Evaluation of the CERF

Tanzania Case Study: Red Locusts

Project Number: OSRO/RAF/909/CHA

Report to FAO-PBEE

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List of Acronyms

BCP	Biological Control Products of South Africa
CERF	Central Emergency Response Fund of the UN
DALDO	District Agricultural and Livestock Development Officer
DGPS	Differential Global Positioning System
EA	Environmental Act of Tanzania
EIA & A	Environmental Impact Assessment and Audit (Tanzania)
EM	Environmental Management (Tanzania)
FAO	Food and Agriculture Organization of UN
HC	Humanitarian Coordinator
IPM	Integrated pest management
IRLCO-CSA	International Red locust Control Organization for Central and Southern Africa
LoA	Letter of Authority
LoU	Letter of Understanding
MAFSC	Tanzania Ministry of Agriculture, Food Security and Cooperatives
NEP	Tanzania National Environment Policy
PHS	Plant Health Services of the MAFSC
PS	Permanent Secretary
TANAPA	Tanzania National Parks Authority
TCE	Special Emergencies Programme Services of FAO
TCP	Technical Cooperation Programme
TPRI	Tropical Pesticides Research Institute of MAFSC
TZ	Tanzania
ULV	Ultra low volume
URT	United Republic of Tanzania
WFP	World Food Programme

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Cover plate:

Hoppers in grass Ikuu plains- Tanzania (photo by IRLCO-CSA)

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Executive Summary

During 2008, surveys of Red Locust populations in known breeding areas of Tanzania, Malawi and Mozambique by the International Red Locust Control Organization for Central and Southern Africa (IRLCO-CSA) highlighted a pre-occupying situation. IRLCO-CSA recommended to undertake extensive locust control operations in the Republic of Tanzania (Rukwa Valley Plains, Ikuu-Katavi Plains and Malagarasi Basin), Mozambique (Dimba Plains) and Malawi (Lake Chilwa Plain), and approached FAO with a request for financial support (initial estimates amounted to US$221,860) for conventional pesticides, airplane fuel and other treatment costs. FAO rapidly allocated US$942,000 from its regular funds in support of Red Locust survey and control operations in the three countries, through two successive TCP[1] projects: TCP/RAF/3118(E), covering Tanzania and Malawi, and TCP/MOZ/3203(E), covering Mozambique only.

These projects supported targeted control operations in the three countries, including one in which Green Muscle®, a fungal biopesticide, was used in the ecologically-sensitive Ikuu plains of Tanzania in January and February 2009. Further surveys conducted by IRLCO-CSA and the Tanzanian Ministry of Agriculture, Food Security and Cooperatives (MAFSC) with the financial support of project TCP/RAF/3118(E) estimated that up to 15,000 ha in the Ikuu-Katavi National Park were infested with widespread populations of banding nymphs at a density of 25-100 hoppers/m^2, as well as 10,000 ha in Rukwa plains and 15,000ha in Malagarasi. It became clear that the resources available through the TCPs were insufficient to effectively control the evolving situation. Conditions seemed ripe for a major outbreak. The combined potential outbreaks in three countries posed a food security threat to the whole of the Eastern, Central and Southern Africa, a region that was already suffering from food shortage due to prolonged drought resulting in poor harvest and loss of pasture.

To deal with this threat, Tanzania, Mozambique and Malawi launched an emergency appeal to FAO for assistance. The UN's Central Emergency Response Fund (CERF) was approached with a proposal for a regional emergency control project. The CERF contributed nearly $2 million under a regional project (OSRO/RAF/909/CHA), which allowed for aerial survey and control operations to be quickly and effectively expanded.

The specific objective of the regional CERF project was to mitigate the chances of swarms leaving the outbreak areas by strengthening the response capacity of IRLCO-CSA and the national plant protection agencies in Tanzania, Malawi and Mozambique to effectively cope with developing Red Locust threats with special attention to the safeguard of human and environment health.

[1] Technical Cooperation Programme.

The project was organised and coordinated by the FAO Locust Group together with IRLCO-CSA in close collaboration with national authorities. In Tanzania, the Plant Health Services section of the MAFSC and the Tanzania National Parks Authority (TANAPA) were key implementing partners. The operation helped to mitigate a potentially massive Red Locust outbreak in the region.

In Tanzania, Locust control interventions focused mainly on three areas: the Ikuu-Katavi National Park, the Lake Rukwa plains and the Malagarasi River Basin. In consideration of protected and ecologically fragile areas, the campaign used the bio-pesticide Green Muscle® (*Metarhizium anisopliae* var. *acridum*) to treat 8,982 ha infested with immature adult locusts in Katisunga-Ikuu plains, one of the Red Locust breeding sites in the Ikuu-Katavi National Park. The campaign marked the first time that a biopesticide was used on a large scale against the Red Locusts.

The campaign in Tanzania was carried out in May-June 2009. An evaluation mission was organised by the FAO Office of Evaluation from 6th to 27th September 2009 with specific terms of reference to review this operation (section 3 of this report). The mission focussed on Tanzania because of the use of Green Muscle® there. It used a combination of tools and methodologies to gain an understanding on how the operation was conducted and what were its results, including a desk review of existing project documents and related research literature, interviews with project management, field staff and consultants, relevant officers in the IRLCO-CSA, Plant Health Services (PHS) and the Permanent Secretary (PS) of the Tanzanian MAFSC, management of the Ikuu-Katavi National Park, and communities living around the Park.

After these wide consultations, the evaluators conclude that:

- The CERF programme responded swiftly to the request for emergency funding from FAO/IRLCO-CSA;
- The situation was correctly assessed and the intervention well formulated;
- The project was timely; project implementation was efficient with procurement and logistics carefully planned;
- The project was well coordinated through a partnership between the regional agency IRLCO-CSA, its national counterparts (Ministries of Agriculture in affected countries) and Tanzania National Park authorities;
- This good collaboration between stakeholders at national, regional and international levels at all stages of the project was a key to the project success, but suffered a few exceptions when conflicting messages were sent through different reporting lines;

- The objective of the CERF project[2] was essentially achieved in that there were no swarm escapes from any of the potential outbreak areas; threats to national and regional food security were minimised, and an estimated 598,000 ha of food crops were protected in Tanzania alone;
- The capacity to deal with Red Locust outbreaks was strengthened at regional and national level;
- The project used a well-tailored combination of IPM tools to contain the Red Locust outbreak; it was demonstrated that Green Muscle® can be used for large scale management of Red Locust populations in ecologically sensitive breeding areas, and that immature adults (fledglings) can be targeted;
- The project addressed both the humanitarian and environmental dimensions of national and regional significance: the strategy was to manage the locust population so that they do not pose a humanitarian threat, and evidently not to eliminate all locusts;
- The residual population in Ikuu-Katavi after Green Muscle® treatments was still perceived as a risk by the MAFSC which insisted on additional spray of conventional pesticide in Ikuu. This last treatment appeared rational at the time but led to unfortunate consequences: chemical pesticides being used in the heart of the Ikuu-Katavi Park and a lingering doubt about the effectiveness of Green Muscle® among MAFSC staff.

The project also revealed areas for improvement which include:

- better communication and education regarding bio-pesticides at all levels;
- development of a more efficient Red Locust control strategy based on preventive measures focussed primarily on hopper bands;
- stronger involvement of the private partner – the supplier company – in all aspects regarding the bio-pesticide formulation and application;
- improvement of technical capacity of the implementing agency and its national counterparts (e.g. new spray and survey aircraft and gear for IRLCO-CSA);
- strengthening surveillance, monitoring and management of residual populations in potential outbreak areas by developing and integrating community-based monitoring and reporting;
- strengthening the financial capacity of the IRLCO-CSA and their national counterparts involved in Red Locust control; IRLCO-CSA member nations should make their annual contributions timely.

[2] "To mitigate the chances of warms escaping from the breeding sites by strengthening the response capacity of IRLCO-CSA and the national plant protection agencies in Tanzania, Malawi and Mozambique to effectively cope with developing red locust threats with special attention to safeguard of human and environment health ".

Since all the known Red Locust breeding sites are wetlands, they are ecologically important and in the view of the mission, Green Muscle® should be considered for use in all such areas for the management of the pest population in future. But despite the good results obtained in the Katisunga-Ikuu plains, there remain a number of knowledge gaps that have to be addressed before use of Green Muscle® can be scaled up to other Red Locust breeding sites in Tanzania. In particular, existing misunderstandings and misconceptions among stakeholders about how the Green Muscle® works and its effects on non-target organisms need to be addressed urgently. Education about use of Green Muscle® is required to facilitate and enhance understanding and wider use of the technology in other Red Locust outbreak areas. Furthermore, research on different formulations of the Green Muscle®, dosage rate in different ecological breeding sites, identification of bio-degradable or commercial spray oil for use with Green Muscle®, post-spraying behaviour of residual populations, auto-contamination effects through contact with sprayed individuals and use of helicopter fitted with ULV rotary atomizer to improve placement on target, should be further researched.

