dr De Meyer with some traps and pheromone for trapping. Dr Hala N'Klo has been trapping in the south and central regions on a project financed by FIRCA (see below) which is not reported yet. He found that in the northern part of the sampled area in April the fly population is almost entirely *Ceratitis cosyra* but they are replaced later by *B. invadens*. He incubated struck fruit (65% of all fruit) for two weeks. This produced a success rate of 52% in emergence of flies. For trapping TA was a better attractant for *Ceratitis* than TML. CNRA is now cooperating with the University of Cocody to supervise diploma (DEA) studies. The team met researchers at Cocody but found that none have experise on fruit flies, though one has experience with parasitic Hymenoptera.

5.8.8 Government agencies providing support for farmers and exporters in the horticulture industry

5.8.8.1 Direction de la Planification, des Programmes et de la Décentralisation, Ministere de l'Agriculture

The team met with M. Yao Haccandy, Director of Planning (Chevalier dans l'Ordre de Merite Agricole de Cote d'Ivoire). He questioned the value of a regional project to Ivory Coast and said that there was no need for a new committee for fruit fly management as there was already the food and feed committee. He expressd the view that a regional fruit fly programme must not be held back by "weaker producer countries". Currently there are no donors with national programmes in agriculture in Ivory Coast. However he pointed out that 500 milion USD is levied from cocoa exports annually[2]. He suggested that CORAF (WECARD) "must approve" any regional research programme.

[2] If he meant to suggest that this means that Ivory Coast can pay for its own crop protection needs, then it may be true but it is patently not happening.

5.8.8.2 Direction de la Protection des Végétaux, du Contrôle et de la Qualité, Ministère de l'Agriculture (DPV)

The team met with Dr K. Lucien Kouame, Directeur de la Protection des Végétaux, du Contrôle et de la Qualité. He confirmed that there is no national action plan for fruit flies. Control recommendations should come from CNRA. There are few products registered for control. Currently chlorpyriphos ethyl and acephate are registered for mango for mealybug control. Ivory Coast has its own national registration system. Provisional authorization can be given for two years for new products in process of registration. Researchers have made proposals for testing but pesticide companies think the market is too small. Phytosanitary inspection is carried out by the state.

Mango exports began in a small scale in 1981-82 by plane to France. CIRAD was involved in promoting the industry and development of nurseries with 30,000 plants by 1990 on 300 ha. 2-300 ha per year were planted in that period. Most of the plantations are within a 100 km radius of Korhogo, together with the pack-houses which are owned by exporters and not producers. Mango brings four times the income of cashew per kg. Orchard borders are planted with cashew. Containers are transferred from lorries to the railway at Ferkessedougou, 50 kms east of Korhogo.

5.8.8.3 Agence Nationale d'Appui au Développement Rural (ANADER)

The team met with Dr Sidiki Cissé, Directeur General Adjoint, ANADER. ANADER is a national service involved in supporting perennial crops and animal production (Division Appui aux Filières de Production Animales et Halieutiques) in rural areas through a network of advisers covering ten villages each (10,000 villages in all) and organised by zones within regions. The mechanism of extension to producers is based on technology packages received from CNRA (e.g. for brown rot in cocoa), but there is currently no package for fruit fly control and no activity in this area.

5.8.8.4 Centre National de Recherche Agronomique (CNRA)

The CNRA was founded in 1998 as a public company, owned 40% by the state and 60% by agro-industrial companies. It conducts research in the agricultural and agro-industrial production sectors. Its mission includes improvement of cash crops and food security leading to poverty alleviation. It has a perennial crops research programme which includes research on fruit trees based at The Station de Recherche de Korhogo at Lataha. Unfortunately Korhogo is in the northern zone which is not under government control. In fact no research has been regularly conducted in the north for five years, since 2002, when rebels seized the area. The research station scientific staff have left Korhogo to work in Abidjan[3]. Some work continues at the Station de Recherche, Marc Delorme at Port-Bouet and the Station d'Experimentation et de Production d'Azaguier

The CNRA campus near Abidjan includes the former Centre ORSTOM d'Adiopodoume, which housed an important and well-known insect collection, still referenced on some biodiversity websites. However a visit to the Centre buildings some 500 metres from the administration building of CNRA, revealed that of the three blocks of accommodation, one has been allowed to become derelict with its roof holed by a fallen tree branch and another is apparently unused. The third block houses some research work, but the boxes housing the insect collection have been piled on the floor in an unused room without air conditioning and are clearly unused and uncared for. There is clearly now no working reference collection in use at CNRA, although individual specialists keep a few reference specimens of fruit flies or

[3] The mission was accompanied during its visit by Dr Achille A. N'Da Adopo, CNRA, Chef de Programme Aboriculture fruitiere, who used to work at Korhogo.

other insects of interest for their work in their offices and some specimens were apparently stored at other research stations. The taxonomic materials seen were in poor condition due to the climate and pests.

5.8.8.5 Fonds Interprofessionnel pour la Recherche et le Conseil Agricoles (FIRCA)

FIRCA is funded partly by government and partly by producers through taxation. It was created in 2003 to provide advisory services, capacity building and research backup for agricultural production and processing. The role of FIRCA is described below in Table XX. Research is funded through a competitive grant facility. Grants go mainly to the sectors which provide funds, but 25% is allocated to those that cannot provide financing. Dr Hala N'Klo has had funding for fruit fly work which is still in progress. This mechanism could equally utilise external funds and distribute them on a similar competitive basis. Producers are represented through representatives on committees which allocate funding. This appears in principle an excellent mechanism for making researchers accountable to producers.

Table 55. Role of FIRCA in the agricultural sector

Created under the decree Nº2002-520 of December 11, 2002, FIRCA is a tool deriving from the provisions of the Act Nº2001-635 October 9, 2001 setting up the FDA (Fund for Agricultural Development) .

FIRCA shall finance, in the sectors of crop, forestry and animal production, programmes related to :

- Agronomic and forestry research
- Carrying out of testing and demonstrations for knowledge transferring between research and exploitation
- Technology research for the improvement of both agricultural and manufactured products
- Popularization of knowledge through informing, demonstrating, training, technical and economic consultancy
- Carrying out of survey, experimentation and expertise
- Supporting a sustainable improvement of farming cost-effectiveness
- Capacity-building of OPA (Professional Agricultural Organizations)
- Professional training of farmers leaders of the OPA and their staffs.

Source: FIRCA website: http://www.firca.ci

5.8.9 Post harvest practices and quality management in packing stations

In the North of the Ivory Coast, in the area which produces mangos for export, there are 13 packing stations (7 in Korhogo, 4 in Sinématiali, 1 in Ferkésségoudou and 1 in Odiénné). Amongst these stations, 8 have obtained their EUREPGAP certification. The five others are evolving to obtaining the certification. Modern stations, of which we are told there are four, have mechanised chains, a grading system specific to round fruit and cold storage facilities (pre cooling room and cold rooms). They belong to the main companies that export mango. The remaining packing centres conduct grading operations manually, are not equipped with mechanical chains and do not have cold storage facilities. Some nonetheless operate as service providers renting their packing premises to exporters that want to send their merchandise to Europe.

According to our information, it seems that almost all packing stations in the Ivory Coast operate according to the model described in Section 4.7.1, above, with some distinctions

resulting mainly from the level of grading and cold storage equipment. The people we met assured us that they did not undertake hot water treatment (with addition of prochloraz) due to the harmful effects it had on the fruit skin. In all stations, the inspection operations are done by women. According to the quantities of fruit to be treated, the number of inspectors varies from four to twelve per packing station.

5.8.9.1 The main phytosanitary constraints managed in packing stations

The main phytosanitary constraints managed in packing stations are the fruit fly, the mealybug and anthracnose. The reputation of the mango inspectors from the Ivory Coast has crossed borders and many foreign mango sectors resort to their know-how both for training their own inspectors and for conducting the inspection in packing stations.

5.8.10 Supply of Plant Protection Products

Registration of pesticides is governed by Decree No 89-02 of 1989, under the Plant Protection law of 1964. Registration is overseen by a National Pesticides Committee. The main agrochemical suppliers are CALLIVOIRE and BAYER CROPSCIENCE-CI. Societé YARA is the local supplier for Success-Appat. UNIPHYTO is a trade association for agrochemicals. It has 10 members. At a meeting with the mission team it was stressed that the market is small and certification research costs around 5 million FCFA per product. The total area in the north for exported mangos is 12-15,000 hectares only. Currently *Bacillus thuringiensis* (Bt) is in process of certification for cabbage caterpillars. The process needs a toxicology dossier and experimental efficacy data. The privatised former Bayer Centre “ARHOS” can do the trials.

5.8.11 Government Phytosanitary control

In the Ivory Coast, the issuing of phytosanitary certificates as well as the inspection and the protection of plants depend on a department of the Ministry of Agriculture, the Direction de Protection des Végétaux et du Contrôle de la Qualité (DPVCQ). the DPVCQ is in charge of phytosanitary certification, export support and pesticide accreditation. A list of registered and authorised pesticides is issued by DPVCQ, the most recent edition being June 2007. The pesticide authorised specifically for mango is Dursban (chlorpyrifos-ethyl), but other pesticides are authorised for fruit trees, including deltamethrin, cypermethrin and acephate (Orthene).

