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BIOLOGICAL CONTROL PROGRAM FOR THE MANGO MEALY BUG *RASTROCOCCUS INVADENS* Williams (HOMOPTERA: PSEUDOCOCCIDEA) IN WEST AFRICA.

FINAL REPORT
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Sommaire

List of abbreviations:

APROMA B	Association Interprofessionnelle de la mangue du Burkina Faso (Burkina Faso)
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement (France)
CMA/AOC	Conférence des Ministres de l'Agriculture de l'Afrique de l'Ouest et du Centre
CNRA	Centre National de Recherche Agronomique (Côte d'Ivoire)
DPV	Directorate for Plant Protection - Direction de la Protection des Végétaux
DPVC	Direction des Protections des Végétaux et du Conditionnement (Burkina Faso)
DPVCQ	Direction de la Protection des Végétaux et du Contrôle de la Qualité (Côte d'Ivoire)
ECOWAS	Economic Community Of West African States
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistics
IITA - Bénin	Institut International d'AgricultureTropicale (Bénin) (Internal Institut for Tropical Agriculture-Benin)
COLEACP	Comité de Liaison Europe Afrique Caraïbes-Pacifique pour la promotion des exportations horticoles ACP
INERA	Institut de l'Environnement et des Recherches agricoles (Burkina Faso)
IPPC	International Plant Protection Convention
IRAG	Institut de Recherche Agronomique de Guinée (Guinée)
MOFA	Ministry of Food and Agriculture's (Ghana)
OCAB	Organisation Centrale des Producteurs-Exportateurs de Bananes, Ananas, Mangues (Côte d'Ivoire)
OMOA	Organic Mango Out growers association (Ghana)
UEMOA	Union Economique et Monétaire Ouest Africaine
CFC	Common Fun for Commodities
NARS	National Agricultural Research Services
NBCP	National Biological Control Pannels
WAFFI	West African Fruit Fly Initiative

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The former Director of AU/SAFGRAD in Ouagadougou

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Staff members

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The delegates of Benin, Burkina Faso, Ghana, Guinea, Mali, Code D'Ivoire Togo , ECOWAS and IITA

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The scientists and representatives of mango producers we met.

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I. INTRODUCTION

1.1. Problem statement

Mango (*Manguifera indica* L.) is the third most important fruit crop in the tropics. It is the most important of the forty one species belonging to the family Anacardiaceae. According to FAO statistics combined production of mangoes and guava has increased by 25% from 972,689 tons to 1,220,900 tons between 2000 and 2007 in West Africa (table 1).

Mango production in West Africa has an important socio-economic impact on farm households and on West African countries economies. Mangoes play an integral part in rural household lives not only by being rich nutrient source but also by serving as a common good that is consumed casually. The fruit is very sweet and is consumed fresh, or transformed into juices, jams, dried fruit etc… Most Western Africa production is consumed locally contributing to food self sufficiency and reduction of poverty. Indeed, one hectare of mango tree can yield annually on average up to $US 500 in revenue to producers. Mango is consumed in rural areas and serves as complementary food to populations during the dry -season when staple crops are not produced and food reserves have dwindled down. Mango is also exported and contributes highly to the economies of some West African countries. Export of Western Africa mangoes to European countries has increased in recent years, reaching over 61 million $US for five countries in 2005 (table 2). Countries, like Côte d'Ivoire, export annually on average 10,000 tons of fruits and have reached 15,000 tons in peak years. Exports generate substantial foreign currency to the exporting countries economy and important cash to traders and farmers associations. Overall mango plays an important role in food security and nutrition quality, and in poverty alleviation.

Mango fruit was not commonly known among consumers outside of the tropics and there was virtually no international trade of the fresh fruit. In recent years, mangoes have become well established as fresh fruit and processed products in the global market. India is by far the major producer of mangoes in the world although its relative share in the world production has been gradually declining. In the United States of America fruit eaters now regularly choose mangoes over apricots, cherries and plums. World demand for mango is now increasing however, particularly in temperate countries, where mangoes are rapidly gaining in popularity. The increase in mango production in non-traditional mango-producing areas has been notable and includes parts of Asia, West Africa, Australia, South America and Mexico.

However the growth of mango production in West Africa is dangerously threatened by: **(1) climate changes that have created favorable conditions to the proliferation of pests who attack and damage both the fruits and the trees thereby affecting negatively productivity and production.** (2) attacks of disease such as anthracnosis and bacterial wilt and by invading insect pests recently introduced in the region which are causing **not only** losses amounting up to 80% of total production in the field (Entomological society of Nigeria, 1991), **but also losses in market shares in Europe and other parts of the world where damaged fruits are destroyed or returned to exporting countries.** Scientists have identified the causal agents which are essentially one species of fruit flies (*Bactrocera invadens*) Vayssiere, (2005) and one species of mealy bug

(*Rastrococcus invadens*) Agounkè (1988) recently introduced in the region. Female fruit flies *Bactrocera invadens* lay eggs which develop into maggots (larvae) in the flesh of the fruit after hatching. The maggots severely damage fruits that rotten and become unmarketable. Mealy bugs *Rastrococcus invadens* suck sap from the leaves, branches, flowers and fruits. They excrete honeydew which develops into black sooty mould. Together, fruits flies and mealy bugs are major constraint to increase mango productivity and production. Mealy bugs' attacks and destroy the trees and the young fruits while fruit flies attacks render the fruits non suitable for consumption and commercialization.

1.2. Rational

The recently introduced insect pests *Bactrocera invadens* and *Rastrococcus invadens* are spreading wild in Benin, Burkina Faso, Côte d'Ivoire, Ghana, Guinea, Mali, and Togo because control effort deployed by each single country is having little impact on their population. According to Hala *et al.* (2004) the mealy bug *R. invadens* appeared in 1989 at the eastern border of Côte d'Ivoire and became in less than four years a major constraint to fruit production nation-wide. In Guinea, Traoré (2001) and Baldé (2002) reported that the area of *R. invadens* attacks has widened rapidly to include the four regions of mango production in the country. Elsewhere in all the countries visited, the tendency is that mango pests, both the fruit flies and the mealy bugs are rapidly spreading and crossing borders. The appearance of the mealy bug in the southern region of Burkina Faso for instance is an indication that the pest came from northern Côte d'Ivoire where it was first reported in the eastern region of that country in 1986 meaning that it probably came from Ghana where the pest was already present in the early 1980s. Invasive insects are non-observing borders pests and consequently should be fought regionally instead of trying to control them at country level. In addition, no single country has the capacities to undertake a meaningful action alone.

It is therefore instrumental that the affected countries unite their efforts to tackle the threat these insects pose. Unless coordinated action against the pests has taken place, any one country's efforts will be easily overcome by these non-observing border insects. Moreover, the scarcity of resources and the fact that West African countries have adopted and are implementing a regional agricultural policy, militate for a sharing of the limited resources available through a common regional program for controlling the pests. In the case of biological control for instance, having adequate infrastructures to mass-produce natural enemies of the pests is a pre-requisite, but such infrastructures can hardly be profitable for one single country mango industry. Burkina Faso has requested and obtained support from the African Development Bank to develop a biological control program against the mango mealy bug *Rastrococcus invadens*. The project seeks to implement biological control of mango mealy bug using two parasitoid wasps *Gyranusoïdea tebigy* and *Anagyrus mangicola* which have put the pest under control in parts of Benin, Ghana and Togo in the eighties. This support from the African Development Bank has allowed the construction of an insectarium for mass producing two parasitoids natural enemies of the mango mealy bug. The infrastructures now available in Burkina Faso complement those of IITA Biological control headquarter in Benin. Together the two insectarium can mass produce the natural enemies for release in the region. If it is deemed necessary, other insectarium can be built in candidate country to meet the demand.