The capacity to avoid and/or minimize future swarming and escapes of Red Locust populations from the breeding sites will largely depend on establishing effective regular surveillance and monitoring of residual populations in potential outbreak areas. Given the limited capacity of IRLCO-CSA and that of the Plant Health Services (PHS) of the MAFSC, it is strongly suggested that IRLCO-CSA and PHS (1) invest in the development of community-based monitoring, reporting and early warning system; (2) adapt and integrate modern surveillance and early warning tools and technologies, e.g. remote sensing and modelling; (3) capacitate all agricultural extension workers based in villages around potential outbreak areas to effectively participate in monitoring, reporting and control of residual populations; and (4) review, update and map out current potential breeding sites, taking into consideration recent land use and climate changes. It is also strongly suggested that IRLCO-CSA acquire a new helicopter if the funding situation improves, that can be used for surveys and spraying to improve its capacity to deal with such emergencies. Additional recommendations to improve management of Red Locust populations in breeding sites are suggested in the body of the report.

1. Introduction

The Red Locust (*Nomadacris septemfasciata* Audinet-Serville, 1883) is a major plague species. The 1930-1944 plague invaded most countries in sub-Saharan Africa resulting in extensive damage to plants, crop loss, famine, and high control costs (COPR, 1982). During this major outbreak, South Africa lost about UK£ 20,000 in 1933-35 due to damage caused to grazing land for sheep and cattle, and crops (maize and cane), decreased livestock productivity due to arsenic poisoning for locust control estimated at UK£ 40,000 and cost of control measures estimated as UK£ 933,000. These estimates are patchy and exclusive of environmental costs that were not considered important at the time. In recent years, limited swarm escapes from Malagarasi plains in 2003 caused extensive damage in Burundi and Uganda (M. Kahyolo, personal communication). In July 2008, swarm escapes from Buzi-Gorongosa and Dimba plains (Mozambique) invaded Southern Malawi and NE Zimbabwe causing extensive damage to food crops and pastures (Spurgin and Chomba, 2009). These mobile swarms were contained through aerial spraying using conventional pesticides. However, there is limited information on the actual costs (loss of food security, environmental damage and control costs) involved during these later outbreaks.

The lessons learned during the 1930-44 plague were used to set up regional Red Locust population management strategies through the establishment of the International Red Locust Control Organization for Central and Southern Africa (IRLCO-CSA) in 1949. IRLCO-CSA is mandated to control Red Locust in its recognised outbreak areas in Central and Southern Africa. This role is achieved in collaboration with respective migratory pests' national staff in the member countries. The breeding grounds are surveyed twice a year for hoppers, fledglings and adult locusts and the results are used for making educated decisions on action to be undertaken.

During 2008, surveys of Red Locust populations in known breeding areas of Tanzania, Malawi and Mozambique by the IRLCO-CSA revealed a pre-occupying situation. IRLCO-CSA recommended to undertake extensive locust control operations in the Republic of Tanzania (Rukwa Valley Plains, Ikuu-Katavi Plains and Malagarasi Basin), Mozambique (Dimba Plains) and Malawi (Lake Chilwa Plain), and approached FAO with a request for financial support for conventional pesticides, airplane fuel and other treatment costs. IRLCO-CSA was cash-strapped due to inadequate member country annual contributions, as evidenced in Table 1.

FAO rapidly allocated US$942,000 from its regular funds in support of Red Locust survey and control operations in the three countries, through two successive TCP projects: TCP/RAF/3118(E), covering Tanzania and Malawi, and TCP/MOZ/3203(E), covering Mozambique only.

Table 1 IRLCO-CSA statement of arrears of contributions as at 31/12/2008

Country	Contribution in Arrears as at 01/01/2008 US $	Add Contribution For 2008 US $	Total Contribution Due for 2008 US $	Less Receipts in 2008 US $	Contribution Outstanding as at 31/12/2008 US $
Kenya	-	130 328	130 328	121 711	8 617
Malawi	1 393 382	126 991	1 520 373	388 601	1 131 772
Mozambique	-	126 991	126 991	126 991	-
Tanzania	1 478 456	160 355	1 638 811	373 053	1 265 758
Uganda	1 838 017	-	1 838 017	-	1 838 017
Zambia – Normal Special Total	- - 	166 716 40 000 206 716	206 716	201 399	5 317
Zimbabwe	2 443 081	130 328	2 573 409	-	2 573 409
TOTAL	7 152 936	881 709	8 034 645	1 211 755	6 822 890

(Source: IRLCO-CSA, 2009)

The two TCP projects started in October 2008 and come to an end by December 2009. They supported targeted control operations in the three countries, including one in which Green Muscle®, a biopesticide based on the spores of the fungus *Metarhizium anisopliae* var. *acridum*[3]. Since all of the Red Locust breeding sites are ecologically fragile wetlands (Malagarasi, Wembere, Kafue and Rukwa plains), and some of them are protected areas (Ikuu-Katavi), it was deemed essential that any control strategies and options used should consider reduction of potential environmental damages. Green Muscle® was used in the ecologically-sensitive Ikuu plains of Tanzania. In January 2009, about 2 000 ha were treated with Green Muscle® and additional 420ha were sprayed with conventional synthetic pesticides in Ikuu-Katavi.

The TCP projects also funded further surveys of Red Locust populations in the three countries. In Tanzania, these surveys conducted by IRLCO-CSA and the Tanzanian MAFSC estimated that up to 15,000 ha in the Ikuu-Katavi National Park were infested with widespread populations of banding nymphs at a density of 25-100 hoppers/m^2, as well as 10,000 ha in Rukwa plains and 15,000 ha in Malagarasi. It became clear that successful breeding had occurred in these areas during November-December 2008 and that the resources available through the TCPs were insufficient to effectively control the situation. Conditions seemed ripe for a major outbreak. Nymphs fledging in March/April would have formed swarms that could escape in July/August and damage food crops and pasture not only in villages adjacent to the breeding sites but also neighbouring countries of Kenya, Rwanda, Uganda, Burundi, Malawi, Mozambique, Zimbabwe

[3] LUBILOSA strain, IMI 330189 isolate.

and DRC. During the same period, swarm escapes were also predicted in Mozambique and Malawi where large nymph populations were spotted.

The combined potential outbreaks posed a food security threat to the whole of the Eastern, Central and Southern Africa, a region that was already suffering from food shortage due to prolonged drought resulting in poor harvest and loss of pasture, coupled with the disturbance to agriculture brought by political instability in a number of countries (Zimbabwe, DRC, Burundi). In Tanzania, people in certain areas were already surviving on relief food supplies.

The MAFSC was very concerned about possible crop losses in the Southwest, considered the bread basket of the country. Food crop production forecast survey for 2009/10 based on 2008/09 production figures in Tanzania indicated that the country would be marginally self-sufficient in food. There is evidence from the surveys that only 35% of all districts will generate a food surplus in 2009/10 while the rest of the country will be deficient (MAFSC, June 2009). Therefore at the time, the food security situation in Tanzania was already of big concern even without potential damage by escaping adult locust swarms.

To deal with this threat, Tanzania, Mozambique and Malawi, the immediately affected countries, launched an emergency appeal to FAO for assistance. The UN's Central Emergency Response Fund (CERF) was approached with a proposal for a regional emergency control project. The CERF contributed nearly $2 million under a regional project coded OSRO/RAF/909/CHA in the FAO nomenclature, which allowed for aerial survey and control operations to be quickly and effectively expanded.

2. Evaluation Methodology

The CERF-funded locust control campaign in Tanzania was carried out in May-June 2009. As part of a wider evaluation of CERF-funded projects implemented by FAO, an evaluation mission was organised by the FAO Office of Evaluation from 6th to 27th September 2009 with specific terms of reference to review this operation (section 3 of this report). The mission focussed on Tanzania because of the use of Green Muscle® there, which opened the door to further use of Green Muscle® against Red Locusts but raised a number of important policy and operational issues.

The evaluation used a combination of tools and methodologies to gain an understanding on how the operation was conducted and what were its results, including a desk review of existing project documents and related research literature, interviews with project management, field staff and consultants, relevant officers in the IRLCO-CSA, Plant Health Services (PHS) and the Permanent Secretary (PS) of the Tanzanian MAFSC, management of the Ikuu-Katavi National Park, and communities living around the Park. The TANAPA HQ as well as international and national project consultants were reached through telephone interviews.

A visit to the IRLCO-CSA headquarters in Ndola, Zambia, provided the team with the opportunity to interact and interview key experts directly involved in the CERF project and to assess the facilities and equipment available for field operations. A wrap-up debriefing meeting was used as the platform to confirm and get team contribution to our findings.

A field visit to Ikuu-Katavi National Park was organised to collect ground information on how the May-July Red Locust campaign was implemented and to get an overview of existing networking between the Park, communities and IRLCO-CSA in the context of Red Locust outbreak control and surveillance in the breeding sites in the Katisunga, Ikuu plains. The Katavi National Park Chief Warden, the park Ecologist and park rangers were interviewed. Focused group discussions with communities (herdsmen, fishermen, beekeepers, crop producers) living in the environs of the Ikuu park were organised and conducted. Due to time constraint, only two villages (Kibaoni and Sitalike) were visited. In Kibaoni village, a total of 16 villagers (2 women) participated; whereas in Sitalike 15 villagers (2 women) participated.