Thirty staff are involved in SPS inspections. Inspectors are present at packing stations in the north and containers are sealed there for export. In the Ivory Coast, phytosanitary inspections are regulated by a law dating from 1988 which concerns agricultural product fraud repression, as well as by a decree dating from 1992 concerning the accreditation and the protection of plant varieties. DPVCQ representatives assured us that the inspection procedures were in the course of being formalised in a manual. In practice, inspections are more rigorous and strict for exports or imports through ports and airports, than for inspections at land borders. There exists a real need for training of DPVCQ agents and custom officers to undertake these inspections. There is also a need to harmonise inspection practices across the sub-region.

5.8.12 Ivory Coast's responses to the fruit fly problem

In general there has been quite a limited response, with most actors looking to CNRA to develop a recommended control strategy. There seems to have been a degree of paralysis in terms of moving forward on promoting baiting as a control strategy (which has been tested in Ivory Coast). There appears to be no awareness of the MAT technique, which has not been used. All actors plead lack of resources and the disorganization caused by the civil disturbances for this inactivity. There does appear however to be a lack of political will, demonstrated by the rather elitist attitude of the Planning Department of the Ministry of Agriculture.

5.8.13 Activities of International donors

There has been little recent activity by donors relevant to the fruit fly problem since the end of the French-funded project on mango pests at CNRA. The mission visited the European Commission offices to discuss the mango value chain with Dr F. Varlet, agro-economist. M. Varlet indicated that he regards mango as a third rank crop (after cocoa and cotton). Cashew in his view is more promising as a crop for the north, since it earned more than cotton in 2007. He stressed the perishability of the mango crop and the problems of bureaucratic delays in the port (containers may wait for 6 weeks without cooling). However, the Quai Fruitier built with EC funding in 2003 is more efficient.

5.8.13.1 COLEACP/PIP Task Force

The COLEACP/PIP took part in the setting up of a Task Force in the Ivory Coast. With respect to the mango sector, the Task Force has worked to identify plant protection products specific to orchards and to disseminate technical advice on mango production, including cultural practices to reduce pest pressure in orchards. Activities of the COLEACP Task Force at a national level include raising awareness and training mango sector protagonists. Following the Senegalese model, there are plans to develop programs designed to appeal to a wide audience such as the program "Ma famille". It will also continue the work already undertaken with respect to prophylactic measures applied in orchards and spot treatments with poisoned baits.

The DPV has been hoping for direct support for conducting trials of plant protection chemicals against fruit flies in Ivory Coast. This has apparently not been forthcoming. The DPV is aware of the PIP programme for certification of products for protection of fruit crops but they say that they have received no reply to their proposal for trials. The DPV would like to test Thiamethoxam (a nicotinoid related to Imidacloprid) and spinosad for localised treatments. There is a national committee for Food and Feed, responding to EC legislation (Reg. 882 of 2004) in this area, which makes government responsible for food quality. PIP aids the committee and sent a consultant to advise on inspection procedures, which proposed training for inspectors and a unified inspection service for export produce as well as upgrading of analytical laboratories.

5.8.14 Difficulties and constraints in fruit fly management

This list is not exhaustive, but focuses narrowly on issues specific to fruit flies. In general Ivory Coast is better resourced than its neighbours in terms of infrastructure, but there is a lack of capital investment. The country's debt burden has meant that there is no new loan funding from the World Bank, which is driving developments in the fruit subsector in other countries in the region. This situation requires that national stakeholders should work effectively in partnership with one another to make the best use f limited means. Major

economic recovery is likely to be contingent on the settlement of the de facto division of the country into north and south which is damaging the business sector and agricultural exports[4].

1. Lack of adequate selection and inspection of fruit for export, leading to quarantine interceptions in Europe and consequent financial losses.

2. Lack of adequate training and equipping of phytosanitary inspectors for checking of fruit consignments, in the face of the pest pressure represented by *B. invadens* and in carrying out surveillance and enforcement to prevent importation of exotic pests.

3. Absence of a clear pest management strategy available tor farmers to reduce the impact of fruit flies, especially after the start of the rains.

4. Absence of an information sharing mechanism to ensure rapid dissemination of new information within the industry and to collect feedback for planning.

5. Lack of a central participatory planning and support group to manage the phytosanitary issues of the industry

6. Lack of an effective research programme targetting fruit fly management and lack of funding, review and accountability of the activities of researchers.

7. Lack of training and capacity-building for farmers in integrated pest management for fruit trees.

8. Lack of processing capacity and clear market intelligence for alternative uses of lightly damaged fruit unsuitable for the fresh fruit export market.

9. There is limited information on the importance of fruit flies in damaging other crops (e.g. cucurbitaceous and solanaceous vegetable fruits). Monitoring of these crops needs to be undertaken on a regular basis because of the potential for invasion by other fruit fly pests

10. There is very limited capacity nationally for identification of fruit flies of economic importance, with only Dr Hala N'Klo of CNRA having been trained.

11. Ivory Coast has different types of orchards in different areas, including large modern orchards producing for export in Korhogo and smaller semi-natural parkland orchards mainly for local consumption in the central region. The need for orchards to be inventoried as basis for planning (and traceability) is apparent.

12. There has been no recent survey (by rearing from damaged fruit) of fruit fly species incidence in Korhogo, on different varieties, and at different times of the year, to determine the current relative impact of the main fruit fly species after the arrival of *Bactrocera invadens*. Initial estimates of damage are very approximate.

13. There is limited access to supplies of materials needed for IPM in fruit trees (traps, lures, baits, pesticides, instruction manuals).

[4] not least because consignments of export produce leaving the north are "taxed" by the rebels (at the rate of 50,000 FCFA per lorry for cotton, for example).

5.8.15 Proposals for a National Action Plan: Ivory Coast

A Regional Action Plan (Section 7) has been developed in parallel with National Plans, to ensure effective division of responsibilities and work. Some items in a National Plan need to be in place in all countries (see item 1, for example).

1. Creation of a National Fruit Fly Planning Body

Government and the horticultural industry are strongly recommended to establish a joint planning and consultative body (Comité National de Lutte contre les Mouches des Fruits) which will have the task of overseeing the development and implementation of a National Action Plan for Management of Fruit Flies. Ideally the National Committee should have co-chairs from the public and private sectors. Members should be representative of all main types of stakeholders in the value chain (grower and exporter associations, regulators, universities, INERA, donors, projects, government agencies).

2. Development of a National Action Plan for Fruit Fly Management

The action plan should take account of the suggestions offered by Dr S. Quilici (CIRAD, Reunion) during his visit to Senegal (Quilici, 2006) which are summarised in this report. The need to adopt different strategies in different areas (large modern plantations and traditional home orchards), and to maintain both control and monitoring activities throughout the year, as well as coordinating a significant research programme, argues for selecting pilot areas of limited size as proposed by Quilici (2006).

3. Applied Research

The research community in Ivory Coast (CNRA, universities) needs to be perceived as a service provider to the horticulture industry. The implications of this are that funding should be by competitive grants for specific work based on submission of a concept note, followed by a detailed plan of the research with clear time frame and quantified outputs. Most of the research needs are not highly complex or original. The methodologies for the most part exist and must be applied conscientiously to achieve results. However they cannot be left to inexperienced students with occasional inputs from external supervisory staff, as seems likely to happen at Cocody. Results of research should be reported rapidly to the National Committee and should be externally assessed before release of further funds. As a start, the work of Dr Hala N'klo recently funded by FIRCA should be critically evaluated to learn any lessons on the efficacy of the process as much as on the technical results. The list of research topics below and the short term research needs proposed by Dr Quilici (see summary in Section 5.1.16.3, above) is not exhaustive but deals with some pressing concerns. These items should be seen as priorities. All of these research activities will benefit from regional cooperation. However ther is probably value in attempting most of them at national level in each country.

(a) Assessing damage to mango by individual fruit fly species

A monitoring activity should be carried out by rearing larvae from fallen fruits collected in the orchards, which is the sole method of quantifying the proportional levels of damage attributable to the different species. Since the MAT/TEM technique is likely to play a major role in future control programmes against *B. invadens*, and because the MAT attractant methyl eugenol (ME) is highly attractive to this species, but not at all attractive to the *Ceratitis* species, information on relative damage levels of *Ceratitis* and *Bactrocera* is essential for planning future campaigns. The aim should be to take samples of infested fruit at intervals throughout the season (e.g. monthly) in several different areas, representative of the range of temperature and humidity across all the mango-growing zones. The only materials needed are plastic containers, sand, infested fruit and mosquito gauze.

(b) Evaluation of control methods
A programme of evaluation of control methods (*méthodes de lutte*) should be started, assessing several methods, including spot spraying with baits (including GF-120) and MAT (technique d'eradication des Males - TEM). Fibre board or wooden blocks (plaquettes) impregnated with parapheromones (in particular methyl eugenol) and a toxicant, are effective against males of species closely related to *B invadens* in Asia, but their effectiveness needs to be demonstrated against *B invadens* in West Africa. See Box QQ for a detailed costing (on per hectare basis) for materials needed for a pilot programme of integrated pest management which should be put in place and monitored by CNRA researchers with the participation of DPV local field agents and representatives of producers organizations.

(c) Surveying fruit fly species composition and damage levels on vegetable fruits
Surveys of cucurbitaceous and solanaceous vegetable fruits are needed to determine which species are present and the level of losses they inflict. Again this needs to involve sampling of produce and rearing of flies for identification, especially on melons and cherry tomatoes.