In line with its mandate and as a partner in the implementation of the Burkina Faso program together with IITA, SAFGRAD was tasked to bring together and facilitate exchange of regional expertise and other resources for a successful implementation of the project in Burkina Faso, and to facilitate and coordinate regional efforts aimed at scaling out the initiative among neighboring mango producing countries. To successfully control the

mango mealy bug, concerted action is required at regional level since the same pests are available in Burkina Faso, Ivory Coast, Mali, Ghana, Benin, Togo, and Guinea.

In light of this observation, AU/SAFGRAD has requested and obtained from Member states, the go-ahead to develop a program for the biological control of mango mealy bugs in the above mentioned countries. The following is the program for ‘’Multi-Country efforts for biological control of the mango mealy bug ’’. The program complements the other regional initiatives that are underway in the region such as the ECOWAS Fruit Flies Initiative.

II. METHOD AND PROCEDURES OF THE STUDY

For the purpose of this mission, AU/SAFGRAD mobilized a team of two consultants comprising an agricultural economist and an entomologist. The team has gone through the following steps in carrying out its mandate.

First the consultants proceeded to review the literature and all documents available on the subject and national and regional initiatives of biological control of mango pests. An emphasis was put on articles published on research done particularly in Africa. More than fifty articles and documents were examined and the most relevant to biological control of mango pests were retained and reviewed for this report. The review was done through library research, and by consulting websites, experts, projects and institutions involved or engaged in the process on pest management in the mango fruit chain in particular and in other agricultural commodities in general.

Second the team travelled to the countries selected for this study and met scientists from national and regional research institutions, representatives of international institutions, agricultural ministries, producers and traders’ organizations and all other stakeholders involved in mango production and trade. The list of people met is in annex. The purpose of these missions was to meet one of the requirements of the terms of reference which is to draft this report in a participatory manner by taking into account the view point of all stakeholders. During these missions of the team to Benin, Burkina Faso, Côte d’Ivoire, Ghana, Guinea, Mali, Nigeria and Togo, interviews and meetings were held with several stakeholders, mainly producers’ organizations, leaders of commercialization and trade structures. Their points of views on the subject were gathered and an assessment of the extent to which the problem of pests and the damages they are causing to the mango fruit chain was made. The team also gathered data, information and documents available in these countries.

The third step consisted of writing up the report. After the missions in the countries, each member of the team returned to his home base to analyze the information gathered and draft a synthesis report. A compilation of the two synthesis reports of the consultants was made to obtain a draft strategy for the biological control of the mango mealy bug project which has been presented for validation at a workshop held in Ouagadougou on the 29 & 30 of December 2009 to ensure that the concerned countries i.e. Burkina Faso, Benin, Côte d’Ivoire, Ghana, Mali and Togo effectively participate to the writing of the project. All the participants (cf. list of attendance) acknowledged the imperious necessity to collectively tackle the problem posed by invasive insect species following climate changes in the region. They made important contributions that improved the initial draft strategy. **The following is the final version of the report that has integrated the recommendations and amendments that were made by the experts during the regional workshop.**.

III. LITERATURE REVIEW

Several studies on biological control of mango pests have been carried out by eminent researchers in well known universities and agricultural research institutes in Africa and elsewhere in the world. The best candidate natural enemies have been researched for, put in quarantine, mass produced and released in the fields. Usually it is in the region of the world where originate the invasive pests that the appropriate exotic natural enemies capable of putting them back into control in the newly infested region are found. This review is an overview of the literature on mango pests which focuses on the studies on biological control of the mango mealy bug especially report on the project that was implemented in Benin, Ghana and Togo and had achieved a good degree of success in the eighties. The review highlights what need to be done to widen or extend this project into a Regional Biological Control Program. Most of the studies reviewed have essentially examined three aspects i.e. 1) the economic importance of the pests; 2) the potential of natural enemies to control the pests, 3) the control achieved after release. This review will focus on the economic importance of the pests and their control.

3.1 Economic importance of mango pests

3.1.1. Economic importance of fruit flies

Fruit flies are of major economic importance because many representatives of this group attack and severely damage important fruit crops, especially mangos, in tropical regions (White and Elson-Harris, 1992). On the African continent, the genus *Ceratitis* has mostly been found associated with mango fruits and citrus. In West Africa, fruit flies attacking mangos have been studied in Côte d'Ivoire (N'Guetta, 1994), Guinea (Vayssières J.F., Kalabane S. 2000) and Mali (Vayssières *et al.* 2004). *Bactrocera invadens* (Diptera Tephritidae), was detected for the first time in western Africa in Benin in June 2004. The pest was observed 15 months earlier in eastern Africa in Kenya. This species, unknown to the African scientific community before its introduction on the continent, originates from the Asian continent. Regular trappings during two years have shown the presence of *B. invadens* in 15 countries throughout central and western Africa (Senegal, Guinea, Sierra Leone, Mali, Côte d'Ivoire, Burkina Faso, Ghana, Togo, Benin, Niger, Nigeria, Cameroon, Equatorial Guinea, the Republic of Congo and the Democratic Republic of Congo). The geographic distribution of the insect contains a broad spectrum of climatic and ecological zones. The current geographical distribution extends at a North-South distance of almost 5.500 km corresponding to a surface of more than 4 million square kilometers (Vayssieres and Goergen, personal communication).

B. invadens attacks 41 species of cultivated and wild host plants belonging to 21 different families. Whereas their preferred crop plants are mango, citrus fruits and guava, on wild fruits the most frequent attacks are observed on the badamier (*Terminalia catappa*), the wild mango tree (*Irvingia gabonensis*) and the shea tree (*Vitellaria paradoxa*). (Vayssieres and Goergen, personnal communication paper). Estimates of the economic impact of fruit flies on mango production vary on early to late maturing cultivars from 30 to 50% depending on host preference (Hala, Personnal communication).

According to the ECOWAS Regional Action Plan against fruit flies, 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 attributed to fruit flies may therefore be almost as much as the current export value (27 million Euros).

3.1.2. Economic importance of mealy bugs

According to Bokonon-Ganta *et al.* (2001) and several others entomologists and actors from the production and processing chains in the countries we surveyed, until recently, damages by pests and diseases on mango in Africa in general, and in West Africa in particular were of minor economic importance. It is only in the eighties that a mealy bug later identified as *Rastrococcus invadens* Williams (Homoptera: Pseudococcidae) and a fruit fly identified as *Bactrocera invadens* were reported causing serious damage to various fruit trees, especially mango, in Benin, Togo and Ghana (Agounkè et al., 1988, Vayssières, 2005).

R. invadens is a native pest from Southeast Asia. It was introduced into western Africa through plant materials (Tobih *et al.*, 2002). It is a pest of more than 21 economically important plant species, but mango is its major host plant. The pest has been reported causing 80% of mango yield losses in Ghana (Entomological society of Nigeria, 1991), 53% to 100% reduction of total production in Côte d'Ivoire (Hala *et al.* 2004), significant reduction in weight and size of fresh mango fruit in Nigeria, Togo and Benin (Ivbijaro and Udensi 1988, Ivbijaro *et al.* 1991, Tobih *et al.* 2002). The insect affects the morphology and physiology of infested trees causing delays in flowering, fall of floral spikes and leaves and slowing the emission of new branches.