The Mpanda District Agriculture and Livestock Development Officer (DALDO-Mpanda) and the IRLCO-CSA field Officer of the Tabora base were also interviewed. The team visited the IRLCO-CSA Tabora base to assess available IRLCO-CSA facilities for field operations.

At the end of the evaluation mission, a wrap-up stakeholders debriefing meeting was organised in collaboration with the PS-MAFSC to share the mission findings. This meeting brought together IRLCO-CSA, MAFSC, FAO-Tanzania, PBEE and the evaluation team.

The evaluation encountered two main difficulties:

- Time allocated for field visit to the Ikuu-Katavi National Park was inadequate. Given the distance (over 350km Tabora-Mpanda) and the condition of the Tabora-Mpanda road, it would have been cost-effective and more efficient to fly to Mpanda and then travel from Mpanda to Katavi National Park by road. The team required a minimum of two full working days to reach communities around Ikuu and Katavi parks and one day to survey the sprayed areas in Katavi National Park.

- It was not possible to meet and get first-hand information from other key personnel based outside Dar-es-Salaam because of logistics. Well planned, the review team could have travelled to Arusha for interviews with TANAPA and Tropical Pesticides Research Institute (TPRI). The team managed to get a 10-minutes telephone interview with TANAPA but it was impossible to do the same with TPRI staff.

3. Project Objectives and Design

3.1 Project design process

FAO and OCHA reacted promptly to the IRLCO-CSA request for emergency funding; first with the two FAO TCP projects, followed by the CERF project in response to the joint IRLCO-CSA/Tanzania/Malawi/Mozambique request. A first proposal for CERF emergency funding was formulated in February 2009 by IRLCO-CSA with financial support of TCP/RAF/3118(E). The request sent to FAO by IRLCO-CSA was fine-tuned and submitted for approval to the three Humanitarian Coordinators (HC) in Malawi, Mozambique and Tanzania in early March 2009. The last HC signature was obtained on 8 April.

The request was for a regional project. Even if it includes the possibility of regional projects, the CERF allotment mechanism appears primarily focussed at the country level, with the whole design and approval process supposed to happen at that level under the authority of the HC. At some point in the approval process the CERF Secretariat asked for a detailed breakdown of the budget per country and FAO provided what they understood to be cost estimates per country. On 20 April, three country-specific Letters of Understanding (LoU) were sent to FAO, one for each country with a specific budget. FAO argued that the resources had to be flexibly allocated among the three countries to address an evolving and mobile threat, and received finally one regional LoU at the end of April 2009. Funds were immediately released by the CERF secretariat in OCHA and field operations started in early May 2009.

3.2 Overview of the project as designed

The **main** objective of the project was to preserve food security and livelihoods of rural populations and to mitigate further damage to the already fragile agricultural production in the region.

The **specific** objective of the project was to mitigate the chances of swarms leaving the outbreak areas by strengthening the response capacity of IRLCO-CSA and the national plant protection agencies in Tanzania, Malawi and Mozambique to effectively cope with developing Red Locust threats with special attention to the safeguard of human and environment health.

In order to achieve the above specific objective, the following **outputs** were expected to be achieved within the framework of the project:

- Survey and control capacities of IRLCO-CSA and affected countries strengthened through the provision of adequate human, financial and physical resources.
- Sound management of chemical pesticide achieved,

- The Government agencies, the donor community and FAO regularly and comprehensively informed of the implementation of the project and the locust situation.

3.3 Planned achievements at the end of the project

- Damage to agricultural production and the livelihood of the rural population prevented,
- The logistical support by the national plant protection services to the locust operations (transport of food, water, pesticides, fuel, camping equipment, etc. is defined and agreed between IRLCO-CSA and the sector ministries of agriculture by early May 2009),
- Seasonal camps in the target areas are established and fully operational by mid May 2009,
- Staff from sector ministries of agriculture seconded to the operations by mid May 2009,
- The size of the infested area is defined and mapped by mid May 2009,
- One turbine spray aircraft hired, received clearance from civil aviation and is operational at the IRLCO-CSA base in Tabora, Tanzania by mid May 2009 latest,
- One international expert on aerial control operation hired for up to three months and received the necessary clearance to operate in the target areas by early May 2009,
- One international consultant on pesticide management recruited for 1.5months to work in the target areas by mid May 2009,
- At least 10,000L of chemical pesticides certified in accordance with internal standards made available from remaining stocks in Mali and delivered to the IRLCO-CSA base in Tabora, Tanzania by mid May 2009 latest,
- At least 800kg of spores of bio-pesticide purchased and delivered by mid May 2009 to IRLCO-CSA HQ in Ndola, Zambia latest and is being applied in ecologically sensitive areas in Tanzania, Malawi and Mozambique as required,
- Vehicles hired, and various survey, spray, communication and camping equipment purchased and available at the site by early May 2009.

3.4 Budget

The total budget was US$ 2,945,209; CERF contributed US$ 1,873,824; Tanzania component was US$ 781,962.

3.5 Implementation arrangements

The project was organised and coordinated by the FAO Locust Group in AGP and its Emergency Division, TCE, together with IRLCO-CSA and in close collaboration with national authorities. In Tanzania, the plant protection agencies of the MAFSC and the Tanzania National Parks Authority (TANAPA) were key

implementing partners. The operation helped to mitigate a potentially massive Red Locust outbreak in the region.

IRLCO-CSA was the overall coordinator of the Red Locust campaign with support from FAO HQ, the FAO Representations in the three countries as well as the FAO international campaign team leader. The IRLCO-CSA in collaboration with the Ministries of Agriculture of Tanzania, Malawi and Mozambique were the implementing partners.

3.6 Project Priorities and Relevance

From its review of project formulation, the Evaluation Team concluded that the need to contain or prevent a likely locust outbreak and swarm escapes from the breeding sites was correctly assessed.

The project was relevant in that it aimed to reduce risks to community livelihoods in the immediate outbreak areas and beyond. The threat emerged at a time when there was already a looming famine due to prevailing prolonged drought that resulted in poor food harvest and inadequate pasture for livestock in many areas of the region. Furthermore, and based on the experience of managing the swarm escapes from Malagarasi plains in 2003 which subsequently invaded Burundi and Uganda, and, similarly, from the Buzi-Gorongosa and Dimba plains in Mozambique which invaded southern Malawi and NE Zimbabwe in July 2008, the situation in February 2009 appeared more threatening compared to previous outbreaks as it was more extensive (covering 3 of the known 4 major breeding sites in Tanzania and including Malawi and Mozambique).

The project was also well-targeted geographically. Based on locust population surveys, the action targeted in priority the outbreak areas in Rukwa, Malagarasi, and Ikuu-Katavi plains in Tanzania, before moving on to Mozambique and Malawi. Tanzania harbours 50% (four out of eight) of the potential Red Locust outbreak areas in Central and Southern Africa. The size of the population in three of the breeding sites during the emergency period was alarmingly high and could have resulted in swarm escapes if not contained.

Finally, the intervention was well formulated because:

- The humanitarian, food security and the environmental dimensions of the problem were considered through a combination of IPM[4] options and tools (survey of breeding sites to verify Red Locust populations and stage of development to be able to make local-specific decisions, use of conventional synthetic pesticides and bio-pesticides).
- The need for regular and comprehensive information sharing between Government agencies, IRLCO-CSA and FAO on the implementation of the project and the locust situation was correctly emphasised. It was implemented through a centralized coordination and decision-making group composed of

[4] Integrated Pest Management.

experts from all stakeholders, positioned in the field and linked to decision makers in Dar-es-Salaam, Ndola and Rome.

- The regional dimensions of the problem and implementation strategies were considered. The project worked through IRLCO-CSA, the mandated regional body for Red Locust control as the main coordination agency. The CERF project included components for Tanzania, Malawi and Mozambique, the three countries with potentially large Red Locust populations that could result in swarm escapes, and resources (two planes, a helicopter, and pesticides) could be transferred from one country to the next so as to flexibly respond to what is in essence a trans-boundary threat.
- The importance of a good integration between regional, international and national experts and decision makers was well foreseen and subsequently achieved during implementation.
- Safe management of chemical pesticides was included in project design as an explicit activity.

The project was also relevant vis-à-vis the CERF criteria (time-critical and life saving criteria). This was not the first time CERF resources were released for disaster prevention, as opposed to disaster relief. For instance, and to limit the review to preventive locust control operations, previous CERF support has been received for similar locust emergencies in Timor Leste, Yemen and Tajikistan. From the Red Locust case study, it would appear that these sorts of circumstances constitute a proper environment for FAO to use CERF funding, because of the time-critical element of preventive locust control as well as the dire humanitarian consequences of locust outbreaks plagues.

4. Project Implementation, Efficiency and Management

4.1 Overview of project implementation

The project was implemented from 1st of May to 31st of July 2009. Procurement and delivery of inputs were completed during this period. One international consultant (Red Locust control operations expert and team leader) and two national consultants (one Red Locust expert and one pesticide expert, operations expert) were identified and recruited within two weeks after project was approved through the FAO Representations in the three recipient countries.

FAO and the World Food Programme (WFP) organized the airlift of conventional pesticides in a so-called “pesticide triangulation” exercise on 21 May 2009[5].