(d) Developing an economic threshold for B. invadens damage

So far as we can ascertain, there has not been any attempt to establish an economic threshold for *B. invadens* damage on mango in West Africa. This would need to be based on a simple and easily available monitoring method, which has been reliably correlated with damage levels on neighbouring trees. The threshold (x flies per trap per day, or per week) could be based on results of field cage studies, using releases of varying numbers of female flies onto protected trees, with ripe mangos. Such work is notoriously difficult to achieve in the tropics because of ant interference. Alternatively it could be based on assessments of damage to sampled trees at different population levels during an actual control campaign. This would require that all species were being controlled and it might not be possible to determine the contribution to total damage due to *B. invadens* as opposed to other species.

4. Procurement of supplies for pest management and IPM capacity building
Government (and donors and external partners, e.g. CIRAD) should avoid becoming seen as the providers of inputs for fruit fly control, except for pilot or experimental purposes. Since it is necessary to promote monitoring and control methods using baits (*appâts*), traps and para-pheromones, it will be essential (1) to find sources of supply of these inputs so that producers can buy them and (2) to devise financial instruments to allow them to purchase them (for example financial guarantees for loans to purchase inputs before the start of the mango season). It is therefore also necessary that the physical inputs and the necessary instructions for using them (extension, training) should arrive at the same time, so as to link together the inputs and the information. Ideally a training of trainers (ToT) approach should be used to equip a cadre of trainers from the industry associations to ensure that their farmers are fully capable of applying the methods in their own orchards.

5. Fruit fly identification capacity and reference collection
Ivory Coast needs to be able to identify all likely fruit fly species which may be found on fruit and vegetables, especially in view of additional imminent quarantine threats to the country (see Section 4.5). This will be best achieved by training senior technical staff of CNRA (not managers), provision of database information and manuals and the designation of a single national clearing house for identification which will maintain a reference collection on behalf of the horticulture industry. Such facilities are not an end in themselves but a practical service provider to the industry. However basic storage facilities are needed, including a room which can be kept air-conditioned (or at least dehumidified) as a collection room and laboratory to prevent deterioration of insect reference collections. Airtight insect pinning boxes are also essential. The abuse of the important colonial insect collections already in the care of CNRA HQ does not inspire confidence. However if an MOU were set up between

CNRA and the industry representatives, this might engender a better performance. The relationship could also be mediated through FIRCA to provide both some small funding and oversight. Fruit flies are poorly known and there is a constant danger of influx of new pests. Reference collections are a forensic tool in understanding the process of pest invasions and population variability within species.

6. Capacity building for the quarantine service

Specialised training, part theoretical and part practical, needs to be designed and delivered to inspectors of the Phytosanitary Service of the DPVCQ, to enable them to meet their obligations in pre-export inspection of fruit, especially mangoes. A quite separate module of training is needed to enable inspectors to assess incoming fruit and also to operate a system of sentinel traps at border posts and fruit markets. Their working conditions will also need to be improved with better equipment and facilities for SPS inspection and diagnosis, both at exit/entry points and at the post-entry centre. DPVCQ staff also need access to current literature and manuals, including internet access.

Regional Issues:

7. Pesticide Registration

Registration of pesticides and other inputs for IPM is an important regional issue. If there will be any changes in the requirements of importing countries (e.g. the pesticides specified for MAT/TEM or baits (appâts), a rapid response will be needed. At present GF-120 is undergoing registration for spot treatment under CILSS, but MAT/TEM blocks with malathion, fipronil or spinosad also need to be registered as a specific use. Since Ivory Coast is not a member of CILSS (though it is a member of UEMOA) there is a need to conduct its own registration process while pursuing harmonization at the level of UEMOA and ECOWAS/CEDEAO.

8. Traceability

The requirement of traceability for imported fruit which is beginning to be demanded by the importers, underlines the need for a unified “audit trail” of responsibility and documentation for phytosanitary certification of produce destined for export. This should involve census and mapping in a GIS database system of all orchards. However in order that this is not seen by producers as yet another tax exercise by government, the database should be held by a civil society organization (e.g. OCAB) representing producers themselves, rather than a government body.

9. Upgrading inward quarantine surveillance

Quarantine and phytosanitary defence against the arrival of further exotic fruit fly pests such as *Bactrocera zonata*, which has already reached Egypt and Libya, are issues probably better managed at regional level. See Section 4.5 and Tables 5 and 6 for an indication of the importance of this issue. However, at national level, as noted by Bonfour (2006), it is important to develop pest risk assessments for specific quarantine threats (such as the species of *Bactrocera* currently present in North East Africa and Arabia). This is a requirement of the WTO and IPPC as is the development of national lists of pests present and not present in the country.

10 Access to an international reference laboratory for fruit fly identification

In relation to fruit fly identification, assistance can be provided by reference to the databases maintained (and recently updated) by the Royal Museum of Central Africa (MRAC) in Tervuren, Belgium, who have the capacity to provide quarantine lists for fruit flies for all West African countries if national research and control staff (and staff of IITA and ICIPE) are prompt and transparent in reporting new records and in sending voucher specimens for verification by the international specialists concerned (Dr M. De Meyer, assisted by Dr I.

White). Study visits and training is also available from Tervuren. In several recent fruit fly projects, some small component of funding has been included (e.g. by USAID) to enable an identification and advisory service to be extended to participating institutions by MRAC. It would be a cost-effective move to continue this since, right across West Africa, the helping hand of Tervuren in orienting researchers to the identification of fruit flies has been an important stimulus to effective problem diagnosis and management of these economically destructive pests.

6 NATIONAL LEVEL PROPOSALS AND ACTION PLANS (RESULT 3)

6.1 Summarizing constraints and problems

The problems and constraints at country level, noted in the National Situation Synopses (Section 5), have been summarised in Table 6-1, with an indication of at least one country where each specific issue has arisen. The overall prevalence of each issue is not comprehensively noted for every country, since some problems occur widely, but were not the focus of attention in every country. However many of these issues are clearly generic and are not unique to any single country.

The issues have been organized for convenience into the following categories:

1. Organizational problems - issues which relate to the organization of the fruit value chain or to institutions;
2. Pest management problems – problems which are largely technical in nature and relate to the control of fruit fly pests;
3. Fruit fly taxonomy and Identification – which relates to defining the nature of the pest itself;
4. Phytosanitary and quarantine issues; and
5. Non-fruit fly problems - issues which, though important for the value chain, are not directly related to the control of the fruit fly pest and the reduction of the losses which it causes. No actions are proposed as part of the Action Plan to address these issues.

6.2 Organizational problems

From the viewpoint of national or regional planning processes, the absence of a national fruit fly management committee, indicated in 6 countries[1], is a serious hindrance to effective action. A national fruit fly control committee sets an initial standard of public-private partnership for the whole enterprise of protecting the horticultural sector against fruit flies and other invasive pests. Current deficiencies in information dissemination and feedback for planning at national level can largely be traced to the absence of such committees.

The dual chairmanship model for the National Committee (which has been shown to be effective in Senegal) constrains the national plant protection organization to play a leading role in addressing the issues, but without controlling the agenda completely. In Senegal this committee was constituted by convening a national workshop which set up the committee and defined its remit and work plan (centred on designing and overseeing a national strategy and then sharing information and feed-back amongst stakeholders).

6.3 Pest management problems

1. Lack of national IPM strategy and coherent research programmes

The main problems identified are subsidiary to the organizational issue already outlined: the absence of a National Fruit Fly Control Committee. In all countries except Senegal, there is neither an agreed national pest management strategy, nor any coherent research programme to back it up. There is consequently no widespread IPM message which is

[1] also applying in Benin, which however lacks a commercial mango production value chain.

conveyed to and implemented by producers to manage the problem, except for an attempt to disseminate and follow the message of orchard sanitation (removal of fallen fruit), which itself is only a single component of such a strategy. In particular there is lack of availability of the necessary means for control (other than conventional spraying) apart from some isolated examples of monitoring traps, parapheromones and baits, mainly in the hands of researchers and mainly distributed through CIRAD, ICIPE, MRAC or COLEACP.

2. Lack of information and training for farmers on available control methods
Equally, there is little information in countries other than Senegal[2], on practical control methods which are available. The COLEACP/CTA booklet is a first effort in this regard but in the absence of demonstrations of BAT and MAT and the wide availability of the necessary materials (baits, lures, treated blocks), it cannot on its own generate adoption of new technologies. Training in IPM for farmers is weak in most countries, as a result of the absence of clear extension messages.

3. Lack of information on damage to fruits and vegetables other than mango
Finally there is an identified lack of information on the pest status and economic impact of fruit flies feeding on vegetable crops and on fruits other than mango. This applies to all countries, despite some efforts at multi-lure trapping to reveal the presence of specific fruit fly species which are known pests of fruit, Solanaceae or Cucurbitaceae. This is an important issue for international trade as another new species of *Bactrocera*, (*B. latifrons*) is poised to invade West Africa. This species only responds to one chemical lure (lati-lure) and it is therefore necessary to deploy traps with this chemical, as well cue-lure and vert-lure for *Bactrocera* and *Dacus* species. See Section 4.5.3 and Tables 6 and 7 of this report. The best approach will involve rearing from infested vegetable fruits, to determine what species are currently causing losses, and sentinel trapping across the region by SPS personnel to detect invasion.