The pest has recently moved into the mango production areas of Burkina Faso in the provinces of Comoé, Léraba and Kénédougou (Otoidobiga, personal communication), in Western Mali in the region of Sikasso (Sidiki Traoré, personal communication), and in Guinea where it is causing alarming losses to mango production. Not only the pest disrupts the production of mango and of many other fruits and ornamental trees, but it is also a nuisance by causing accumulation of excreted honey dew that results in the formation of sooty mould which in turn arrests normal growth, photosynthesis, flowering and fruiting of the attacked plants (Pitan *et al.* 2000). As a consequence, growers are even deprived from enjoying the shade of attacked trees.

In Benin, a survey among mango producers over a large area estimated that the biological control program allowed interviewed farmers to gain on average US$ 328 annually. This amounted, when extrapolated to all farmers of Benin, to an estimated net yearly gain of $US 50 million for the whole country (Bokonon-Ganta *et al.* (2001)). The authors of this study concluded that the added value of the biological control is estimated at $US 531 million over 20 years. These benefits are based on the total cost of biological control of mango mealy bug estimated at $US 3.66 million and which includes costs in other African countries involved in the program and the cost of importing the natural enemy from India. The figures translate in a benefit-cost ratio of 145:1 in favour of benefits for Benin alone.

In Côte d'Ivoire Hala *et al.* (2004) reported that *R. invadens* appeared in 1989 at the eastern border of the country and became in less than four years a major constraint to fruit production nation-wide. By 1996 the mango mealy bug had reached the northern region, the main area for export mango production. It was evaluated that 53% of mango yield losses occurred as the result of *R. invadens* infestations in Korogho-Lataha research station. Yield losses even reached 100% in some farms and farmers responded most often by cutting down and destroying all the trees in the infested orchards. On the average, the infestation rates reached 82, 36 and 11% respectively in the cities, villages and orchards.

In Guinea *R. invadens* was first observed in 2000 and later confirmed by IITA. Initially localized in one region, the pest rapidly infested the entire country. According to the scientific community and the majors groups of actors in the mango value chain, the bug infestations are causing serious damages to mango production in Guinea. Over the last few years, the infestations have had a negative economic impact on producers and traders of this commodity. Although the rates of infestations are most important in urban areas than in orchards, the economic and social strain on farmers seem to be greater given the importance of the revenue of mango production, trade and consumption on farmers' income and welfare. Indeed mango production plays a fundamental role in procuring extra income to farmers in rural areas all over Guinea.

3.2. Control of *R. Invadens*

The most common method used by local farmers to control *R. Invadens* is cutting down infested trees (Agricola *et al.*, 1989). Investigations by National Research Services (NRS) have yielded little alternative control approaches to mitigate the threat caused by *R. invadens*. In Burkina Faso, Côte d'Ivoire and Mali, chemical control has been experimented but the technology has been poorly adopted by farmers because of little efficiency and fears that the use of insecticides will erase the organic nature of mango production of the region and expose mango export to pesticide Maximum Residue Limit restrictions in force in the European Union markets where most of the exported production is sold.

R. invadens has been successfully put under control in Benin, Ghana and Togo using biological control exerted by two parasitoid wasps, *Gyranusoïdea tebigy* and *Anagyrus mangicola* released in the eighties. The parasitoids was found in India and *G. tebigy* was first introduced in Togo in 1987 by the CAB International Institute of Biological Control in a project sponsored by the Deutsche Gesellschaft für Teschnische Zusammenarbeit (GTZ) and the Food and Agriculture Organization (FAO) (Agricola *et al.*1989). In 1988 the Biological Control Program of the International Institute of Tropical Agriculture (IITA) based in the republic of Benin was given the responsibility of continuing this effort (Neuenschwander *et al.*, 1994) and this allowed the introduction of *G. Tebygi* in Benin in 1988. All releases of the parasitoid resulted in successful establishments (Agricola *et al.*, 1989, Neuenschwander *et al.*, 1994). The parasitoid proved to be an effective biological control agent against *R. Invadens* by establishing a marked and stable reduction of the pest levels in all the infested zones where it has been released (Agricola *et al.* 1989; Matokot *et al.* 1992; Neuenschwander *et al.*, 1994, Boavida *et al.* 1995).

Nevertheless, in spite of the presence of *G. Tebygi*, infested spots persisted where *R. Invadens* continued to cause losses. This situation justified the introduction and release of a second parasitoid, *Anagyrus mangicola* Noyes (Hymenoptera: Encyrtidae) in localized zones of Benin to improve the biological control of the mealy bug. *G. Tebygi* prefers to oviposite in younger *R. Invadens* larvae than do *A. Mangicola*. This difference in host

preference by the two parasitoids allows both of them to successfully establish and complementarily control the mealy bug in the same ecological niche (Boavida *et al.*, 1995; Bokonon-Ganta *et al.* 1995). Unfortunately this Biological Control Program was discontinued while the pest is invading new areas.

Other biological control programs have been successfully implemented in the past in Africa (e.g. the biological control of the cassava mealy bug (*Phenacoccus manihoti* Mat.-Ferr. and the green spider mite *Mononychelus tanajoa* Bondar (Herren 1982, 1984 and Herren and Benett 1984), the biological control of the larger grain borer *Prostephanus truncatus* Horn (Böye *et al.* 1988, 1989; Dobie, 1988). In each case it took time to firmly establish and consolidate the control of the pest through coordinated actions with national research services to include all affected countries. The present study is undertaken with objective to achieve the implemention of coordinated actions against *R. invadens* at regional level in line and in conjunction with the ECOWAS approach which is developing action plans for coordinated approaches at regional level to deal with threats of such magnitude from fruit flies.

IV. RESULTS OF MISSIONS AND CONTACTS

4.1. Benin

In Benin the consultants met with two representatives of the national research center and three members of IITA. In this country the two introduced natural enemies are still keeping the mealy bug under control in southern and middle Benin where they have been released. The control they are exerting is such that the bug is now a pest of minor economic importance. However the mealy bug is now causing serious damage in the northern part of the country which was not infested when the biological control program was implemented. Benin has a good experience of the biological control of the mango mealy bug. Benin was one of the three countries that benefited from the first project in the domain of biological control of the mango mealy bug during the early eighties. The project has allowed the build-up of some capacities in the country on which a regional program can be rooted. The national research institute of Benin is actively pursuing research on the mealy bug enemies and following the evolution of the pest on the field where the two first enemies were released. The representatives of the national research centre were enthusiastic about opportunity to be part of a regional program and therefore having the chance to restart the biological control project by increasing their activities and extend them to the northern zone of the country.

The consultants also visited IITA which said it is ready to provide technical assistance to the present initiative. It has already met with INERA Burkina Faso's technical team and has provided this institution with the construction plans of the insectarium in Benin which can serve as a model in building the one in Bobo-Dioulasso. IITA is willing to provide, during the first two years of the program, backstopping, training and help to evaluate and assess the impact of the releases on the evolution of the population of mealy bugs in the field. In addition, IITA is ready to get into a long term partnership with INERA to cooperate in the biological control of agricultural product pests.

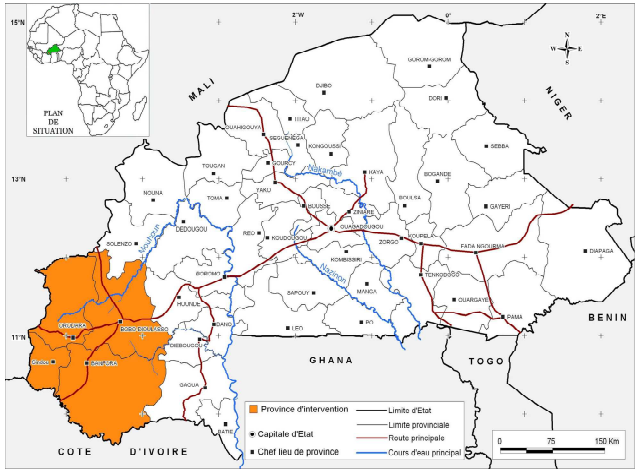
4.2. Burkina Faso

In Burkina Faso, the main mango producing areas are located in the south-western and center-western regions of the country. The south-western region provides 75% of the national production. Mango orchards occupy 15,000 ha and produce annually 120,000 tones. About 6,000 tones have been exported in 2006 of which 2,000 tones were sold on the international market. The varieties exported as fresh fruit are Amélie, Kent, Keitt and Valencia. Brooks, Lippens, and part of Amélie are dried or transformed into juice for exportation and local consumption.