[5] The FAO-sponsored triangulation strategy aims to manage stockpiles of pesticides available for control of various locust pest species in Africa. National pesticide stocks are constantly monitored and those stocks which approach their nominal expiry date regularly tested. If found within specifications, such stocks are shipped to countries urgently needing them for the prevention or control of a locust outbreak, so as to be used before becoming obsolete.

Twenty thousand litres of Sumicombi 50 ULV[6] were donated by Mali and airlifted by WFP at short notice from Bamako to Tanzania and Zambia (10,000l to each country), at a cost of US $83,495. In Tanzania, the product was used to treat around 4,500 ha in the Rukwa and Malagarasi regions.

In Tanzania, the control campaigns focused on three areas: the Ikuu-Katavi National Park, the Lake Rukwa plains and the Malagarasi River Basin. In the Ikuu plains and in order to protect large wild animals (elephants, hippos, and giraffes), birds, fish and other rare species in the wetlands of the Iku-Katavi National Park, the campaign used primarily the bio-pesticide Green Muscle® (*Metarhizium anisopliae* var. *acridum*, (see Text Box). A total of 220 flying hours were used to survey (145 hrs), spray (75) and monitor the locust populations. Twenty thousand ha were found infested with immature adults. However, only 8,982ha had population densities above the action threshold i.e. more that 10 locusts/m^2. This entire area was sprayed with Green Muscle®. The population density in the remaining areas (about 11,000ha) was below the treatment threshold and therefore not sprayed at all. One should note that the Katavi plains were sprayed with conventional pesticides, even though they are part of the Park as part of the implementation plan. This being the first large scale application of Green Muscle®, there was a lot of learning by IRLCO-CSA and MAFSC regarding (1) method of application to optimise mortality (2) logistics required for control operations of this magnitude, and (3) development of an efficient pre-spray mixing technique that could be used in large scale aerial spraying (Spurgin and Chomba, 2009). Similarly, the Lake Rukwa plains and the Malagarasi River Basin plains were sprayed with chemical pesticides (Sumicombi from Mali and Fenitrothion provided by the MAFSC).

Green Muscle® efficacy was assessed using a standard method for bio-pesticides that used locusts collected from treated areas and placed in cages at the Mpanda airport. Based on this methodology, it was established that Green Muscle® caused a minimum of 60-70% mortality of the locusts five weeks post-treatment. IRLCO-CSA and the MAFSC also undertook field surveys of the residual locust population using the IRLCO-CSA helicopter (most breeding areas being flooded at this period, surveys are almost impossible to conduct using ground vehicles). These surveys evidenced that the locust population was still of fairly high density in the Ikuu plains. This apparent contradiction between cage results and field observations is analysed further in the next section.

[6] A commercial mixture of two conventional pesticides: the synthetic pyrethroid Esfenvalerate and the organophosphate Fenitrothion. This product was originally supplied by FAO for the 2004 Desert Locust control campaign in West Africa.

What is Green Muscle® and how does it work?

Green Muscle® is a bio-pesticide based on the fungus *Metarhizium anisopliae* var. *acridum*. strain IMI 330189 isolated from the grasshopper *Ornithacris cavroisi* in Niger by the FAO LUBILOSA (Biological Control of Locusts and Grasshoppers) project. Contrary to conventional chemical pesticides, the fungus is effective only against locusts and grasshoppers (FAO, 2009). It acts relatively slowly, killing locusts over a period of 1-3 weeks depending on prevailing climatic and other factors. The fungus spores germinate when they come into contact with the locust cuticle, invading the insect body, producing toxins, multiplying in the locust body (sporulation) and eventually killing the locust. Once locusts get in contact with the Green Muscle® they become sluggish, move and feed much less than healthy ones, making them easy prey for birds, reptiles etc. This is why cadavers are difficult to find after the use of Green Muscle under field conditions. The speed at which the fungus spreads through a locust is primarily determined by temperature: infected locusts tend to sun themselves and in so doing raise their body temperature to slow spread (much as fever does in humans). As a result, a level of infestation that might kill a locust in 5 days under laboratory conditions can take up to 10 days or more in the field. Spores exposed to sunlight are killed within hours but those in shaded or hidden in plants can survive for several weeks and continue to affect individuals that have escaped direct contact at spraying time. This may reduce the need for re-spraying. Green Muscle® is safe compared to chemical pesticides and can be used in wetlands and near water courses. Therefore and unlike conventional pesticides, surplus quantities of Green Muscle® do not represent a risk to human and environment health.

While the field-based team of experts considered that this residual population after Green Muscle® treatments in Ikuu was innocuous, it was perceived by the MAFSC as a significant risk. The MAFSC insisted on a “mop-out” spray using conventional pesticide. The team agreed and spot-sprayed 2,000ha in the Ikuu plains with Sumicombi.

4.2 Efficiency and timeliness

4.2.1 Input supply

Tenders were pre-launched and evaluated by mid April 2009. As soon as the project proposal was approved, purchase orders were issued. The operation team was swiftly formed and on the ground by mid May 2009. Procurement of the leased aircraft and the pesticides were organised and delivered quickly. Equipment and material listed in the project budget were shipped to Lusaka, and collected by IRLCO-CSA (whose HQ is in Ndola, Zambia) through the FAO Representation in the country.

It was noted that Green Muscle® was delivered in four lots (lot 1 was received on 20th May 2009, lot 2 on 4th June 2009, lot 3 on 17th July 2009 and lot 4 in September 2009). Given the nature of the operations, only 500kg (lot 1 [300kg],

lot 2 [200kg]) were available for application in Ikuu plains before the end of the spray schedule. The product was enough to treat the 8,982 ha at the recommended rate of 50g/ha. The 3rd lot delivered after mid July arrived too late to be used during the emergency operations in Tanzania. This said, the bio-pesticide had never been meant for Tanzania only but for Mozambique and Malawi in case those countries would require it.

In Ikuu, the Green Muscle® was sprayed over the following dates:

- 1st target area 23-28 May (11 spray sorties)
- 2nd target 8 June (2 sorties)
- 3rd target 11&12 June (2 sorties)
- 4th target 13 &14 June (2 sorties)

The spray interval between 1st and 2nd spray was thus 9 days. This was due to delays in delivery of the consignment from BCP-SA (mentioned above). During this period, the team sprayed the Malagarasi and Rukwa plains with conventional pesticides, so the time was not lost.

The small company producing Green Muscle®, BCP, was under a lot of stress to produce such quantities and could not spare an engineer to provide "after supply support" in the field, analyse and solve mixing problems, etc. However, according to FAO AGP, BCP took on all observations immediately into account to make the product more user-friendly.

Prior to use, the Green Muscle® formulation had to be mixed with diesel. Mixing was time and labour-consuming, even though the provided formulation (dry spores without solvent) was easier to mix with diesel than all earlier formulations. After one day of experimentation, the local loading team managed the process. Sedimentation of the prepared mixture was also much less as compared to earlier formulations. However, as evidenced by field team members, small amounts of spores were lost during the mixing process due to high winds because (ca. 80 % of the 2nd batch) of the packs were not vacuum-sealed (this “loss” was a perception only, the amount of spore material lost by wind action was probably minute and physical measures – moist cloth over the mixing buckets to catch “dust” were put in place to try and minimise this loss. According to FAO, BCP corrected the mistake: vacuum-sealed packs supplied later posed no problems.

Initially the Green Muscle® formulation tended to clog the standard fine mesh filter in the spray equipment. This fortunately did not cause delays in spraying operations since the spray aircraft continued to work without a filter until the aircraft engineer constructed a makeshift filter with locally-available material. The correct filters were quickly supplied by the company and the rest of the Green Muscle® application was relatively trouble free.

The synthetic pesticides were delivered timely by WFP and relocated to holding stores in the operation areas timely by IRLCO-CSA. It was reported that one of the containers was not labelled and that it exploded during handling causing some damage to spray equipment.

As of the dates of the evaluation, there were still 2,000L of pesticide donated by Mali unused in Tanzania whose expiry date is November 2009. The stock should be tested and if it is found to be within FAO specification, then it can be used in Tanzania or any other country next year. If it cannot be used, then it should be properly disposed of through the Africa Stockpile Programme (ASP).

4.2.2 Spray timing relative to locust developmental stages

The issue of timeliness of anti-locust control operations is crucial for their success. There are two windows of opportunity to control the Red Locust: one at nymphal stage in January-February, another at adult stage in June-July. The first window implies higher costs (weather can be rainy thus interrupting treatments, locusts are less concentrated hence larger areas to be surveyed and treated) but lower risks since at that stage the locusts are not yet ready to swarm. This option is more consistent with preventive control. The second window is more risky (the swarms may take off at any moment and any technical problem e.g. aircraft failure can be disastrous) but implies lower costs because the locusts are more concentrated and often flying near the ground and hence the areas to survey and treat are smaller and placement on target better. Therefore, the operations in May- early June 2009 were out of the ideal window.

Ideally, an efficient Red Locust control strategy should include both windows: the hopper band treatment can be done in January-February while the treatment of adults forming swarms can be done in June-July. The first window is perfect for Green Muscle® (there is ample time for the product to take effect, spaying large areas implies no ecological problem with Green Muscle® but would be an issue with synthetic pesticides). One can still make use of Green Muscle® at the beginning of the second window in June-July, but as the time for swarming and escapes comes nearer, synthetic pesticides may be preferred because they kill the locust faster and more effectively.