6.4 Fruit fly taxonomy and Identification

Taxonomy is fundamental to the pest management of a group of similar-looking but distinct species which require different monitoring techniques and possibly different control strategies for their management (See Section 4.5). Since fruit flies are quarantine pests, it is important for all countries to know what species are present and which are not present as a basis for SPS surveillance at borders, ports and airports, as well as within the country. Capacity for prompt and accurate identification of fruit fly species is lacking in most of the countries visited by the mission. The best capacity exists in Cote d'Ivoire and Senegal, where government officers have been trained in Belgium at MRAC (Table 4-8), but there is a need to create a larger pool of taxonomic capacity for identification of the more serious pest species, including those invasive species which have yet to arrive in West Africa, but pose an imminent quarantine threat. The mission did not find any official reference collections of fruit flies, but rather small holdings of a few specimens maintained by individual researchers. There is a need to ensure that national reference collections are created and that such important common goods are not privatised by individuals and subsequently lost.

[2] Senegal has two booklets in circulation, in French and in Woloff which provide some guidance but are still insufficiently focussed and detailed for wide adoption.

6.5 Phytosanitary and quarantine problems

6.5.1 Pre-export SPS procedures

The high rate of interceptions of mangos exported by air to the EU in recent years, suggests the need for improved training and better equipment (electric lights, magnifying lenses etc) for inspection of produce.

6.5.2 Incoming quarantine surveillance for the ECOWAS Area.

A survey of the capacity and resources of national phytosanitary authorities in West Africa was outside the remit of this study. However it is evident from studies conducted by USAID (Ghana, Gambia) and STDF (Mali) that there are deficiencies in national systems of inspection of incoming produce, especially at land borders. SPS officers face a lack of equipment, transport, information resources and training to undertake their work, which includes preparation of pest risk analyses (for which proformas exist on IPPC and EPPO websites), detection and reporting of exotic invasive species and preparation of separate lists of pest insects believed to be present or absent from the country. The International Plant Protection Convention (IPPC)[3] lays down standards for recognition and reporting of quarantine pests.

One requirement of the IPPC is to notify new pests and diseases affecting plants ("Pest Reports") to the IPPC Secretariat[4]. There have only ever been six pest reports posted from Africa, and Senegal (31 Jan 2006) is the only African country to have notified the presence of *Bactrocera invadens* to the IPPC. It is also a requirement of the IPPC that contracting parties develop lists of regulated pests (Article VII, 2i). However there is not a single pest list for Africa registered with the IPPC Secretariat. This is partly because of the problems of identifying pests reliably, but also the unwillingness of countries to admit to the presence within their borders of quarantine pests which may provide a reason for trading partners to refuse exported produce.

The losses of export value for mangos across West Africa in 2006 probably amounted to around one third of the total value of exports (9 million Euros), and possibly more. To carry out a proper economic analysis it would be necessary to estimate the value lost due to an early termination of the annual campaign with the advent of the rains. This occurs in late May or early June in Ivory Coast, although fruit are available for a further 2-3 months. It would also be necessary to factor in the costs of heightened surveillance and control operations (including the labour costs of collecting fallen fruit on an almost daily basis). The true value of exports lost may therefore be almost as much as the current export value (27 million Euros).

However the value of the additional losses if *Bactrocera zonata* (the peach fruit fly) should become established in West Africa will be at least as great again and may result in temporary refusal of imports by the European Union pending installation of more effective phytosanitary controls. It is to be hoped that the costs of additional surveillance and heightened biosecurity may appear cost-effective to ECOWAS countries in this context.

[3] The IPPC was initially developed in 1952 and its most recent version was promulgated in 1997 and became effective in 2005. Among the Scoping Study countries, only Benin and The Gambia are not contracting parties to the IPPC.

[4] International Phytosanitary Portal (IPP)https://www.ippc.int/ ~~

ECOWAS/CEDEAO Secretariat has indicated its intention to produce a regional SPS regulation for West Africa which meets the requirements of UEMOA and non-UEMOA countries and is in harmony with IPPC standards and WTO requirements, by early December 2007[5]. In light of this it seems appropriate to engage with them on the subject of tightening up quarantine surveillance related to fruit flies (see Section 7, below).

For each country, possible national level actions have been identified in the National Situation Synopses (Section 5) which address some of these problems and constraints at national level. These are summarised in **Table 56**. The constraints and proposed actions at national level have been reviewed to identify constraints which are perceived as having a regional dimension. For these cases, specific actions are proposed as part of an intended regional intervention in the sections that follow.

Table 56. Summary of Problems and Constraints Identified at National Level

Problems and Constraints	Benin	Burkina Faso	Gambia	Ghana	Guinea	Ivory Coast	Mali	Senegal	Grand Total
1. ORGANIZATIONAL PROBLEMS									
Country linguistic isolation			1						**1**
Lack of engagement with fruit fly problem by national plant protection and research agencies	1								**1**
No National Fruit Fly Management Committee		1	1	1	1	1	1		**6**
Lack of specific farmer organizations for mango					1				**1**
Need for inventory and mapping of orchards as a basis for national planning						1			**1**
No information exchange between stakeholders on pest problems	1				1				**2**
Perceived lack of leadership by Plant Protection Department				1					**1**
Perceived proprietorial attitude by Plant Protection Department to fruitfly monitoring								1	**1**
Poor information dissemination and feedback for planning		1		1	1	1	1		**5**
Poor maintenance of smallholder orchards makes phytosanitary activities difficult					1			1	**2**
Work plans need to be realistic to ensure achievement of agreed results								1	**1**
Need for new projects to avoid duplication of effort					1			1	**2**
2. PEST MANAGEMENT PROBLEMS									
No national IPM strategy for farmers for fruit flies in orchards		1		1	1	1	1		**5**
No effective national fruit fly IPM research programme		1			1	1	1		**4**
Lack of registered pest management strategies for farmers meeting international best practice			1	1					**2**
Lack of exposure to latest fruit fly IPM technologies (e.g. MAT)			1	1					**2**
Lack of farmer (and researcher) awareness of value of weaver ants for biological control	1	1				1			**3**
Lack of training for farmers (and extension) in fruit	1	1		1	1	1	1	1	**7**

[5] ECOWAS SPS Regional Harmonization Workshop for non-UEMOA Countries. Final Report. Abuja, 16-18 May 2007. ECOWAS Commission.

Problems and Constraints	**Benin**	**Burkina Faso**	**Gambia**	**Ghana**	**Guinea**	**Ivory Coast**	**Mali**	**Senegal**	**Grand Total**
tree IPM									
Limited or no access to IPM materials (Traps, baits, lures), manuals	1	1			1	1	1	1	**6**
Need to disseminate IITA information in practical management programmes for farmers	1								**1**
No rearing survey from fruit for B. invadens and *Ceratitis* spp. impact in different zones					1	1		1	**3**
Lack of information on fruit fly species incidence and severity on fruit (apart from mango), cucurbits and solanaceae		1	1		1	1	1	1	**6**
Need to evaluate threat to melons and cherry tomatoes								1	**1**
Some fruit fall attributed to fruit flies may be caused by unrecognised infestation with of mango seed weevil (*Sternochaetus*)								1	**1**
3. FRUIT FLY TAXONOMY AND IDENTIFICATION									
Lack of access to current taxonomy and limited national capacity for identification of fruit flies		1	1		1	1	1	1	**6**
4. PHYTOSANITARY AND QUARANTINE ISSUES									
Lack of literature, teaching materials and internet information sources for SPS inspection and diagnosis etc				1					**1**
Lack of standardised regional SPS legislation at level of ECOWAS/CEDEAO			1	1					**2**
Lack of training and equipment for SPS inspectors		1		1	1	1	1	1	**6**
Need better checking of fruit before export		1				1	1		**3**
5. NON FRUIT FLY ISSUES									
Lack of market intelligence on regional and international export opportunities	1								**1**
Lack of processing capacity and market intelligence on alternative uses for rejected fresh fruit		1				1	1		**3**
Need to reverse decline of mango production in disadvantaged areas	1								**1**
Grand Total	**8**	**12**	**7**	**10**	**14**	**14**	**11**	**12**	**88**

Table 57. Summary of Actions Identified at National Level

Actions	Benin	Burkina	Gambia	Ghana	Guinea	Ivory Coast	Mali	Senegal	Total
VALUE CHAIN ORGANIZATIONAL ISSUES									
Convene a national awareness raising workshop meeting of stakeholders in the mango value chain and the fruit fly problem in order to explore common interests and set national priorities.	1								**1**
Encourage industry partners to take responsibility for bulk purchasing of inputs for fruit fly management.						1		1	**2**
Set up National Fruit Fly Management Committee with representatives of all stakeholders and co-chaired by public and private sector.		1	1	1	1	1	1		**6**
National Fruit fly management Committee to draw up Action Plan with realistic strategies for protection of commercial export plantations and local smallholder production for the regional and local market, using a piloting approach based on available resources.				1		1	1	1	**4**
STAKEHOLDER TRAINING									
Ensure that training of farmers is undertaken before the start of the season and instruction sheets or manuals are available to them along with the inputs and equipment for fruit fly control.		1			1	1	1	1	**5**
Source funding for bursaries to enable industry personnel to obtain training relevant to the needs of the industry.				1					**1**
Improve linkages between IITA and national plant protection and research institutions to test and transfer technologies to farmers.	1								**1**
Printed documents, handbooks, manuals and electronic sources of information including CD ROMS and internet access should be made available in central national resource centres for horticulture value chain stakeholders.				1					**1**
Training of trainers for producer/exporter associations and government plant protection staff to equip them to train farmers to apply IPM strategies for fruit flies.			1	1				1	**3**
INTEGRATED PEST MANAGEMENT									
After efficacy and toxicology trials, MAT/TEM blocks with malathion, fipronil or spinosad will need to be registered as a specific use, by CILSS, UEMOA and non-member countries within ECOWAS/CEDEAO.						1	1		**2**
Find sources of supply of appropriate traps, attractants and baits		1			1	1	1	1	**5**