Late maturing varieties (Kent, Keitt and Brooks) are most infested than early maturing ones. Up to 40% of fruits are attacked by fruit flies. Respectively five, one and zero shipments have been intercepted and destroyed at European ports respectively in 2004, 2005, and 2006. The numbers of intercepted shipments at Eurpean ports have decreased because exporters were forced to shorten their campaign. As a consequence of fruit flies' infestation an important quantity of the production is abandoned in the field. A project, PAFASP is contributing to solving fruit flies problems and a facility has been built in Bobo-Dioulasso to boost mango exports on the international market. Also FAO and CFC have planned on helping elaborate and implement a regional project.

An agricultural research station created in 1924 at Banfora and transferred to INERA in 1994 is specializing in research on the development of mango production. The facility produces mango nurseries, trains producers and technicians involved in the development of mango production. Research on integrated management of mango pests is conducted in collaboration with colleagues at Farakoba agricultural station. Five species of fruit flies, of which four are ceratitis spp. (Diptera: Tephritidae) and one is *B. Invadens* have been identified to date (Ouédraogo, 2007). The methods currently suggested to control fruit flies are chemical (Terpinyl or Methyl-Eugenol food bait)

R. Invadens has been introduced in the Côte d'Ivoire. Initially limited to Niangoloko neighbourhood, the insect has spread to invade all the south-western region of the country (cf. fig1 & 2). A project is initiated to use Biological control it. An insectarium has been built to mass produce *Gyranusoïdea tebigy* and *Anagyrus mangicola*, two natural enemies parasitoids of *R. invadens* for release against the pest.


PLAN DE SITUATION
MALI
NIGER
BENIN
GHANA
TOGO
COTE D'IVOIRE
Province d'intervention
Capitale d'Etat
Chef lieu de province
Limite d'Etat
Limite provinciale
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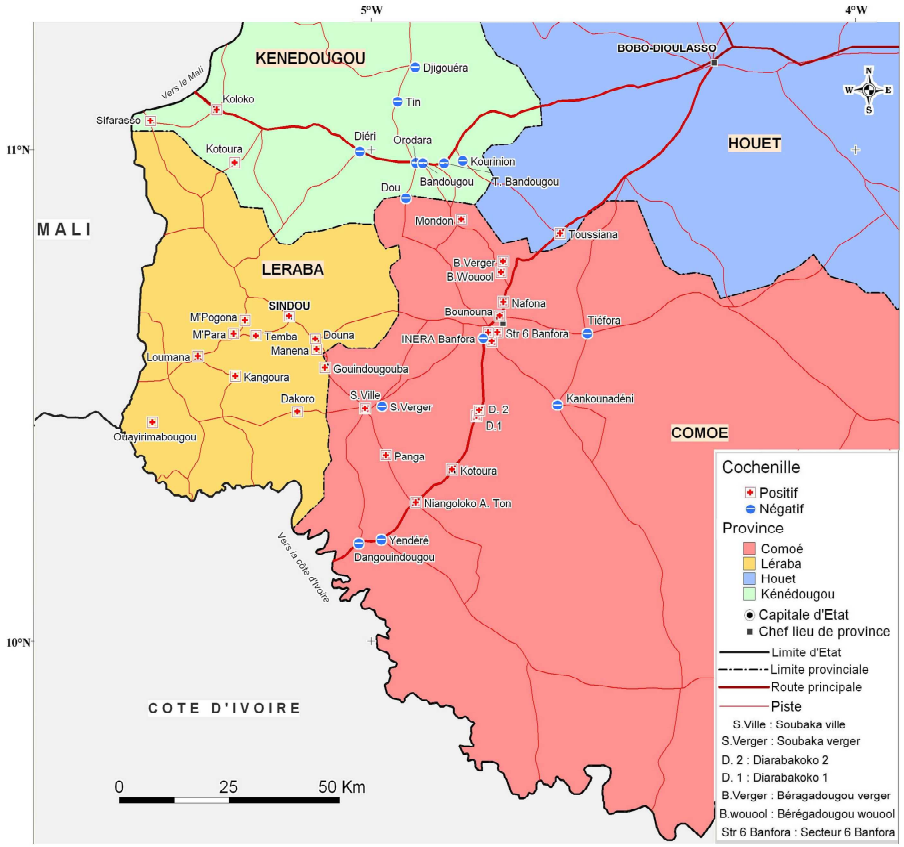

Fig. 1& 2: areas infested by *R. invadens* in Burkina Faso.

4.3. Côte d'Ivoire

In Côte d'Ivoire, the mission met the Deputy Director General of Scientific Affairs assisted by the Director of Research Programs, the head of International Cooperation Unit and the Head of the Department of Research and Development and the Members of the research team working on fruits and vegetables at the National Center for Agronomic Research (CNRA). According to these stakeholders, Côte d'Ivoire is confronted with the problem of mango fruit flies, anthracnosis and mealy bug. Côte d'Ivoire has been among the first countries affected by the recently introduced mango insect pests. Research on mango fruit flies and mealy bugs started in 1992-3 with the development of exportation of mangos. A biological control project with IITA released parasitoids against mealy bug has been implemented over the period of 1996-99. Inventory of fruit flies started in 1999. The CNRA has mainly pursued studies of the host range and distribution of fruit flies through trapping with pheromone lures and baits 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 Côte d'Ivoire in 1994, and has continued with subsequent studies by Ouattara (1998), Barbet (2000), Hala N'klo (2000), Kehe, et al., 2001, and N'depo Ossey (2006).

Researchers at CNRA have produced a number of scientific publications on mango pests but the monitoring of the pests populations has been interrupted since the ignition of the civil war in the country in September 2002. Disturbances caused by the war have greatly disrupted research work and curtailed and limited financial resources available for rerseach. Some work is conducted at the former Bayer Experimental station in Yamousoukro which is now run independently by its former staff. The National School of Agronomy (ESA) of the Houphouet Boigny National Polytechnic Institute, also in Yamousoukro, trains agronomists and does some research on fruit pests.

CNRA has created in 1981-1982 an agricultural research station located at Korhogo-Lataha in the north of the country which is specializing in research on the development of mango production. The facility produces mango nurseries, trains producers and technicians involved in the development of mango production. Thanks to its activities mango production in Côte d'Ivoire has rapidly increased and the country is currently one of the major mango producers in West Africa.

Among the activities at the Korhogo-Lataha mango research station are researches on the integrated management of mango pests. N'Guetta (1994) and Hala (2003) found that the main mango insect pests in Côte d'Ivoire are fruit flies (Diptera: Tephritidae) and mealy bugs (Homoptera: Pseudociccidae). Twenty species of Tephritidae have been reported. *B. Invadens* has been reported in 2005 and rapidly become the predominant species in many samples from diverse localities. Coulibaly (2000 & 2001) and Kamagate (2001) found that anthracnose is the main disease of mango in Côte d'Ivoire and that only 2% of farmers know the disease.