All the consulted experts at international and national levels, including IRLCO-CSA and the MAFSC specialists, concurred that the optimum timing for the locust control using Green Muscle® would have been at the nymphal stage (January-February) rather than at the adult stage. Nymphal stage treatments were initiated with the TCP projects in February 2009 but had to stop before the problem could be successfully tackled because of insufficient funds (only 2,000ha were treated in Ikuu with Green Muscle®).

However, the nymphal stage was not an option for the CERF project, because it came into operation at the fledging stage (adult emergence). There were two conflicting opinions regarding optimum spray timing at that time:

- According to the FAO Locust Group, the international and national Red Locust experts including IRLCO-CSA, the spray operation could have been more efficient (achieved higher mortality rates) if spraying started one month later and targeted swarming immature adults. Existing environmental conditions (prevailing weather, high dense vegetation in identified concentration sites, and behaviour of the fledglings) were considered unfavourable. This justified the need to delay spraying until the grass dries up, thus increasing visibility of locust populations and optimizing spray placement on target.
- According to MAFSC experts, the imminent threat of swarm escapes forced immediate control action to avoid exacerbation of regional humanitarian catastrophe already caused by prevailing prolonged drought.

The point of view of the MAFSC prevailed and the treatments started towards the end of May, i.e. as soon as feasible. The same applied to the final “mop-out” spray using conventional pesticides in Ikuu which was requested by the MAFSC. To sum up, in the evaluated project, the timing of control was dictated more by humanitarian and political reasons (imminent risk of humanitarian disaster on a regional scale) rather than technical reasons (locust behaviour and ecology). Another way to say this is that national stakeholders considered more important to deal with the threat to food security, whatever the means, than to apply the most cost-effective and environmentally-friendly techniques.

In the end, the main goal of preventing swarm escapes was achieved, and this is probably what matters most.

4.3 Partnerships and Coordination

It was noted that the success of the project depended on good collaboration between public and private partnerships:

- The IRLCO-CSA and the migratory pest unit of the MAFSC participated fully in the formulation and implementation of the CERF project. The MAFSC seconded three scientists (two from PHS and one from TPRI) and several vehicles to the project during the operations.
- TANAPA and the Ikuu-Katavi National Park management spotted and warned IRLCO-CSA of unusually large fledgling swarms around the Katisunga plains, which prompted IRLCO-CSA to mobilize resources that culminated in the emergency operations in Ikuu. The Park management also facilitated entry to the park during population survey, spraying and post-spray monitoring of residual populations, and released one park ranger to participate in the 5-day training course on use of Green Muscle® conducted at Mpanda under the

TCP projects. Park rangers regularly participate in ground surveys and monitoring of the Red Locust breeding sites.

- Regional significance was emphasized in the request to CERF through the FAO Locust Group. Tanzania, Mozambique and Malawi components were clearly articulated in the request. IRLCO-CSA was the regional coordinator and implementer of the campaign in accordance to its regional mandate.
- Effective international collaboration was essential. The FAO Locust Group responded positively and promptly to national requests, developing and forwarding the request to CERF and also committed almost US$ 1M from FAO's own resources, recruiting one international and two national Red Locust experts for advice and technical support to the regional and national teams, and mobilising airlifting of additional pesticides for locust control from Mali with assistance of WFP. The CERF Secretariat also responded positively and promptly.
- Involvement of private sector: the Biological Control Products (BCP)-SA supplied the Green Muscle®; Bell-South Africa carried out repairs and upgrading of the spraying and survey equipments (aircraft and helicopter).

Generally these partnerships worked quite satisfactorily. However, it is noted that:

- Communication on operation progress could have been better coordinated to ensure transparency and collective ownership of the results. The MAFSC tended at times to rely upon parallel channels of information (not necessarily well qualified and informed) rather than trust the information emanating from the project coordination team. It is understandable for a government to keep its own channels of communication open, but it also indicates a lack of trust in FAO and IRLCO-CSA. This is problematic, since the very same government asked FAO and IRLCO-CSA to step in and help control the outbreak.
- Inadequate information sharing and education about Green Muscle® and its use became flagrant in the process of the evaluation. Education and raising awareness about use of Green Muscle® and expected results should have been enhanced at all levels. There are still wide misconceptions, misunderstandings and unrealistic expectations about Green Muscle® and how it works which contributed to differing views on the results obtained in Ikuu during the CERF project. This is despite the fact that Green Muscle® has been tried several times in some of the Red Locust breeding sites within Tanzania, particularly Ikuu-Katavi (see Text Box).
- The additional treatment with conventional pesticides in Ikuu strained the so-far good collaboration between stakeholders at national, regional and international levels. Conflicting messages were sent through different channels, the MAFSC apparently giving priority to effectiveness in controlling a perceived risk to food security while FAO and IRLCO-CSA placing greater importance on the ecological dimension of the problem and on proving that Green Muscle® was an effective alternative to synthetic pesticides. As explained above, the project addressed both the food security and the

ecological dimensions of the problem, and this was one occasion when the two dimensions were perceived as conflicting.

Previous use of Green Muscle® in Tanzania

- In 2003, 165kg of Green Muscle® were applied on 3,500ha in Wembere plains using Jet-A1 as the solvent. This was the first trial to use Green Muscle® for Red Locust control in Tanzania. The results were poor (<30% nymph mortality) mainly because Jet-A1 was not an ideal solvent (Spurgin 2003).
- In September 2003, about 2,600ha in Katisunga-Ikuu plains were sprayed with 100kg of Green Muscle® using diesel as the solvent. The results were very encouraging. In short grass, 75% adult mortality was achieved compared to 50% in tall grass (Spurgin., 2003). This justified further large-scale evaluation of different rates of Green Muscle® in Ikuu in which the 25 g/ha rate caused 70% mortality 4 weeks post-treatment (Kooyman et al., 2003).
- During January 2009, about 2000ha in Katisunga-Ikuu plains were sprayed with Green Muscle® but the operations were curtailed due to lack of resources (Kooyman, 2009).

4.4 Involvement of communities and district-level extensionists

Based on limited discussions with communities in two villages surrounding the Ikuu Park, the evaluation team concluded that the communities in the environs of the park had not been adequately informed about Red Locust spray campaigns. They saw planes and helicopters flying over the park but did not know what was happening. Kibaoni village was given a Red Locust poster produced by IRLCO-CSA (seen pinned on the village notice board) but no explanations or additional information were provided, at least to the 16 persons met by the evaluation mission. Sitalike village had no information about activities pertaining to Red Locust control at all despite its proximity to the park. This lack of information is a serious issue because it could generate mistrust between the park authorities and the surrounding communities.

Community members were keen to learn about Red Locust control strategies and to participate in monitoring and reporting. For this to be realised, there is a need for resources for education and infrastructure to facilitate proper stakeholder reporting and feedback mechanism.

In both villages, people under 30 yrs of age have not witnessed Red Locust swarms, had very little knowledge about Red Locusts and their potential threats to food production and pasture. They said it was the first time for them to hear about Red Locusts and that they breed in Katisunga plains, an indication that IRLCO-CSA has done commendable management of the Red Locust populations in the nearby breeding grounds. Yet at the same time, this is an indication of insufficient community education by MAFSC on this important potential food security threat.

At district level, there is also a need to strengthen capacity and knowledge on Green Muscle® use for Red Locust control. It is important to note that, like the villagers, most agricultural extension workers have no experience of Red Locust swarm escapes and associated threats.

5. Project Results and Effectiveness

5.1 Overview of project results

The key achievements and their associated impacts are summarised in table 2.

Table 2: Summary of project results

RESULTS	IMPACTS
• No Red Locust swarm escapes from permanent breeding areas	• Threat to national and regional food security and environment minimised. In Tanzania an estimated 598 000 ha of food crops were saved (IRLCO-CSA, 2009).
• IRLCO-CSA & national teams given additional hands-on training on how to use Green Muscle®; the spray and survey equipments were repaired and upgraded, additional spray gear (motorised sprayers, PPE, laptops, digital cameras, GPS) were provided to national Red Locust control programmes	• Capacity to deal with potential large Red locust outbreaks at regional and national level strengthened.
• 1st large scale field use of Green Muscle® for the management of Red Locust populations in wetlands/ecologically important and protected areas implemented	• Potential outbreak contained at relatively low environmental costs. 8 982 ha in Ikuu successfully treated with Green Muscle® and swarm escapes contained • Results of international recognition • Skills and ability of solving problems associated with large scale use of Green Muscle® in locust control improved.
• Experiential learning on the management of potential Red Locust outbreaks using a combination of IPM tools and strategies by FAO, IRLCO-CSA and national counterparts	• Lessons learned useful at national, regional and international level.
• The CERF disaster prevention initiative of international scope	• Humanitarian and environmental risks reduced at national, regional and international level. • National, regional and international partnerships and collaboration enhanced • A total of 20,999ha infested with large

	swarms were treated with conventional synthetic pesticides in addition to 8,982ha sprayed with Green Muscle®, this preventing swarm escapes from the breeding sites

One scheduled activity could not be completed: an analysis of pesticide residues in Red Locust sprayed areas in Tanzania was budgeted and procurement initiated through a tender but the offers were found too expensive. The College of Engineering and Technology of the University of Dar-es-Salaam (CPE – UDSM) was selected as the best offer. However, since its bid was worth US$ 84,000 which is over and above the Tanzania FAO-R procurement delegated authority; the LoA for this assignment was to be done at FAO HQ level. The delays in processing this LoA at HQ led to the idea being dropped, since the samples had to be taken immediately after spraying.