Actions	**Benin**	**Burkina**	**Gambia**	**Ghana**	**Guinea**	**Ivory Coast**	**Mali**	**Senegal**	**Total**
Develop financial instruments to allow farmers to purchase pest management inputs before the start of the mango season (for example financial guarantees for loans).		1			1	1	1	1	**5**
Develop IPM programmes that integrate several compatible best-bet technologies - and test them for sustainability with farmers.	1								**1**
Establish an economic threshold (or thresholds) for *B. invadens* damage on mango in West Africa. This would need to be based on a cheap, simple and easily available trap monitoring method, which has been reliably correlated with damage levels on neighbouring orchards.						1			**1**
Identify synergies and economies between IPM for fruit flies on fruit and on vegetable fruits (some common pests, some common monitoring and control strategies, possibilities for co-location of traps and fruit/vegetable crops).	1								**1**
Review status of production statistics and economic value of fruit fly problems on mango, papaya, water melon and solanaceous and cucurbitaceous crops, and set priorities for pest management.			1						**1**
Assess overall damage to mango and the contribution of individual fruit fly species (of *Ceratitis*, *Bactrocera* and *Dacus*) by sampling and rearing fly larvae from fruit to in main growing areas throughout the season.		1			1	1	1	1	**5**
Set up a pilot programme for assessment of BAT, MAT, trap monitoring and rearing of fruit flies from fruit		1			1	1	1		**4**
Survey fruit fly species guild composition and damage levels on vegetables (including Solanaceae and Cucurbitaceae primarily) by fruit sampling and rearing from infested fruit for identification and prevalence assessment.	1	1			1	1	1	1	**6**
ORGANIC PEST MANAGEMENT									
Negotiate an organic certification for control operations, such as spot bait applications and traps or parapheromone blocks (methyl eugenol) which are useful against fruit flies and *Bactrocera invadens* in particular.		1					1		**2**
The level of natural control of fruit flies by ants in orchards should be assessed using the methods pioneered by van Mele, with a view to disseminate this organic technology to organic producers.		1					1		**2**

Actions	Benin	Burkina	Gambia	Ghana	Guinea	Ivory Coast	Mali	Senegal	Total
FRUIT FLY TAXONOMY AND IDENTIFICATION									
Commission the Royal Museum of Central Africa (MRAC) in Tervuren, Belgium, to assist countries to develop quarantine lists for fruit flies for all West African countries						1			**1**
Designate a single national clearing house for identification of fruit flies and maintenance of a reference collection on behalf of the horticultural industry		1			1	1	1		**4**
Include a component of funding in any regional fruit fly management project to enable an identification and advisory service to be extended to participating institutions by MRAC, Tervuren (with subcontracting of other experts as necessary).						1			**1**
Training one or two senior technical staff (not managers) of organizations with a mandate for providing services to the horticultural industry, in fruit fly taxonomy and rearing, trapping, specimen preparation, identification, and curation of reference collections at MRAC Tervuren (in English or French language medium as required), or at IITA or ICIPE.		1	1		1	1	1	1	**6**
PHYTOSANITARY AND PLANT QUARANTINE ISSUES									
Capacity building and enhanced access to information sources (including internet and manuals) for phytosanitary service inspectors to conduct pre-export inspection of fruit, especially mangoes.		1			1	1	1	1	**5**
Capacity building and enhanced access to information sources (including internet and manuals) for phytosanitary service inspectors to assess incoming fruit and also to operate a system of sentinel traps at border posts and fruit markets.		1	1		1		1	1	**5**
Commission study of risk analysis and risk management for mango exports from West Africa to the European Union in line with systems utilised by USA with a view to making risk of rejection insurable.		1							**1**
Develop national lists of pests present and not present in the country.		1			1	1	1	1	**5**
Develop pest risk assessments for specific quarantine threats (such as the species of *Bactrocera* currently present in Tanzania, North East Africa and Arabia).		1			1	1	1	1	**5**
Ensure that national SPS legislation is compliant with new ECOWAS regional system and IPPC/WTO requirements.								1	**1**

Actions	Benin	Burkina	Gambia	Ghana	Guinea	Ivory Coast	Mali	Senegal	Total
Facilitate a regional discussion at the level of ECOWAS/CEDEAO of the needs for inward quarantine enhancement (increased surveillance, use of sentinel fly traps at markets and borders, ban on fruit movements into ECOWAS zone and ban on uncertified fruit.		1							**1**
Improved access to facilities and equipment for SPS inspection and diagnosis of pests.		1			1		1	1	**4**
Pursue harmonization of SPS procedures, PRAs and lists of quarantine pests with neighbouring countries to address the common threat of further exotic pest and disease introductions.				1					**1**
Strengthen SPS legislation and procedures to prevent further quarantine pest introductions.				1					**1**
Strengthen role of Plant protection departments to act as a watch dog and advise government on emergency quarantine threats.				1					**1**
Upgrading inward quarantine surveillance.								1	**1**
FRUIT FLY RESEARCH									
Evaluation of control methods: MAT, BAT.								1	**1**
Provide back-stopping and mentoring of researchers in West Africa by senior research staff at IITA, CIRAD, MRAC and ICIPE.		1							**1**
Research and extension staff to design demonstrations for scaling up of recent IITA experiments in baiting, MAT and weaver ant control.	1								**1**
Review earlier work on mango varietal resistance to fruit fly and mealybug damage and assess prospects for reducing susceptability through varietal selection.		1			1		1		**3**
Review recent trials of pest management strategies and component technologies against fruit flies (especially COLEACP-PIP trials) in light of best practice elsewhere (especially MAT and BAT) as a basis for new registration requests to national and CILSS approval bodies.			1						**1**
Set up a research network to bring together all concerned research staff in West Africa and create a high quality peer group in this field across the region.		1							**1**
Set up competitive grant system for financing research on fruit flies.		1			1	1	1	1	**5**
Set up linkages with ICIPE's African Regional Postgraduate Programme in Insect Science (ARPPIS) by enrolling selected candidates for higher level training in specific subject areas or negotiate to submit special research topics which will address their needs.				1					**1**

Actions	Benin	Burkina	Gambia	Ghana	Guinea	Ivory Coast	Mali	Senegal	Total
Utilize IITA potential for regional capacity-building in fruit fly management (training and research back-stopping in IPM methodologies, taxonomy, insect rearing, pest monitoring, biological control etc).	1								**1**
PESTICIDE REGISTRATION									
Exchange approved lists of chemicals with neighbouring countries within ECOWAS and promote a common approach to homologation of new products and uses, for control of fruit flies and in furtherance of the Prior informed consent (PIC) Convention.				1					**1**
Participation for registration of new pesticide uses through CILSS, UEMOA or ECOWAS channels and adoption of compatible national policies.					1			1	**2**
NON FRUIT FLY ISSUES									
Commission study of economic viability of increasing processing capacity (pulp, juice, dried mango) in major production areas (Bobo Dioulasso, etc) to utilise fruit rejected for fresh export).		1							**1**
Develop clear standardized record systems and documentation for traceability of origin and phytosanitary certification of export produce, and for annual production statistics, based on GIS mapping and census of orchards involved in export of mangos.				1	1	1	1		**4**
Commission economic study of current and potential market for Benin's mangos in the region.	1								**1**
Facilitate organization of the mango chain in northern Benin with a view to developing exports within the region, and possibly to Europe.	1								**1**
Grand Total	**9**	**23**	**6**	**11**	**18**	**20**	**21**	**19**	**127**

7 REGIONAL ACTION PLAN (RESULT 4)

The purpose of a Regional Action Plan is to reinforce and facilitate efforts being made at national level to reduce the economic damage to the fruit industry resulting from fruit fly attack. Problems and constraints in relation to controlling fruit fly damage to fruit crops have been identified in the National Situation Synopses and highlighted in Table 6-1, above, and some actions have been proposed at national level (Table 6-2). Some of these actions and other actions related to them, have the potential to be supported or undertaken at regional level and these are dealt with in the following sections.

In creating a regional action plan for management of fruit flies, it is necessary to ensure feasibility and sustainability by utilising as far as possible existing institutional structures and mechanisms. It is also necessary to consider issues of institutional culture and the effectiveness of particular structures, and the degree of accountability and responsiveness to stakeholders (the farmers and fruit producers of West Africa) which specific organizations display, as evidenced by a track record of success in the same or a similar context. This is especially necessary taking into account the financing procedures of the European Development Fund. In framing the actions proposed below, an attempt has been made to play to the existing strengths of actors in the sector.

The action plan has been represented as a Logical Framework in **Table 58**. Inevitably this is incomplete at this stage. The outline of proposed research topics in **Box C** will form the basis for a series of sub-actions which in a putative regional project will be carried out by research groups in more than one country. The number of topics to be chosen will need to be established by a further process of project preparation which will need to decide priorities within (or beyond) the suggested list, in light of the research plans of other significant projects (to avoid duplication), the available resources (human and financial) and the most appropriate mechanism for deciding what research should be undertaken in which country or countries.