Losses of mango yield attributed to insect pests in Côte d'Ivoire reach on average 34 %. They vary from 9 % to more than 80 % depending on the variety, the period of harvest, the site of the orchard and the zone (HAULED, 2001). Losses due to *R. Invadens* alone often reach 100% when

farmers are obliged to cut down infested trees. The value of mango shipments rejected at European ports because of insect infestations reached 200 million francs CFA in 2001. No estimation was available on the impact of anthracnosis but the importance of the disease is increasing.

Research on the control of mango pests in Côte d'Ivoire focuses on fruits flies, mealy bugs and anthracnosis. Documentation of information is underway on pest identification, population dynamics, control, natural enemies and the susceptibility of mango varieties. Applied chemical control remains essentially at the experimental stage, but farmers are often using cotton insecticides which yield little satisfaction. Natural control of fruit flies is exerted by three species of parasitoids *Fopius sp*., *Psyttalia cosyrae* et *Diachamimorpha sp*. (HALA, 2001), while those of mealy bugs is exerted by *Gyranusoidea tebygi* and *Anagyrus mangicola* (Hymenoptera: Encyrtidae). The effectiveness of *G. Tebygi* and *A. Mangicola* is impeded by the hyperparasitoids *Marietta leopardina* and *Chartocerus hyalipennis* (Hymenoptera: Signiphoridae) that affect up to 65.18% of the parasitoids.

Research projects Côte d'Ivoire will like to implement following the monitoring of the mango pests and the inventory of the assets of agronomic research are:

- Integrated management of fruit flies *B. Invadens* and mealy bug *R. invadens*.
- The development of a control method against mango anthracnosis.
- Breeding or selection of mango cultivars fruiting during low pest infestation periods.

The mission also met the Executive Secretary of OCAB, which is exporting Côte d'Ivoire mangoes. According to data from COLEACP, Côte d'Ivoire has exported 14,500 tons of mangoes to the European Union in 2006 representing 6.8% of the Union importation. The numbers of shipments intercepted and rejected because of insect pest infestations were 14, 4 and 7 respectively in 2004, 2005 and 2006. As a consequence the campaign of exportation is shortened to reduce the rejection of shipments in Europe because when a shipment is rejected, not only the exporter loses all the merchandises, but he is also fined for the destruction on the rejected shipment. Losses at export were estimated at half a billion CFA francs of value in 2004. In addition up to 80% of fruits are sometimes rejected at field edge after sorting during heavy infestation periods.

4.4. Ghana

After our meeting in Benin and Togo, we deemed it necessary to visit Ghana which was the third country involved in the mango mealy bug biological control project undertaken during the eighties. The purpose of our visit was to have discussions with the experts who carried out the project, researchers and the representatives of farmers associations, exporters of mangoes, in short with the main stakeholders in the fruit chain if possible. Given time constraint, we were not successful in meeting all stakeholders during our visit. We met with the representatives of farmers association and fruits producers and exporters who welcomed the idea of designing and implementing a regional biological control of mango pests. According to these stakeholders, mango pests will become a serious problem in Ghana if adequate measures are not taken to curb the expansion of the pests. Indeed, in Ghana there are more and more attacks and damages in the mango fruit chain caused by fruit flies and meal bugs. The situation is under control in the areas where the natural enemies of the mealy bug were released during the implementation of the project in the eighties.

Ghana has a very good and experienced agricultural research institute which is carrying out many activities regarding all forms of pests control in general and biological control in particular. Ghana has successfully conducted experiences and implemented project on biological control of crops and food pests. The stakeholders in Ghana believe that there is an urgent need to address the problem of mango pests specifically the mealy bug attacks and damages of these attacks to productivity and production of mangoes. They are well aware that the problem of mango pests is a regional problem and acknowledge that the solution could not come from Ghana alone. Therefore they are in favour and willing to cooperate in a regional program for biological control which results could be harnessed for the wellbeing of rural populations in West Africa.

4.5. Guinea

In Guinea, the meeting with stakeholders took place on February 19, 2009 at the headquarters of the National Institute of Agronomic Research (IRAG) in Conakry. The meeting was held with representatives of the national institute of agronomic research including the Director General himself, experts from the national service for plants protection and stocked food, and a representative of producers' organization. The consultant was accompanied in this meeting by Dr Mahama Ouédraogo of AU/SAFGRAD and an expert from AU/FOUTA-DJALLON. Vayssiere, a researcher of IITA/CIRAD also participated in the meeting where very fruitful and technical discussions on the issue of biological control of the mango pests in general and of the mealy bugs in particular took place.

In Guinea, in addition to damages caused by the mango mealy bug, producers are faced with the problem of anthracnosis and attacks from the fruit flies which are the major constraint to meeting production and exporting phyto-sanitary measures. The mealy bug which was confined to one region is now a day a country wide problem which needs to be addressed quickly to avoid a major disaster in the mango industry.

Guinea has a good and well established program and a lot of experience in the biological control of crops and food pests. Guinea has also successfully implemented a project on biological control of cassava mealy bug. The results of these biological control projects executed with the assistance of IITA are all positive and very encouraging. With these encouraging results Guinea is keen to undertake biological control of other pests. However Guinea is lacking financial resources to start new programs of biological control of pests such as the mango mealy bug. Therefore, Guinea welcomes the initiative to carry out a regional program of biological control of this new pest of the mango industry. Guinea has human resources and some equipment that could be useful in the pool of resources required for implementation of a regional program for which Vayssière of CIRAD/IITA has agreed to serve as scientific backstopping. The participants came to the conclusion that a regional program is a must in West Africa in order to eradicate mango pests among which mealy bugs and therefore to safeguard the mango fruit chain from collapsing.

4.6. Mali

In Mali the mission met the Director of the Institute of Rural Economics, the Director of Scintific Affairs, the Coordinator of Scientific Affairs and a representative of the Team of researchers working on fruits and vegetables. Mangoes represent 60% of Mali total fruit production and provide billions of FCFA each year. Kolondiéba and Yanfolila, two associations of mango producers respectively exported for 249,545,705 FCFA and 881,756,052 in 2006 procuring on average an income of 432,479 and 751,070 FCFA respectively to each of their members. The activity is therefore very important for the Malian economy. The quantities of mangoes exported to Europe were 1164, 2417, 2679 and 3670 tons respectively in 2003, 2004, 2005 and 2006.

The main constraints to mango production in Mali are fruit flies and mealy bugs. Nineteen species of Ceratitidae of which *Ceretitis cossyra* is predominant and one species *B. Invadens* new to the country have been identified. The most damaging mealy bug species is *R. Invadens*. This insect has been introduced in Mali from Côte d'Ivoire and is affecting the region of Sikasso, the main mango production area of the country. All these insects also infest citrus, increasing their economic importance.

Researches conducted to date in Mali have investigated the population dynamics of the pests, their control and their impact on fruit production. The pests are most abundant from May to August with a peak in the last decade of June. Their populations decrease afterward to reach their lowest level in august. In addition the species of flies and their alternate host plants have been identified. Insecticides have been experimented to evaluate their effectiveness and determine control action thresholds against the pests and the date of application that limit residues in harvested fruits.

Mango losses attributed to fruit flies are estimated between 45 and 50% of total production. Early maturing varieties are less affected than late maturing ones. According to the COLEACP 14, 3 and 8 shipments of mango from Mali have been intercepted respectively in 2004, 2005 and 2006 at European ports because of infestation by fruit flies. To avoid this inconvenience mango exporters have shortened the period of mango exportation. Little information is available on the impact of mealy bug *R. Invadens* except that the pest is mainly found in cities' neighborhood and that some farmers have been forced to cut down infested trees in their orchards.