5.2 Efficacy of Green Muscle®

The efficacy of Green Muscle® was assessed using a standard method for bio-pesticides that used locusts collected from treated areas and placed in cages at the Mpanda airport. Based on this methodology, it was established that Green Muscle® caused a minimum of 60-70% mortality of the locusts five weeks post-treatment. The results after 35 days give on average of 70% overall mortality for all sprayed blocks and 63.5% of collected locust showing fungus sporulation (a definitive proof of death due to Green Muscle®).

The results are not easy to extrapolate to field conditions. Experiences from other countries indicate that Green Muscle®-infected locusts (nymphs and adults) become sluggish and weak and more prone to attacks by predators and parasitoids, which contribute to overall treatment efficacy in the field. At the same time, their cadavers are quickly utilized by scavengers hampering direct efficacy assessments. The cage observations with locusts collected from the Green Muscle®-treated areas in Ikuu also provided evidence of infected locust "sporulating", i.e. becoming infectious and leading to continued infection build-up in the population and subsequent locust mortalities. These side effects of Green Muscle® on increased natural predation and self-infection are important for the bio-pesticide overall efficacy, but they are notoriously difficult to measure. On the other hand, locusts in their natural habitat might have more ways to fight the disease than those placed in cages (i.e. inducing an artificial fever by basking in the sun for long hours).

These considerations could not be proven through follow-up field observations because of the inaccessibility of the areas by ground teams, shortage of staff and high helicopter costs. Post-spray evaluation was conducted on the 24th June (11 days after the last spray and only 17 days after the 2nd spray), and four weeks after the first effective spray. No other field evaluations were conducted after the 24th June observations because of the needed and overdue shift of the

operations to Mozambique and Malawi. In effect, the team had to base their conclusions upon incomplete information about the effectiveness of the treatment operations, as is often the case in emergency operations.

The fact that the 24th June 2009 field surveys evidenced that the residual locust population was still of fairly high density in the Ikuu plains is partly due to the natural tendency of locust to congregate at this period of the year, and also partly due to the effect of bush fires which also occur at this period of the year. The combination of these two factors forces locust populations to concentrate in non-burnt areas. Parts of the area treated with Green Muscle® were re-infested from neighbouring areas because these surrounding areas were burnt by park rangers as a routine range management practice.

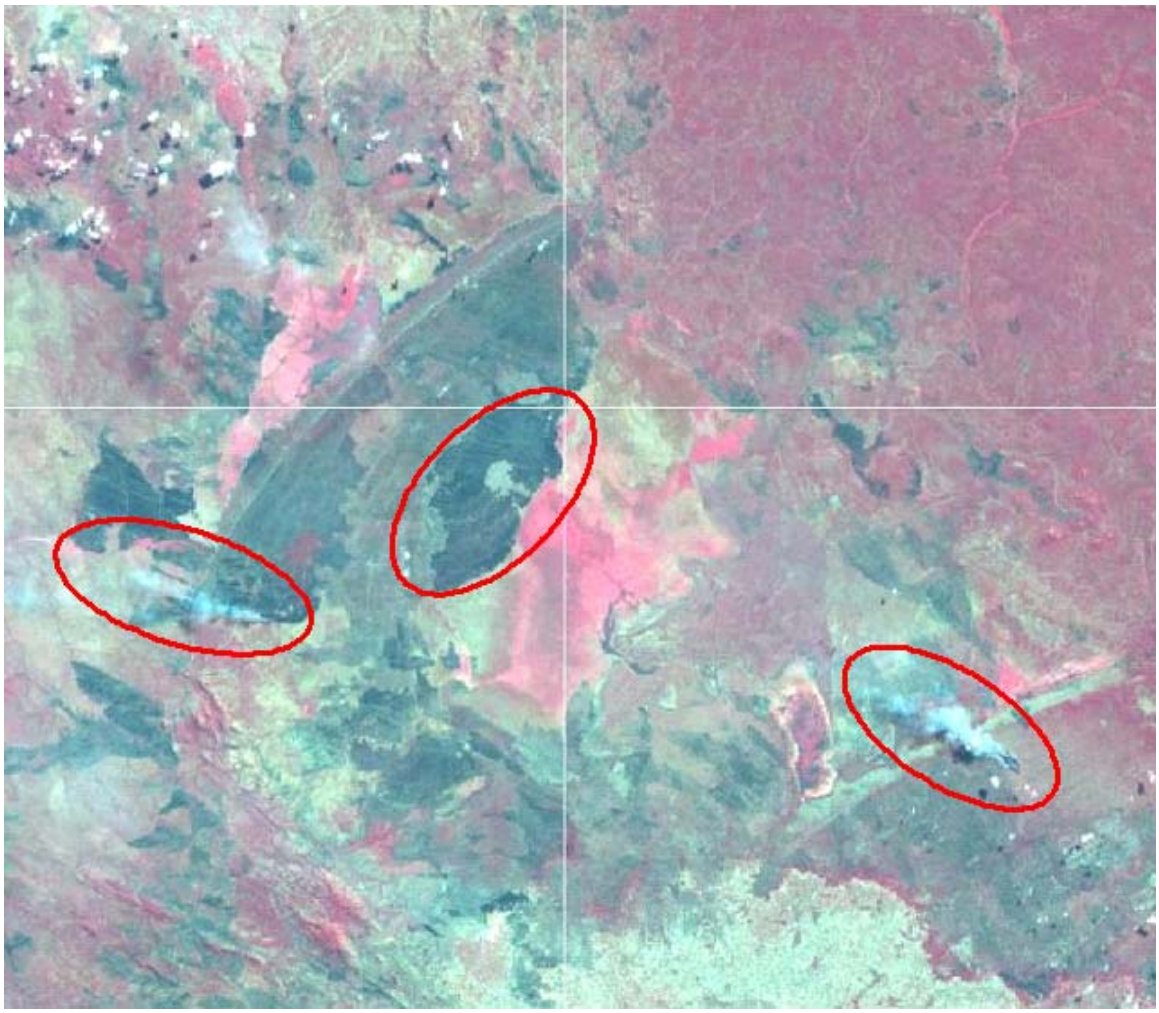
Annual bush fires are part of the local vegetation management strategy which is regularly used by park rangers, herders and farmers to encourage grass growth. As such, bush fires are unavoidable and should be taken into consideration during locust survey and control operations. One possibility to do this would be to use remotely sensed data (satellite images) to monitor burned areas. As an illustration, the figure below represents a Landsat image of a part of Ikuu taken on June 18, 2009 (a few days before the after spray field surveys mentioned above). Burned areas and smoke trails are clearly visible.

A field visit to Ikuu plains treated with Green Muscle® was done by the evaluation team on 17th September 2009. A rapid assessment (counting all adults flushed out of the vegetation by a moving vehicle) of the residual adult Red Locust population was conducted on 5 points located at 0.5 km intervals over a 2.5 km L-shaped drive in unburnt grass areas. The vegetation was dense and tall and therefore not easy to search for live adult locusts and/or cadavers.

Table 3: Summary of adult locust numbers recorded per 0.5km length and respective coordinates, September 2009

Station	GPS Readings (UTM)	GPS Reading (standard)	Number of adult Red Locusts flushed out of grass
1	Not read		7
2	Not read		9
3	917masl, 36M 0299380, UTM 9243772	917masl, 31.184635E, 6.838083S	5
4	920masl, 36M 0299889, UTM 9240560	920masl,31.18904E, 6.867140S	5
5	915masl, 36M 0300491, UTM 9243270	915masl, 31.194578E, 6.842658S	2

With the valuable guidance of Mr Mathias Kahyolo (IRLCO-CSA Field Officer-Tabora-Base), the residual Red Locust population in the surveyed portion was estimated as 0-3 adult locusts/$m^{2.}$ At this level, given that the treatment threshold is 10+ locusts/m^2, the population was well controlled. However, this information should be taken with a pinch of salt because we only managed to cover a small portion of the plains. More detailed surveying of the area were planned in October/November 2009 to be carried out by IRLCO-CSA.



5.3. Efficacy of synthetic pesticides in Rukwa, Malagarasi and Katavi

In the Malagarasi river basin, 4,144 ha (6 target areas treated on 30 & 31 May [2,144 ha] and 17 & 19 June [2,000 ha] in the Lake Sagala area was sprayed with 4,000 litres of Sumi-combi Alpha at the rate of 1.0l/ha. Post-spray assessment carried out ten days after the first treatment indicated high concentration of locust populations on ca. 200ha that warranted re-spraying. Further surveys in that general area on 16 June located additional new populations that had moved in from elsewhere and concentrated due to grass

fires and drying of vegetation. These populations were treated on 17 & 19 June (and the 200 ha re-sprayed was part of this treatment.