7.1 Support to formation of National Fruit fly Committees

Action 1. Facilitate formation of National Fruit Fly Control Committees.

The National Committee must be seen as the primary point of contact in each country, because of its role in bringing together both public and private stakeholders of the value chain. It is strongly recommended that a regional action plan should include facilitation to form national fruit fly control committees which have leadership shared between the public and private sectors. In Senegal, with donor support, the National Committee has been a useful catalyst for a range of activities. The same mechanism could be duplicated in the six other fruit exporting countries[6], applying lessons learned from the experience in Senegal. The committee may have varying status in different countries, but is likely to be taken seriously by governments to the extent that it is made clear by donors, that this is the grouping which they regard as competent to develop policy and action plans for fruit fly control, and through which they, the donors, will deliver their support.

[6] However, it may be not cost effective to attempt this in Benin at present, due to the lack of a sufficiently valuable horticultural industry and the apparent low priority of fruit flies in the work of the plant protection department.

Box C. Research areas for support by a regional funding mechanism

1. Economic studies

Economic threshold and cost benefit for control
Conduct cost-benefit studies on export plantation and smallholder orchard mango production pest management options, including orchard sanitation, early harvest, MAT and BAT. Establish an economic threshold (or thresholds) for *B. invadens* damage on mango in West Africa. This would need to be based on a cheap, simple and easily available trap monitoring method, which has been reliably correlated with damage levels on neighbouring orchards.

2. Pest assessment studies

Sampling of mango for damage data, fruit flies and parasitoids
Surveys of overall levels of damage to mango and the contribution of individual fruit fly species (of *Ceratitis*, *Bactrocera* and *Dacus*), and presence and impact of parasitoids, at fixed locations in main growing areas throughout the season using protocols developed under Action 10, above.

Fruitfly breeding surveys on vegetable fruits
Survey economic damage levels and fruit fly species guild composition and damage levels on vegetables (including Solanaceae and Cucurbitaceae primarily), by fruit sampling and rearing from infested fruit for identification and prevalence assessment.

3. Assessment of biological and cultural control methods

Improved pruning and orchard sanitation
Conduct trials of lowering and pruning trees and orchard sanitation as a basis for preparing training materials. Pruning needs to be carried out in ways which avoid damaging trees and introducing diseases, while orchard sanitation needs to be made more economical in terms of labour use if it is to be undertaken at all.

Augmentation and conservation of natural control of fruit flies by weaver ants
Natural control of fruit flies by weaver ants in orchards should be assessed using the methods pioneered by van Mele, with a view to disseminate this organic technology to organic producers.

Study of varietal Resistance to fruit fly and mealybug.
Desk study review of work on mango varietal resistance to fruit fly and mealybug damage (e.g. Rey in Guinea), and assessment of prospects for reducing susceptibility to attack through varietal selection of commercially acceptable mango cultivars. The study would provide a basis for any further work on this topic, if justifiable.

Review of potential of Metarhizium biocontrol
Conduct a review of work on biological control of fruit flies using Metarhizium biopesticide, developed by ICIPE (see **Annex 12** for details of ICIPE research under AFFI), and estimate potential for West Africa, based on efficacy trials conducted in Kenya, with a view to importation and trials in West Africa if judged potentially useful, especially in an organic context.

Box C. Research areas for support by a regional funding mechanism (continued)

3. Assessment of biological and cultural control methods (continued)

Review potential of biocontrol using *Fopius arisanus*
Conduct a review of work on biological control of fruit flies using *Fopius arisanus* and other parasitoids under domestication at ICIPE (see **Annex 12**), and estimate potential for West Africa, based on efficacy trials conducted in Hawaii, Reunion and Kenya, with a view to importation and trials in West Africa if judged potentially useful. If review is satisfactory, proceed with importation:

Import, multiply and release parasitoids against *Bactrocera invadens*.
If documented host range specificity tests already carried out in Kenya, and IPPC requirements for biological control introductions[1] are met, put in place a biological control programme, initially using *Fopius arisanus* against *Bactrocera invadens* in a selected country (possibly Benin, in order to use the existing expertise in rearing wasps at IITA). An expert external to both institutions should be asked to prepare a project brief and cost estimate for this, e.g. CIRAD Reunion.

4. Trials of bait application technique (BAT) and male annihilation technique (MAT)

Review of BAT for use by growers in West Africa
Review work by COLEACP-PIP and others on bait application using GF-120 in West Africa as a basis for future recommendations. Conduct tests of other bait/insecticide formulations (e.g. local brewery waste yeast).

Trials of MAT against *B. invadens* and *C. cosyra*
Prepare and conduct a pilot experimental deployment of MAT blocks using locally prepared materials (wood or fibre board blocks) but with commercial para-pheromones (ME and TA) against *Bactrocera invadens* and *Ceratitis cosyra* respectively, using a pre-agreed common experimental protocol, in two or more West African countries in large plantations (using collecting funnels beneath traps to catch target and non-target insects killed). This can be undertaken in late season 2008 (May-July) when *B. invadens* populations will be highest. If these activities are satisfactory, the information gained should be used to update training materials for growers (see Action 8, below).

[1] ISPM 03 Guidelines for the export, shipment, import and release of biological control agents and other beneficial organisms. IPPC. 2005 https://www.ippc.int/cds_static/en/

7.2 Support to organization of pest management research and development

Action 2. Set up a competitive grant system for financing research and development activities on fruit flies.

This could be set up by consigning funds through national research funding agencies, using the model of FNRAA in Senegal and FIRCA in Cote d'Ivoire. Alternatively it could be channelled via ECOWAS or CORAF/WECARD or through the network proposed in Action 3. The EC has funded regional competitive research grant procedures in Africa before, through ASARECA in East Africa and through ICART CRARF in Southern Africa. The mechanism is thus feasible. The aim must be to spend as little as possible on the administrative mechanism itself and to assure accountability and the delivery of greatest possible results.

The design of the system should include some external input into research in West Africa by a panel of senior research staff at IITA, CIRAD, MRAC and ICIPE. who would review proposals, and assist in focussing the work plan of the research initially. This is sometimes done through a project preparation workshop where shortlisted applicants are assisted to improve their proposals before the research is financed. The expert panel would provide back-stopping, mentoring and annual reviews subsequently.

Action 3. Set up a research network for fruit fly management

Set up a research network for fruit fly management to bring together all concerned research staff in West Africa and create a high quality peer group in this field across the region. The network should have a minimal secretariat and produce an electronic news letter. Ideally this could be hosted by IITA Benin, but needs to have a dedicated local secretary with experience in pest management information dissemination. WARDA (based at IITA Benin) has had good experience in coordinating an effective participatory research network for rice research which argues for the feasibility of this proposal[7]. Inception of a research network could take place at a regional workshop which could also review priorities for regional research topics to be funded under the competitive fruit fly research initiative. A West African Fruit Fly Management Network could affiliate with the newly formed association of Tephritid workers of Europe, Africa and the Middle east (TEAM)[8], which organises conferences and a newsletter and brings together research workers in fruit fly studies in its area.

Action 4. Set out a regional research programme and propose standardised research protocols to be followed in national surveys and trials to ensure comparable information is generated in different countries.

The topics for research submissions should be defined in general terms. Several areas are proposed above (**Box C**). Criteria for acceptability of research proposals must include demonstrating the near-market adaptive nature of any technology development, and a review of previous work which clearly demonstrates the value of the proposed research in relation to current practices and resources. For example a proposal for *"surveys and assessment of plants attractive to fruit flies for use as lures"* would not meet this criterion on several counts: local capacity to extract and analyse plant chemicals is poor, plants would have to be grown in large amounts around orchards, and in any case more effective synthetic lures for fruit flies already exist and only need to be made more generally available. On the other hand locally produced fruit fly baits using waste brewers' yeast have been shown repeatedly to have

[7] Narteh, L.T, M. Winslow, O. Youm and S. O. Keya. 2006. Partner-driven agricultural research-for-development networks in West Africa: the case of ROCARIZ. KM4D Journal 2(2): 84-90. www.km4dev.org/journal
[8] http://www.tephritid.org/twd.team/loc/en/html/welcome.htm

superior performance to some commercial baits[9], and a proposal to produce and test these would be cost-effective and likely to yield useful results.

Action 5. Facilitate sourcing of pest management inputs for fruit fly control

Find low cost sources of supply of appropriate traps, attractants and baits for fruit fly control by liaison with suppliers and manufacturers within and outside West Africa (e.g. South Africa, Asia). Facilitate development of retailing and/or licensing agreements. If necessary develop financial instruments to allow farmers to purchase inputs before the start of the mango season (for example financial guarantees by producers' associations for bank loans, or bulk purchases of monitoring traps by associations on behalf of their members). Similar mechanisms are already in use for export credit guarantees.

7.3 Support for regional development and dissemination of Information and Training products

Action 6. Create a virtual library and resource centre for African Fruit fly pest management.

Setting up of a "virtual library" would be achieved by setting up a moderated internet website, accessible from national sites which would make paper copies available. As well as having a database of reports, research papers and CD ROMS (e.g. the Taxonomy of Dacina of Africa CD by Ian White), donated by researchers and programmes. Ideally this website would be moderated by the Research Network (Action 3, above). Many of the papers and reports used for the Scoping Study are available as electronic files which could be uploaded to the website to form the nucleus of such a collection. The site could have links to other sites such as the CABI Crop Protection Compendium (includes risk assessment module), taxonomic and host plant databases (Royal Museum, Tervuren), natural enemy databases (Texas A& M University), Tephritid workers database etc.