Mali is pursuing an integrated control of mango pests and is interested in the implementation of a regional program that will have a national anchoring.

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4.7. Togo

As in Benin the mealy bug problem persists in Togo in mango production zones recently colonized by the pest. Togo is one of the countries where the first biological control of the mango mealy bug project was implemented in West Africa. The results of the project were so encouraging that all the stakeholders are ready to adhere to the new regional program envisaged.

Togo is conducting several activities on plants and food pests control in laboratories and in the field. However, the research institute is confronted with a lot of constraints which undermine these research activities. Despite the need for solid research results and the need to eradicate mango and other pests that destroy and affect the quality of the products, the research institute is not endowed with consequent resources to carry out its activities. The prospect of changing this situation in the medium term is not so good given the socio-political and economic situation of the country. Therefore the research institute in Togo has adopted a strategy based on regional cooperation. Like other countries in West Africa, the mango fruit chain in Togo is not only confronted to the problem of damages caused by the mealy bug but also to attacks and damages of fruit flies which are one of the major concerns of producers and especially exporters. Overall, Togo is favorable to the idea of a regional biological control program of the mango mealy bug. To implement this program, Togo will need to import the natural enemies because the country does not have the capacities to mass produce them.

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4.8. International Institutions

The Commissions of ECOWAS and UEMOA were approached to determine with the experts of these institutions the possible linkages of this project with the regional phyto-sanitary programs they are implementing in the framework of the regional agricultural policies they have adopted. The Commission of ECOWAS and CMA/WAC have initiated a regional program to fight fruit flies and improve the quality of fruit to meet international norms and standards for export. The Commission of UEMOA has elaborated and adopted a regional program on sanitary and phyto-sanitary measures which is being implemented by its member states. In that context, the Commission of UEMOA is addressing the issue of mango pests and the damages they are causing to the fruit chain.

V. DISCUSSIONS

The challenges posed by invasive pests recently introduced in the western Africa region and the opportunities offered by biological control technologies already available to adequately tackle the threat have been assessed in the consultation and at the workshop. The challenges include not only the presence and devastative impact of the recently introduced invasive insect pests in the entire mango producing countries, the limited adequacy of chemical control method, but also the requirement that the countries of the region come together in a collaborative effort to collectively deal with

the threats. The opportunities include the presence locally of technical packages developed by researchers, and of good infrastructures (e insectarium in Burkina Faso and Benin for mass producing natural enemies, and experts well experimented on the subject at IITA and in several countries).

Mango pests (mealy bugs, fruit flies) and anthracnose are serious threats to the fruit chain in all the seven countries visited. All the countries have individually taken initiatives to deal with the threats. However, their efforts are rendered ineffective by the fact that they are not sustained and coordinated with neighbouring countries actions. Most of the projects and programs have stopped or been interrupted for lack of financial resources or due to social and political unrest. All the countries agree that regional programs will be more appropriate in handling the problems of mango pests than individual countries initiatives. This position of the countries can be explained by the following reasons: 1) although each country has an agricultural research institute, a national service of plants and crops protection, and other services in charge of plants and crops quality and norms, these institutions are not endowed with enough human and financial resources to undertake their missions and achieve their objectives; 2) mango pests are the same in these countries and also non-border observing insects; 3) the challenges the pests are posing to producers are the same from one country to another; therefore it makes sense to treat these problems in a regional program from which countries can benefit from the pooling of resources and experiences acquired in others; 4) West African countries are embarked in an integration process and have elaborated a regional agricultural policy which require the coordination of their efforts at the regional level.

VI. STRATEGY AND KEY COMPONENTS

The present initiative seeks to bring together and facilitate exchange of regional expertise and other resources for a successful implementation of the project in the region, to facilitate and coordinate regional efforts among West African countries affected by the mango mealy bug. The general objective of the strategy is to increase mango production in reducing the damages caused by the mealy bug through its control by the released natural enemies. This will increase the quantity of mango exported, mango producers' income and therefore reduce poverty in mango producing rural areas. Based on the results of the consultations and the technical package already developed by researchers for the biological control of the mango mealy bug, the countries represented at the workshop unanimously welcomed the initiative and mandated UA/SAFGRAD to go ahead for its implementation. Since the initial steps of a classical biological control program consisting of identifying, putting into quarantine, and devising techniques to mass produce the appropriate natural enemies have been made in previous initiatives, this UA/SAFGRAD initiative propose the following strategy with six components.

Table 1: Components of the biological control programme of the mango mealy bug project, activities, levels of execution and responsibilities.

COMPONENTS	**ACTIVITIES**	**REGIONAL LEVEL**	**NATIONAL LEVEL**	RESPONSIBILITIES.
1. Coordination of the Program	Mobilization of resources	x		SAFGRAD
	o Monitoring & Evaluation of national programs	x		
	o Development of partnership	x		
	o Finances and administration	x		
	o Communication	x		
	Harmonization of Programs	x		
	o Planning of activities	x		
2. Production & Diffusion	o Parasitoid Mass production	x	x	IITA/NARS
	o Parasitoid shipment to countries	x	x	IITA/ NARS
	o Training of staff (researchers and technicians)		x	NARS
3. Capacity building	o Training of producers	x	x	NARS /DPP
	o Infrastructures and Equipments	x	x	state/Donors
4. Research & Development	o Inventories of natural enemies		x	IITA/ NARS
	o Monitoring of population dynamics		x	NARS
	o Mass release and monitoring of populations		x	NARS /DPP
	o Technology generation and diffusion	x	x	NRAS/IITA
	o Extension		x	DPV/NRAS
5. Monitoring & Evaluation	o Monitoring and Evaluation of activities	x	x	Coordination at regional and national levels
	o Monitoring of the impact of the Program (indicators of impact)	x	x	Coordination at regional and national levels
6. Communication	o Design and plan a strategy of information, Communication and sensibilization (mass media, round table, etc.)	x	x	Coordination at regional and national levels

A steering committee of the programme should be put in place. This steering committee should meet at least once per year or as necessity dictate to plan the activities of the programme. National Biological Control Panel (NBCP) should be put in place in each participating country to oversee the activities of the NARS and coordinate their activities. The national agricultural research services themselves will be responsible for: 1) importing the parasitoids from Burkina Faso, 2) releasing and monitoring their establishment and performance in the field, 3) building/reinforcing the capacity of technicians and mango producers, 4) informing, sensitizing and training the actors of the mango sector on the application of the biological control program, and 5) making the inventory of all major pests of mango and their natural enemies. A national coordinator of the programme should be nominated. A comprehensive effort to increase mango protection against exotic invasive insect species in Western Africa should include two mains tasks:

1) The control of mango mealy bugs which are primary enemies that can annihilate mango production by destroying trees in the orchards and
2) The control of fruit flies which attack and damage the fruits

As the The control of fruit flies is being implemented by the ECOWAS Action Plan, to achieve a meaningful increase of mango production in West Africa the biological control of the mango mealy bug project should be launched concomitantly.

The proposed regional biological control program of the mango mealy bug consists in reenergizing and coordinating the project which has been tested successfully in Benin, Togo and Ghana during the eighties. The proposed strategy is derived from findings and results of discussions with stakeholders in the region and findings of research carried out by some of the best and well known scientists in crops and food pests control and specifically mango mealy bug biological control. It is also based on the information and data gathered by the two consultants during their fact finding missions in the seven countries selected for this study and on the conclusions of the international workshop held in Ouagadougou on December 29 and 30, 2009. The purpose of this 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 mealy bug attacks.