In June 2009, 24,00ha were surveyed in the Lake Rukwa potential outbreak areas. High Red Locust swarms ranging from 10-30 locusts/m^2 were located in the South (4,000ha) and North (1,000ha) plains. The areas with high locust concentrations were sprayed with Sumi-combi at 0.75 to 1.0l/ha. During the post-spray assessment, 648ha treated with Sumi-Combi 0.75l/ha were found to have high locust concentrations that required re-spraying. This area was re-sprayed with Fenitrothion 96 ULV provided by MAFSC (Okhoba, et al., 2009). (Note for information - the fenitrothion ULV provided was marked Locufen 96% on drums but no label was provided from MAFSC until late June. Enquires to MAFSC were made and the pesticide was determined to be fenitrothion 96 ULV (960 g a.i./L) which equates to 79%). Where ever possible the Sumi-Combi was used first to reduce the stocks of this older pesticide. In most cases the newer fenitrothion was used once supplies of Sumi-Combi had been depleted at each control base.

In the Katavi plains, out of 7,000ha surveyed in May 2009, 4,000ha were found to harbour high locust concentrations at density of 5-15 locusts/m^2. However, only 2,800 had populations above 10 locusts/m^2 and these were sprayed with Fenitrothion 96. Post spray assessment carried out a week later revealed 90% kill and therefore there was no need for re-spraying (Okhoba et al., 2009).

Therefore, the Ikuu plains were not the only areas that were re-sprayed following bush fires and concentration of locust populations in areas which were not burnt: Re-spraying also occurred in Malagarasi (200ha) and Lake Rukwa (640ha) to suppress residual adult populations that could otherwise have resulted in minor swarm escapes.

It appears that there was inadequate coverage of targets in some of the sprayed areas (except in Katavi where 90% mortality was achieved) due mainly to the prevailing vegetation types (tall and dense) and the roosting behaviour of the locusts (not flying during spraying).

Because of the perceived need for re-spraying with conventional pesticides of the areas previously sprayed with Green Muscle®, the evaluation team concurs with the international and national Red Locust consultants that within the timeframe of the evaluated project, the spray timing for bio-pesticide was sub-optimal (too early).

6. Sustainability, Connectedness and Programme Approach

The CERF resources added value to the ongoing FAO-supported projects under the two TCPs, without which it would have been much more difficult to prepare an application for CERF support on time.

As early as March/April 2008, surveys conducted by IRLCO-CSA in collaboration with MAFSC reported high density locust populations in three of the four major outbreak areas but no control was done due to shortage of resources. Further surveys were conducted in October 2008 and January/February 2009 with financial support from the FAO TCP/RAF/3118(E). The January/February data identified several hopper bands with very high densities ranging from 25-100 hoppers/m^2 in Ikuu-Katavi, Malagarasi and Rukwa, that needed urgent action. This formed the basis for the application for CERF support.

The CERF resources in the case study helped Tanzania's capacity to deal with Red Locust outbreaks, and ensured a useful intervention at the regional level as explained above (section 5). Lessons learned during the FAO TCP/RAF/3118(E) on mixing and application of Green Muscle® in February 2009 became useful under the CERF emergency campaign in May-June 2009, thus saving time and resources. Similarly, lessons learned during the implementation of the CERF project in terms of managing potential outbreaks, use of Green Muscle® in protected and ecologically fragile locust breeding sites have enhanced the capacity of IRLCO-CSA and its preparedness to deal with Red Locust. IRLCO-CSA has established a cold storage facility for Green Muscle® at its HQ in Ndola in preparation for scaling up use of Green Muscle® in other outbreak areas as need arises to avoid delivery delays. Furthermore, the IRLCO-CSA spray and survey equipments were repaired and upgraded, this improving its capacity to respond faster to threatening Red Locust populations in the future.

7. Conclusions and Recommendations

The specific objective of the CERF project – "to mitigate the chances of swarms escaping from the breeding sites by strengthening the response capacity of IRLCO-CSA and the national plant protection agencies in Tanzania, Malawi and Mozambique to effectively cope with developing Red Locust threats with special attention to safeguard of human and environment health" – was achieved. There were no swarm escapes from any of the potential outbreak areas.

It was also demonstrated that Green Muscle® can be used for large-scale management of Red Locust populations in ecologically sensitive outbreak areas, and that with careful planning and equipped with sound spray machinery, nymphs and immature adults (fledglings) can be targeted.

7.1 Large scale use of Green Muscle® in the management of Red Locust

The Green Muscle® application in the Katisunga-Ikuu plains resulted in effective control of the immature adult populations and prevented swarm escapes.

However, despite the fact that there were no swarm escapes from the Ikuu Green Muscle® treated area, misconceptions and misunderstandings about how Green Muscle® works and expected results are still wide spread among certain groups of experts. As commented above, using Sumicombi after Green Muscle® blurred the picture, making it more difficult to ascertain the effectiveness of Green Muscle®.

After careful review of project documentation, information provided by all stakeholders and its own observations, the Evaluation Team concluded that the application of Sumicombi in the Green Muscle® sprayed area could have been avoided. The risk of escapes was deemed low by most of the international and national Red Locust experts, and the application of the conventional pesticide was uneconomical and environmentally harmful to the fragile wetland ecosystem of the Ikuu-Katavi National Park. Furthermore, this action made it more difficult, if not impossible, to fully assess the effectiveness of the Green Muscle® in the treated area and learning from the experience. The lack of exposure and experience about locust swarms among some of the MAFSC staff resulted in unnecessary pressure to kick off the bio-pesticide spray operations a month earlier than the optimum window. In turn, this led to the perceived need to re-spray the residual locust populations congregated in the Green Muscle® treated areas after bush fires with conventional pesticides.

TANAPA and the park management were very happy that IRLCO-CSA has introduced Green Muscle®, a biological control agent, for the management of Red Locust populations in the Ikuu-Katavi Park because their role is to conserve *all* living organisms within the park. Considering that this is a protected area and that TANAPA's mandate and responsibility is biodiversity conservation, the park management was stressed that the Red Locusts are a good source of food for other species in the park and therefore the effort should be to contain swarm escapes and not total eradication of the Red Locust from the breeding sites. However, the long-term effects of continued use of Green Muscle® **and** conventional pesticides on both, the Red Locusts and non-target organisms, are of concern to the park administration. Research to address these issues is imperative to facilitate scaling–up use of Green Muscle® in the Ikuu-Katavi National Park and other ecologically fragile protected areas which are breeding sites for the Red Locust.

The current Tanzania National Environmental Policy (NEP) 1997 followed by the Environmental Act (EA) 2004, the Environmental Impact Assessment and Audit (EIA&A) Regulations, 2005, and the Environmental Management [EM) (Soil Quality Standards) Regulations, 2007], provide a framework for environmental protection considerations by different sectors into the mainstream of decision-making to ensure minimum negative environmental impacts due to agricultural practices and use of external inputs. Environmental impact assessment for any operation in the National Parks is mandatory and yet this was not done due to the emergency nature of the evaluated anti-locust campaign. The Environmental

act was violated in the case study due to the case's emergency nature, although there is still room for compliance e.g. organizing and collecting baseline data from the sprayed areas that can be used for impact assessment.

The need to balance humanitarian and environmental issues is not only critical for park management. All the potential outbreak areas – be they located inside or outside of a park – are wetlands and are a source from which local fishermen catch fish and then smoke and sell it all over western Tanzania. Therefore there is a serious risk that chemical pesticides sprayed over these areas could make their way into the human food chain. Consequently the use of Green Muscle® for locust population management should be strongly advocated in all these areas.

7.2 Scaling-up the success from the Ikuu plains

The lessons learned during the CERF operations in the management of Red Locust populations in Ikuu plains using Green Muscle® are invaluable to IRLCO-CSA in strategizing on how best to introduce the bio-pesticide in other potential outbreak sites in Malawi, Mozambique and Zambia, which are also ecologically important. Already IRLCO-CSA is stockpiling Green Muscle® for emergency use. Given adequate funding and political support, the capacity to scale-up is available:

- A cold storage facility for Green Muscle® is already in place at the Ndola compound
- Staff at national and regional level have good and reliable experience from the hands-on training
- Spray equipment (repaired and upgraded under CERF), additional spray gear provided under CERF
- A full upgrade of application equipment for the IRLCO-CSA Cessna 185 spray aircraft with the purchase and installation of a new spray equipment, pesticide tank, Micronair AU5000 rotary atomisers and a track guidance system are in place (provided for under the CERF project).

However, and given that Green Muscle® has been tested in the Ikuu several times (2002/03, Jan/Feb 2009, and May/June 2009), it is time to consider full registration of the product in Tanzania to facilitate access for ecologically viable control of locusts and pest grasshoppers such as the elegant grasshopper (*Zonocerus elegans*). Since registration is the responsibility of TPRI, the Tanzania pesticide registration body and the green muscle manufacturer BCP should take the leadership in this important issue, assisted by the mandated administration.

There remains a generally skeptical tone and opinion among the MAFSC personnel regarding Green Muscle®. This can be explained in part by unrealistic expectations and insufficient understanding of its mode of action and impact on locusts.

The opinion that the Green Muscle® would work better on nymphs is shared by most national and international experts. However, it should be kept in mind though that nymphal control presents certain logistical difficulties because of larger areas to survey, unfavourable weather etc. The only window available to target nymphs with effective results would be in January-February, during a short dry spell (March-May is a period of heavy rains and therefore not ideal for survey and spray operations).