Action 7. Set up research training linkages with ICIPE's African Regional Postgraduate Programme in Insect Science (ARPPIS)

Useful linkage with the African Fruit Fly Initiative (AFFI) (**Annex 12**), in Nairobi, should be created by providing bursaries for selected candidates to enrol for higher level training in specific subject areas or to undertake special research topics which will address their national needs, based at ICIPE and collaborating universities. Currently ARPPIS is only cooperating with Anglophone universities (Legon, Ghana; Addis Ababa, Ethiopia; and Harare, Zimbabwe).

Action 8. Develop improved ToT materials for BAT and MAT

Develop training materials or manuals for BAT (based on 2007, and previous years' trials of GF-120, Success Appat) and MAT/TEM (based on trial use of impregnated blocks) and field test early drafts in regional training of trainers for producer/exporter associations and government plant protection staff to equip them to train growers to apply IPM strategies for fruit flies, using the same materials, which can be centrally designed and locally edited and

[9] See for example: P Rousse, PF Duyck, S Quilici et P Ryckewaert. AMAS 2003. Developpement et optimisation d'attractifs alimentaires pour la mouche du melon *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae). Food and Agricultural Research Council, Réduit, Mauritius.

produced. The aim should be to run courses based on current knowledge and progressively improve materials and techniques advocated as experimental data become available.

Action 9. Develop short regional training courses

Short courses could be developed for researchers, plant protection and extension staff to be held at ICIPE, IITA, or countries in the region, for other topics including: control methods, monitoring trap technologies, lures, baits, lab rearing, specimen preparation, taxonomy, etc. Courses should utilize IITA potential for regional capacity-building in fruit fly management (training and research back-stopping in IPM methodologies, taxonomy, insect rearing, pest monitoring, biological control etc). See Section 5.6.15, for areas of comparative advantage for IITA training. IITA can assist research and extension staff to design demonstrations for scaling up of recent IITA experiments in baiting, MAT and weaver ant biocontrol against fruit flies.

7.4 Support for regional pest assessments and deployment of pest management technologies.

Action 10. Develop standardised sampling protocols for damage data, fruit flies and parasitoids in mango

Develop and distribute protocols for standardised sampling and rearing from fruit to assess overall levels of damage to mango and the contribution of individual fruit fly species (of *Ceratitis*, *Bactrocera* and *Dacus*) in main growing areas throughout the season and presence and impact of parasitoids. Field test protocols in at least three countries including at least one where such work has not been conducted previously (e.g. Ghana).

Action 11. Support for registration of new plant protection products

Review recent trials of pest management strategies and component technologies against fruit flies (especially COLEACP-PIP trials) in light of best practice elsewhere (especially MAT and BAT) as a basis for ongoing and new registration requests to national and CILSS approval bodies and support dossier submissions by COLEACP on behalf of affected countries and dissemination of standard procedures and target MRLs to users.

Action 12. Support for organic certification for MAT and spot application of GF-120 (BAT)

Based on recent trials, negotiate organic certification for control operations, such as spot bait applications and traps or parapheromone blocks (methyl eugenol) which are useful against fruit flies and *Bactrocera invadens* in particular.

7.5 Support for regional development of Fruit fly taxonomy and Identification

Action 13. Provision of taxonomic back-up services for identification and confirmation of fruit fly species

The Royal Museum of Central Africa (MRAC) in Tervuren, Belgium, is a European centre for research on taxonomy of the Tephritidae of Africa (See Section 4.5.5 and references in the bibliography for details). As well as housing an important reference collection and a comprehensive database on African fruit flies, MRAC provides taxonomic training and

support with identification of samples from trapping and rearing programmes. Within a regional fruit fly management project it would be desirable to include a component of funding to enable an identification and advisory service to be provided to participating institutions by MRAC, Tervuren (with subcontracting of other taxonomic experts as necessary[10]). In relation to SPS strengthening, MRAC could also be commissioned to assist countries to develop quarantine lists as a basis for Pest Risk Assessments for fruit flies for all West African countries (see below).

In any regional project to be funded by the EC, it should be a precondition for assistance, that participating Ministries of Agriculture agree to any new records of fruit flies detected in samples being checked at MRAC Tervuren and if confirmed, being entered on the African Fruit Fly Database (in compliance with IPPC and WTO rules). It must be remembered that while the EC intends to facilitate the maximum benefits for the West African horticultural industry in promoting its exports of tropical fruit to the EU, it is also seeking to enable the exporting countries to become compliant with IPPC and European phytosanitary standards. The EU horticulture industry itself is placed at potential risk of economic losses on a large scale if African and Asian fruit flies should colonise the citrus-growing areas of southern Europe. The proposed transparency arrangement will ensure early warning for the EU of any heightened risk due to further invasions in West Africa likely to be imported to Europe in fruit.

Action 14. Bursaries for training and equipping of national fruit fly identifiers[11]

Within the scope of a regional project, it would be appropriate to provide funding for one or two representatives of national organizations, with a mandate for providing services to the horticultural industry, for training in fruit fly taxonomy at MRAC Tervuren (in English or French language medium as required). The appropriate trainees are likely to be staff of institutions such as national Plant Protection, SPS, or University departments. However the host institutions of these trainee taxonomists are likely to be poorly provided with microscopes, collection boxes, identification manuals and various minor equipment and consumables items need as “tools of trade” for their work after their return to their own country. It is proposed that for each trainee a package of equipment shall be provided which will enable the specialist to function in the same manner in which they have been trained. To facilitate the use of databases supplied under the training, a portable computer and various CDs of information could be supplied as part of this package. The aim is to create a stand-alone fruit fly identification facility for each participating country, with back-up to deal with new situations.

[10] In particular the services of Dr Ian White, world authority on dacine fruit flies of Africa in UK, and possibly experts from Australia, for inputs in the event of any further invasions of exotic species from Asia.

[11] It is strongly recommended that any training provided should not be on a quota basis with governments selecting candidates, but on a competitive basis, with the project management unit selecting the best candidates in terms of the evident positioning of the candidate’s host department in relation to service provision for the industry, as well as the apparent suitability and commitment of the candidate. It should also be borne in mind that Cote d’Ivoire and Senegal each have one professional who has already received such training (in research and plant protection, respectively).

7.6 Support to development of fruit inspection and phytosanitary management capacity

7.6.1 Post-harvest fruit quality management

Action 15. Fruit handling and quality control Manual.

Procedures for fruit handling from the field to the cold store are basically similar throughout West Africa. It would therefore be feasible and desirable to produce a practical training manual outlining best practice in fruit collection in the orchard and in quality control at the packing station, based on HACCP principles. However, companies which specialise in these activities, such as Bureau Veritas, make their living from providing quality assurance services and certifying the result. They regard their methods as commercially sensitive information. It is not clear whether they might be prevailed on to assist with such work on a consultancy basis, or whether other sources may have the same information. COLEACP are probably the best intermediaries for this.

Action 16. Hot water treatment of mangos.

Hot water treatment is practiced in some areas in West Africa, mainly against anthracnose. It would be useful to conduct a feasibility study for use of the technique to kill fruit flies. It has been said that Kent and Keitt varieties do not tolerate hot water treatment well. Much experimental work has been done in South Africa and in CIRAD in recent years and it may be possible to benefit from this. A short desk study of previous findings and a pilot scale demonstration of the technique could be undertaken at one of the most advanced packing stations which has temperature controlled water baths and chilling rooms. For this purpose, say 200 kg of mangos could be treated according to the current recommended practice, with half sent to Europe by air and half by boat, for evaluation. Again COLEACP have the connections for this, through CIRAD and the South African fruit industry.

7.6.2 SPS Pre-Export fruit inspection and certification

Action 17. Training for SPS Inspectors

Training for phytosanitary service inspectors to conduct pre-export inspection of fruit, especially mangoes. This could be organised as a regional ToT hosted in one country (e.g. at the Terminal Fruitier in Bobo Dioulasso, Burkina Faso, at the start of the mango campaign) with a view to the expertise gained being “cascaded” to other inspectors in each country by the graduate(s) of the training, within one month of their return. To help ensure that this happens, funds could be consigned to a third party agency in each country to enable the national SPS agency (using copies of the materials originally provided at the ToT) to provide an in-country training also financed under the regional project. This ensures that there are absolutely no pretexts for failure to follow up the initial ToT training received (as often happens). A pilot activity could be held in Year 1 and repeated, with the benefits of experience, in subsequent years. Initially the appropriate trainers for this activity would be Bureau Veritas, who are the most proficient and highly certified company working in quality control in fresh fruit in West Africa.

Action 18. Risk analysis, risk management and insurance study

In conjunction with European SPS counterparts it would be useful to commission a study of risk analysis and risk management for mango exports from West Africa to the European

Union in line with systems utilised by US quarantine authorities, with a view to making risk of quarantine rejection insurable in the medium term.

Action 19. Explore possibilities for creation of areas of low pest prevalence

The principles of establishing and designating areas of low pest prevalence for fruit flies need to be explored with the horticultural industry and the national SPS authorities, in selected countries, as a pilot demonstration, once the capacity to bring down current high populations has been demonstrated and regular fruit fly monitoring and control is in place[12]. The approach would be based on MAT and BAT wide area control programmes in key export growing areas of countries (e.g. Korhogo, Cote d'Ivoire, Bobo Dioulasso, Burkina Faso; etc)

7.6.3 Incoming quarantine surveillance for the ECOWAS Area.

Action 20. Facilitate ECOWAS assessment of required actions against fruit fly quarantine threats.