In proposing this regional action plan for the management of mealy bug, we were concerned about it feasibility and sustainability. Therefore we think that by utilising as far as possible existing institutional structures and mechanisms will greatly help. 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 which specific organizations display, as evidenced by a track record of success in the same or similar context. A coordination of the programme headed by UA/SAFGRAD will soften this concern.

We have endeavoured to present this Action Plan in a logical framework. Inevitably at this stage the framework could be incomplete. The proposed research topics 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 technology generation and diffusion

which will need to decide priorities. Within (or beyond) the suggested activities, 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 are yet to be decided.

VII. SUMMARY AND CONCLUSIONS

The mango mealy bug *Rastrococcus invadens* is a pest which originates from Southern Asia and invaded western Africa in the eighties. The pest threatens to bankrupt the mango industry in the region. Introduced without its natural enemies it has found a favorable ground to expand its population wild in the field. Few control methods are able to keep the pest under economic injury level. At the inception of the problem a biological control program has been implemented which has allowed the introduction, release and successful establishment of two natural parasitoid enemies in Togo, Ghana and Benin. This biological control project was working well, but has been abandoned because of resources shortage.

A consultation conducted in seven countries to evaluate the magnitude at which *R. Invadens* is affecting the mango industry in the region found that the pest has now invaded all the mango production areas of western Africa, seriously threatening the viability of the entire mango industry. On their own alone, National Agricultural Research and Plant Protection Services can hardly tackle individually the threat.

Given the situation, one reliable alternative is that the interested countries unite their efforts to confront the pests. In this prospect, they were convened at workshop help in Ouagadougou on December 29 and 30, 2009. They unanimously agreed that the insectariums of Burkina Faso and Benin be used to reinitiate the biological control program prematurely stopped in the eighties to serve as the foundation of the regional biological control efforts against the pest.

A strategy to implement the regional biological control of the mango mealy bug in West Africa is proposed. The strategy aims at expanding and coordinating actions among all the countries to release the natural enemies. It has six components: 1) Coordination of the Program; 2) Production & Diffusion; 3) Capacity building, 4) Research and Development; 5) Monitoring and evaluation and 6) Communication

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ANNEX 1: Mango and Guava Production in Western Africa (FAOSTAT June 2008).

Countries	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Benin	12000	12000	12000	12000	12200	12500	12000	12500
Burkina Faso	5000	5000	7500	9000	9000	9300	9000	9600
Cape Verde	4500	4500	4500	4500	4500	4500	4500	6000
Côte d'Ivoire	23655	27490	25758	25054	30865	30428	118000	120000
Gambia	629	554	560	560	600	650	560	700
Ghana	4000	4000	4000	4000	4000	6600	6996	6800
Guinea	83000	120000	155812	160000	164000	162000	164000	165000
Guinea-Bissau	4500	4700	4700	5000	5000	5000	5000	5300
Mali	25905	33097	29145	60434	55000	61424	65386	70000
Nigeria	730000	730000	730000	730000	730000	731000	731500	734000
Senegal	73000	83715	78523	85365	65840	61646	82194	84000
Sierra Leone	6500	7000	7000	7500	7500	7800	6500	7000
Western Africa	972689	1032056	1059498	1103413	1088505	1092848	1205636	1220900

ANNEX 2: Income generated by mango and guava export (FAOSTAT 2005)

Pays	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Burkina Faso	373,000	373,000	560,000	673,000	673,000	673,000
Côte d'Ivoire	2,622,000	2,622,000	2,622,000	2,622,000	2,622,000	2,622,000
Ghana	2,227,000	2,227,000	2,227,000	2,227,000	2,227,000	2,227,000
Mali	2,881,000	3,681,000	3,241,000	6,722,000	3,448,000	6,832,000
Nigeria	49,137,000	49,137,000	49,137,000	49,137,000	49,137,000	49,137,000
Toal Income	57,240,000	58,040,000	57,787,000	61,381,000	58,107,000	61,491,000

Annexe 3: Rapport de l'atelier sur le projet de stratégie sous régionale de lutte biologique contre la cochenille farineuse du manguier

Ouagadougou, 29-30 décembre 2009

PROJET DE RAPPORT FINAL

Les 29 et 30 décembre 2009, s'est tenu dans la salle de réunion n°2 de l'hôtel Palm Beach de Ouagadoug ou un atelier sur le projet de stratégie sous-régionale de lutte biologique contre la cochenille farineuse du manguier.

Ont pris part à cet atelier, les producteurs, des directeurs généraux ou leurs représentants des structures de recherche et de développement du Burkina Faso, du Bénin, de la côte d'ivoire, du Ghana, de la Guinée, du Togo et du Mali, ainsi que ceux des organisations telles que l'UA/SAFGRAD, la CEDEAO et l'IITA.

La liste des participants est jointe en annexe.

Le présent atelier qui s'est fixé pour objectifs de présenter les résultats de l'étude ainsi que la validation du projet de stratégie d'élaboration et de mise en œuvre d'un programme sous régional s'est déroulé en deux phases à savoir une cérémonie d'ouverture et les travaux proprement dits.

I- Cérémonie d'ouverture

La cérémonie d'ouverture a été présidée par Monsieur le Ministre délégué chargé de l'Agriculture du Burkina Faso. Elle s'est déroulée en présence du Directeur Général de l'INERA et du coordonnateur de l'UA/SAFGRAD.

Trois allocutions ont marqué cette cérémonie d'ouverture. Celle du coordonnateur de l'UA/SAFGRAD, du Directeur de l'INERA et le discours d'ouverture du Ministre de délégué chargé de l'Agriculture du Burkina Faso.

Les différents intervenants ont souligné l'importance de cette rencontre en ce sens qu'elle concerne l'agriculture de plusieurs Etats. La filière mangue joue un rôle important dans l'économie, elle représente plus de 60% de la production fruitière mais connait plusieurs contraintes parmi lesquelles figurent les problèmes phytosanitaires.

En situant la rencontre dans son contexte, M. le Ministre Abdoulaye COMBARI a exprimé tout son espoir que le projet permettra d'harmoniser davantage les efforts des pays en matière de lutte biologique contre le pseudococcus du manguier *Rastrococcus invadens* en Afrique de l'Ouest.

Après une brève suspension, les travaux se sont poursuivis sous la conduite du bureau de séance ci-après :

- Président : Monsieur Famoi BEAVOGUI (Guinée)
- Rapporteurs : Monsieur Haruna BRAIMAH (Ghana)
  Madame Raki KIEMA KOUELA (Burkina Faso)

L'ordre du jour adopté après amendements se résume comme suit :

- Présentation du sujet, contexte et justification
- Présentation des résultats de l'étude suivie de discussion
- Présentation de la stratégie suivie de discussion

- Présentation de la CEDEAO

II- Travaux proprement dits de l'atelier

2-1 Présentation du sujet, contexte et justification

Cette présentation a été faite par M. OUEDRAOGO Mahama de l'Union Africaine. Elle a porté essentiellement sur : La genèse, les objectifs assignés, le partenariat, l'approche développé et les résultats attendus pour le nouveau projet.

2-2 Présentation des résultats de l'étude suivie de discussion

Les résultats de l'étude ont été présentés par Dr Lapodini Marc ATOUGA.. L'étude réalisée a permis de ressortir six résultats qui s'articulent autour des points suivants :

- La confirmation de l'Importance socio – économique du manguier ;
- Les défis à relever tels que l'impact des dégâts et les méthodes de contrôle des insectes, la collaboration entrez Etats et les opportunités à saisir comme la production de mangue biologique afin d'accroître l'exportation internationale;
- Les capacités scientifiques et techniques existantes telles que les paquets technologiques, les infrastructures (insectarium de Bobo), les centres de recherche et les compétences techniques (chercheurs);
- Les documents de contrôle qui portent sur les initiatives pour chaque pays pour le projet afin d'harmoniser la lutte ;
- La lutte régionale avec des initiatives des organisations sous régionales comme la CEDEAO et la CMA
- La stratégie Régionale de contrôle qui acquiert le soutient des états.