Facilitate a regional discussion at the level of ECOWAS/CEDEAO of the needs for inward quarantine enhancement, including increased surveillance at borders, use of sentinel fly traps at markets and borders, a ban on all commercial fruit movements into the ECOWAS zone and a ban on carrying of any uncertified fruit in personal baggage across land borders as well as entry via airports and ports. This could perhaps be done as a regional planning workshop hosted by the Nigeria EC Delegation with some input from ECOWAS. The topic however should be specific to regional phytosanitary collaboration for exclusion of invasive fruit flies from outside the ECOWAS region.

Action 21. Regional Pest Risk Assessments for exotic fruit fly quarantine threats

As part of the ECOWAS dialogue, develop regional pest risk assessments for specific quarantine threats (the three species of *Bactrocera* currently present in Tanzania, North East Africa and Arabia). Ideally this activity should be at least partly carried out as a participatory workshop exercise with national SPS senior staff, so that some skills transfer takes place. Fruit flies would effectively be used as a case study to build capacity for repeating the process with other pests.

Action 22. Train SPS inspectors in fruit fly quarantine surveillance.

If Action 20, above, is successful, carry out training and provide enhanced access to information sources (including internet and manuals) for phytosanitary service inspectors to assess incoming fruit and also to operate a system of sentinel traps at border posts and fruit markets, using multiple species attractants. It would be desirable to prioritise those border posts and entry points regarded by ECOWAS as the most heavily used entry points into the ECOWAS zone from Eastern and North-eastern Africa and from Arabia and to provide improved equipment for SPS inspection and diagnosis of pests, at these points.

[12] See FAO IPPC Draft ISPM: Establishment of areas of low pest prevalence for fruit flies (Tephritidae) (December 2007).

Table 58. Logical Framework for a Regional Action Plan for Fruit fly Management in West Africa.

Part 1. Overall and specific objectives, expected results, indicators, verification and assumptions.				
	Intervention Logic	**Objectively verifiable indicator of achievement**	**Sources of verification**	**Risks and Assumptions**
Overall Objectives (Goal)	West Africa's edible horticultural production and export sector and the nutrition and livelihoods of its dependants and beneficiaries protected.			
Specific Objective (Project Purpose)	Availability and quality of fruits and vegetable produce for both local markets and export sales enhanced through improved management of fruit flies.	Annual increases in the proportion of production achieving local and international sales.	Annual national statistics for exports of soft fruit	No other new or resurgent pest or pathogen causes increased loss levels during the evaluation period
Expected results	1. Producers in participating countries aware of viable options for managing fruit flies and actually applying them. 2. Level of fruit infestation by all major fruit fly species together in mango plantations serving the export market reduced by 60% (short term) and 90% medium term, and marketed production from small-scale orchards serving local and sub-regional markets increased by 50%. 3. Quarantine interceptions in Europe reduced to <0.05% of containers exported to the EU. 4. Participating research and plant protection staff carrying out competent comprehensive fruit fly surveys and efficiently executed field trials of new control strategies. 5. Identity and damage potential of all fruit flies affecting fruit and vegetable crops in target countries clarified.	1.1 X training of trainers courses in fruit fly pest management with Y participants in Z countries. 1.2 Producers' associations in sampled countries report 70% increase in uptake of fruit fly management measures by members. 2.1 Sample surveys show 60% decrease in infestation in 1 year, 90% in 3 years 3.1 Production from monitored orchards shows 50% increase in sales. 3.2 Official quarantine interceptions reported by European SPS agencies reduced to <0.05 of throughput. 4.1 Number and quality of fruit fly surveys and pest management field trials completed and documented. 5.1 Lists generated from sample surveys and rearing from fruit and vegetables with names cross-checked by MRAC, Tervuren.	1.1.1 Course reports, lists of participants, course evaluations; field surveys; 1.2.1 Producer's association surveys and reports; 2.1.1 Regular sampling reports by plant protection agencies and producers' organizations; 3.1.1 Producer's association surveys and reports; 3.2.1 Official EC SPS Records 4.1.1 Trial reports submitted to national committee and donor. 5.1.1 Reports of sampling surveys submitted to National Committee and donors.	1. Farmers are able to obtain credit to purchase inputs and inputs are available. 2. Producers' Associations cooperate in collecting production data from their members. 3. Agency responsible for collating EC quarantine records (EU Food and Veterinary Office) is prepared to cooperate by releasing interception data. 4. Sufficient numbers of researchers and plant protection staff are available to undertake field trials and have access to mango-growing areas.

Part 2. Activities for Result 1.

Activities		Means	Costs	Pre-conditions
Result 1	**Producers aware of, and using, new IPM strategies for fruit fly control**			
	SHORT TERM			
Action 1	Formation of national fruit fly control committees facilitated	Initial discussions by email; National workshop convened and held constituting committee		
Action 5	Sourcing and purchase of pest management inputs for fruit fly control facilitated	Credit extended to producers by banks with guarantees or by producers' associations with pre-financing from project	To be assessed	
	MEDIUM TERM			
Action 11	Registration of new plant protection products supported	COLEACP financed to prepare dossier for submission to CSP		

Part 3. Activities for Result 2.

Activities		Means	Costs	Pre-conditions
Result 2	**Reduced infestation of export mango orchards and increase in marketed production from small orchards**.			
	SHORT – MEDIUM TERM			
Action 8	Improved training materials for ToT on bait application technique (BAT) and male annihilation technique (MAT) developed and disseminated	Consultancy by experts working within the region (e.g. IITA)		
Action 9	Short regional training courses delivered to build capacity in pest management for fruit flies as needed.	Consultancy by experts working within the region (e.g. IITA)		
Action 4	Relevant regional research programme on fruit fly pest management completed and results disseminated (this activity also contributes to result 4)	Depending on the size and duration of the programme to be funded, some or all of the programme of research in Box 3 will be delivered.		

Part 4. Activities for Result 3.

Activities		Means	Costs	Pre-conditions
Result 3	**Quarantine interceptions in Europe reduced**			
	SHORT TERM			
Action 15	Fruit handling and quality control manual prepared and disseminated.	Consultancy from inspection company, e.g Bureau Veritas		
Action 16	Hot water treatment of export mangos piloted.	Exporting company with consultancy input (CIRAD or S. Africa?)		
Action 17	SPS inspectors trained in pre-export inspection of fruit, especially mangos.	Bureau Veritas + SPS consultant e.g KEPHIS?		
Action 21	Regional pest risk assessments for exotic fruit fly quarantine threats completed.	SPS consultant facilitator + workshop		
	MEDIUM TERM			
Action 20	ECOWAS response to exotic fruit fly quarantine threats facilitated.	Workshop + SPS consultant facilitator		
Action 22	SPS personnel trained in fruit fly quarantine surveillance using multi-species sentinel trapping.	Possibly consultant from MoA South Africa or USDA		
Action 19	Feasibility of creating areas of low pest prevalence for fruit flies investigated.	SPS consultant facilitator + workshop		
Action 18	Risk analysis, risk management and risk assurance study completed.	Consultancy study		

Part 5. Activities for Result 4.

Activities		Means	Costs	Pre-conditions
Result 4	**Participating research and plant protection staff carrying out competent and comprehensive fruit fly surveys and efficiently executed field trials of new control strategies**.			
	SHORT TERM			
Action 2	Competitive grant funding for research and development activities on fruit flies operational	Several options available (see Section 7.2)		
Action 3	Regional research network for fruit fly management operational.	Embedded unit in IITA with one website developer initially and one information specialist part time.		
Action 4	Relevant regional research programme on fruit fly pest management set out and standardised research protocols established and disseminated	Depends on resources and time available (see **Box C** for priority objectives)		
Action 10	Standardised fruit fly sampling protocols for damage, fruit flies and parasitoids developed and disseminated via research network.	Consultancy desk study from e.g. IITA		
Action 6	Virtual library and resource centre for African fruit fly management created	Maintained by IITA (see Action 3)		
	MEDIUM TERM			
Action 7	Research training linkages with ICIPE ARRPIS Programme in place and researchers trained	Depends on number of suitable trainees and resources available		
Action 4	Relevant regional research programme on fruit fly pest management completed and results disseminated (this activity also contributes to result 2)	Depending on the size and duration of the programme to be funded, some or all of the programme of research in **Box C** will be delivered.		

Part 6. Activities for Result 5.

Activities		Means	Costs	Pre-conditions
Result 5	**Identity and damage potential of all economic fruit flies on fruit and vegetables in participating countries clarified**			
	SHORT – MEDIUM TERM[13]			
Action 13	Taxonomic back-up services for fruit fly and parasitoid identification provided	Fixed consultancy for n days work per year		Participating institutions agree to any new records of fruit flies detected in samples being checked at MRAC Tervuren and, if confirmed, being entered on the African Fruit Fly database.
Action 14	Training and equipping of fruit fly identifiers carried out	Could work with two trainees at a time for one month, repeated depending on need or resources available. Equipment for trainees to take home would be purchased and sent with them		

[13] Identification services and training of identifiers would continue during the lifetime of the project, hence short-medium term

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