A l'issue de ces présentations, plusieurs questions ont été abordées. Il s'agit notamment de:

- ✓ La faible représentation des producteurs et transformateurs à cet atelier ;

- ✓ L'effectif réduit du genre féminin « chercheur » à la rencontre ainsi que le rôle de la femme dans le projet ;
- ✓ Le retard mis pour la rédaction du projet de stratégie de lutte (2002 à 2008);
- ✓ La manifestation de l''engagement des pays dans la lutte biologique dans une stratégie régionale ;
- ✓ Le lien et le rôle de l'insectarium de bobo qui veut avoir un caractère régional et celui de l'IITA ;
- ✓ La modification du titre du projet de stratégie pour éviter une contradiction avec les autres initiatives régionales comme celle concernant les Tephritidae par la CEDEAO ;
- ✓ L'existence de paquets technologiques éprouvés réellement pour mener une lutte biologique efficace afin d'atteindre les objectifs de production et d'exportation des marchés biologiques et équitables ;
- ✓ Le lien existant entre le projet régional de lutte intégrée et ce nouveau projet ;
- ✓ La lutte contre les ravageurs au niveau des concessions familiales vu l'importance du manguier pour les ménages ;
- ✓ L'utilisation unique de la lutte biologique au lieu de la lutte intégrée pour venir à bout de *Rastrococcus invadens.*

A toutes ces questions, des réponses satisfaisantes ont été trouvées.

Des observations et amendements ont été faits:

- Faire apparaitre dans le rapport, les capacités de chaque pays ;
- Décrire brièvement les projets et les initiatives de recherche dans chaque pays ;
- Indiquer les acquis transférables à l'issue des dits projets ;
- Organiser des rencontres avec les producteurs pour diffuser les acquis ;
- Utiliser la stratégie de lutte biologique qui servira de relais en intégrant la gestion

A la demande de certains participants, chaque pays et institution a été invité à partagé son expérience en matière de lutte contre la cochenille farineuse. Il ressort de ces échanges que la cochenille farineuse est un redoutable ravageur pour le manguier. Les luttes chimique et biologique sont utilisées pour contrôler les populations de ces cochenilles.

Pour la lutte chimique, les pesticides tels que le Thiamethoxame et le chlorpyriphos Ethyl ont été appliqués respectivement au Burkina Faso et en Cote d'Ivoire. En ce qui concerne la lutte biologique, elle a consisté à l'utilisation des ennemis naturels de la cochenille dans tous les pays. Cette activité s'est réalisée grâce à l'appui de l'IITA. Le taux de parasitisme varie de 15 à 70 % selon les pays.

2-3 Présentation du projet de stratégie

Le projet de stratégie a été présenté par Dr Otoidobiga Lenli Claude. Les points suivants ont été développés :

- L'importance socio économique de la mangue dans les pays ouest africains ;
- Les dégâts et pertes causés par les nuisibles telles que les maladies et les insectes ;
- Le contrôle de ces nuisibles par la lutte intégrée (produit chimique, bio-insecticides, ennemis naturels, parasitoïdes) ;
- La lutte biologique classique qui s'avère moins coûteuse contre la cochenille farineuse par l'utilisation des ennemis naturels tels que *Anagyrus mangicola* et *Gyranusoïdea Tebigy noyes ;*
- Les options de lutte possible par l'interdépendance entre les pays pour juguler les contraintes financières et transfrontalières;
- Les différentes composantes que sont :
  - ✓ L'insectarium ;
  - ✓ L'unité de coordination régionale ;
  - ✓ Les services de recherche nationaux ;
  - ✓ L'UA/SAFGRAD, CEDEAO et autres institutions.
- L'organigramme du projet.

Avant de passer aux discussions sur le projet de stratégie, Mr TRAORE SY Alain de la Commission CEDEAO a fait une présentation du Plan d'Action Régional de Lutte contre la mouche des fruits

Il faut signaler que ce plan a été validé et attend sa mise en œuvre. Il sert de guideline pour l'élaboration du projet de stratégie et n'a pas été objet de discussions

Des échanges fructueux sur le projet de stratégie, il en est ressorti six composantes pour le projet (Voir tableau ci-dessus).

La journée du 30 décembre 2009 a été consacré à la poursuite des discussions sur la stratégie de mise en œuvre du projet de lutte biologique . Elles ont essentiellement portées sur :

- la définition des composantes du programme ;
- les activités à réaliser ;
- les niveaux de mise en œuvre des activités ;
- la désignation des principaux responsables.

Les résultats de ces discussions ont permis d'identifier 06 six composantes et leur contenues qui sont présentées dans le tableau ci-dessous.

Tableau : composantes et activités du programme de lutte biologique

COMPOSANTES	ACTIVITES	NIVEAU REGIONAL	NIVEAU NATIONAL	Principaux Responsables
7. Coordination du Programme	o Mobilisation des ressources	x		SAFGRAD
	o Suivi & Evaluation	x		
	o Développement de partenariat	x		
	o Administration et Finances	x		
	o Communication	x		
	o Harmonisation des Programmes	x		
	o Planification des activités	x		
8. Production & Diffusion	o Elevage de masse et distribution	x	x	IITA/SNRAs
	o Formation des formateurs (chercheurs, techniciens)	x	x	IITA/SNRAs
	o Lâcher		x	SNRAs
9. Renforcement des capacités	o Formation des acteurs (producteurs, etc.)	x	x	SNRAs/DPV
	o Infrastructures et Equipements	x	x	Etat/Donateur
10. Recherche & Développement	o Inventaire des ennemis naturels		x	IITA/SNRAs
	o Suivi de la dynamique des populations		x	SNRAs
	o Lâchers et Suivi des populations		x	SNRAs/DPV
	o Développement d'autres méthodes de lutte compatibles	x	x	SNRAs/IITA
	o Stratégies de Vulgarisation		x	DPV/SNRAs
11. Suivi & Evaluation	o Suivi et Evaluation de l'exécution des activités	x	x	Coordinations régionale et nationale
	o Suivi de l'impact du Programme (indicateurs d'impact)	x	x	Coordinations régionale et nationale
12. Communication	o Concevoir, Exécuter un Plan de stratégies d'information de Communication et de sensibilisation (mass media, table-ronde, etc.)	x	x	Coordinations régionale et nationale

NB : les différentes activités sont à affiner et les principaux responsables à préciser.

Les organes de pilotage retenus à l'issu des débats sont :

- **AU NIVEAU REGIONAL**
    - Une Coordination régionale assurée par l'UA/SAFGRAD ;
    - Un Comité Directeur (Steering Commitee) qui se réunit une fois par an et ou exceptionnellement.

- **AU NIVEAU NATIONAL**
    - Un Comité National de lutte biologique contre la cochenille farineuse du manguier composés des organisations de Producteurs, de systèmes nationaux de Recherche et Vulgarisation, des Directions de la Protection des Végétaux qui pourraient se réunir deux fois par an ;

    - Un Coordonnateur National de programme chargé de coordonner la mise en œuvre des activités dans son pays

Fait à Ouagadougou, le 30 décembre 2009

L'Atelier

2009

BIOLOGICAL CONTROL PROGRAM FOR THE MANGO MEALY BUG RASTROCOCCUS INVADENS Williams (HOMOPTERA: PSEUDOCOCCIDEA) IN WEST AFRICA

AU-SAFGRAD

AU-SAFGRAD