The MAFSC also stressed the need to identify local strains of the fungal pathogen that could be more effective on the Red Locust. This idea of looking for local, more virulent pathogens (and postponing the available bio-pesticide use until such strains are found) should be taken with a grain of salt. The isolate currently used in Green Muscle® was found in West Africa (Niger) and on a grasshopper species other than the Red Locust. It is not impossible that more potent isolates against the Red Locust could eventually be found in East Africa (some strains already found in Tanzania but not developed, Nyambo 1991) although screening of such pathogens is a very time- and resource-consuming venture. Furthermore, the path from finding an isolate in the field to its commercial mass production is a serious bottleneck: practice shows that it can take decades and will cost hundreds of millions of USD. As such, it is much more pragmatic and realistic to concentrate on refining protocols for use of the currently existing products such as Green Muscle® rather than putting all hopes for an efficient bio-pesticide aside, until a new pathogen-panacea is found, developed and commercialized.

7.3 Recommendations

- The financial status of IRLCO-CSA should be strengthened to minimize the magnitude of emergency outbreaks. The current emergency situation was caused by lack of operations in 2007 and 2008 because of lack of funds, this resulting in two parent populations accumulating in early 2009, and hence the emergency. It is therefore imperative that IRLCO-CSA and respective national counterparts are given adequate resources and that the resources are timely availed to avoid another crisis.

- Community participation and/or involvement in monitoring of Red Locust populations have been suboptimal if at all. Given the limited resources and capacity of IRLCO-CSA and national counterparts, routine surveillance of residual/potential outbreaks could be improved with community participation. The MAFSC already has experience with armyworm early warning system through community-based monitoring and reporting that has now been scaled up to most of the armyworm outbreak areas in Tanzania. The lessons learned could be used to setup a similar system in Red Locust outbreak areas using herdsmen, fishermen and park rangers. Due to ecological differences between potential outbreak areas, it is necessary to pilot in specific areas before scaling up/fine-tuning for locale specifications.

- Similarly, all agricultural extension workers located in districts surrounding potential Red Locust areas must get basic training in Red Locust survey, monitoring and control.

- Public education on use of Green Muscle® and how it works is needed before scaling-up its use for the management of Red Locust and other pest grasshoppers in outbreak/breeding sites. In particular, proactive PR presentations to Ministries by IRLCO-CSA in all potential outbreak countries (Tanzania, Malawi, Mozambique and Zambia) are necessary. Suggestion – the short documentary film produced during operation for FAO should be used at such presentations.

- The fungus is a slow killer that takes 1-3 weeks depending on a combination of biotic and abiotic factors and therefore not always suitable to manage swarm escapes. Green Muscle® is a low risk alternative when rapid mortality is not crucial. Green Muscle® should be used proactively to treat breeding sites targeting nymphs, rather than reactively to control swarming adults. This way there will be no panicky decisions to be made.

- Scaling-up use of Green Muscle® to other ecologically important outbreak areas will strengthen IRLCO-CSA operational experience with this material and demonstrate its efficacy to stakeholders and the wider community including policy makers not only in Tanzania, but also in Malawi, Mozambique and Zambia.

- There are still knowledge gaps that need to be addressed (see also report by P. Spurgin and R. Chomba, 2009):

    - Laboratory and field studies are required to provide additional information on the effective dose (number of spores per hectare) required to kill Red Locusts (nymphs and adults), viability over time of *Metarhizium* spores exposed to UV in different habitats as well as the effect of behavioural fever and time to death under different temperature regimes for both nymphs and adults.

    - Additionally, information is needed on the behaviour of residual locust population after Green Muscle® application (e.g. flight and swarming capability, mating, egg-laying and viability of eggs). If there are long-lasting, cumulative impacts of the fungus, then the need for re-spraying might not be necessary, leading to cost cutting. All these factors need to be investigated under local conditions and not just extrapolated from other areas.

    - Equally important are the effects of auto-contamination when locust populations congregate due to bush fires and/or other factors that could lead to high population concentrations after Green Muscle®

application. It is possible that following spraying with the bio-pesticide those locusts which are not killed outright by the infection, may not be able to leave or reproduce in the outbreak area and so would pose a much lesser threat to agriculture in surrounding areas.

- The use of remotely sensed data (satellite images) to monitor burned areas should be explored further.

- As suggested by Spurgin P. and R. Chomba (2009), the use of a helicopter fitted with ULV rotary atomizers may offer a solution to the treatment of settled locusts roosting in tall vegetation using Green Muscle®. This application method was used successfully in Timor Leste in 2007. It is therefore recommended that if funds are available, IRLCO-CSA be provided with a new second helicopter that can be used for spraying and surveys in its mandate area of operation. It will definitely be more cost-effective than buying a fixed-wing spray plane that will be used for spraying purposes only.

- Taking into account that Green Muscle® has been tested several times in Tanzania between 2002 and 2009, it is time to consider its full registration under the Tanzania pesticide registration regulation to facilitate locust and other pest grasshopper control. This is primarily the responsibility of TPRI and BCP-SA but could also be promoted by interested parties.

- The condition of the vehicles at the IRLCO-CSA Tabora Base (and probably in other IRLCO-CSA bases in the region) is deplorable. It would be cost-effective if these old vehicles (more that 20 years old) are disposed and the proceeds invested in the purchase of new ones.

- TANAPA and the Katavi management are concerned about the potential long-term effects of continued use of conventional pesticides and Green Muscle® in the management of Red Locust populations inside protected areas. To date there is no local information regarding these aspects, and therefore, it should be given due consideration. The information will be useful for policy makers and for the wider public, particularly development agencies, given growing international environmental concerns. If this is done, it will also be responding to the Tanzania Environmental act which is a Legal requirement for all plant protection operations.

- The 2,000 litres of Sumicombi remaining from the Mali stock held in one of the Tanzanian stores should be relocated and used in other Red Locust control areas ideally before its expiry date in November 2009. However, its viability has to be tested. If found active, then it can be used by Tanzania and/or any other country. If found to be below acceptable levels, then it should be properly disposed through the ASP project.

Annexes

1. People met and institutions

IRLCO-CSA Ndola
Mr. Moses M. Okhoba, Director
Captain John M. Malawa, Chief Pilot
Mr. Masausa Banda, Chief Engineer
Mr. Blessing Sibanda, Aircraft Engineer
Mr. John Ngondi Katheru, Scientist (I & F)
Dr E.S. Zitsanza, Chief Scientist

MAFSC Tanzania
Mrs Sophia Kaduma, Deputy Permanent Secretary, MAFSC
Dr Francisca Kategile, Acting Assistant Director, PHS
Mr Damian Gasana, migratory pests, PHS
Mr. Ayub Nchimbi, migratory pests, PHS
Mr Fabian Mkondo, coordinator migratory pests
Dr. M.M.Msolla, inputs Department, MAFSC

FAO Tanzania
Mr. James Yonazi, Assistant Representative (Programmes)
Dr Louise L. Setshwaelo, FAO Representative Tanzania

DALDO Mpanda
Mr. Fabian Kashindye, District Agricultural and Livestock Officer

IRLCO-CSA Tabora-Base
Mr Mathias Kahyolo, Field Officer

Telephone Interview
Mr. Peter Spurgin, International Red Locust expert, project consultant (Australia)
Mr. Ramadhani Chomba, National Red Locust expert, project consultant (Kigoma)

Stakeholder debriefing meeting, 18th September 2009
Present:
Dr F. Kategila, PHS
Mr Damiani Gasana, PHS
Mr. Ayub Nchimbi, PHS
Mr. Richard Magoma, PHS
Mr. Moses M. Okhoba, Director IRLCO-CSA
Mr. Raphael Laiser, FAO-TZ
Mr. Olivier Cossée, PBEE
Brigitte Nyambo, FAO-Rome CERF TZ evaluation team

Ikuu-Katavi National Park
Mr John Ignace Gara, Chief warden
Mr Elisa Palanchyo Manase, Park ecologist
Mr Saidi Seki, Park ranger, Ikuu rangers' post

2. Itinerary

4th September 2009:

Morning: ALatchininsky travel Laramie-Lusaka (arrival 5th September)

6th September 2009:

Morning: BNyambo travel Nairobi-Lusaka
Afternoon: Working meeting: BNyambo and ALatchininsky

7th September 2009
Morning: Team travelled; Lusaka-Ndola
Afternoon

- Debriefing-IRLCO-CSA management
- Interviews with Director, Chief scientist and Scientists (Information)

8th September 2009
Morning: interviews with pilots, engineers and assessment of spray and survey equipment and accessories
Afternoon: Debriefing senior management

9th September 2009
Team travel:Ndola-Lusaka-Nairobi-Dar

10th September 2009
Morning
1. FAO Tanzania
    - James Yonazi, Assistant Representative (Programmes)
        i. Debriefing about the mission objectives
        ii. Develop a workplan for the TZ leg of the mission
        iii. Set appointments with key stakeholder/representatives
    - Contact Ikuu-Katavi National park and inform about planned visit on 16-17th September 2009 (through the FAO-Rep secretary)
    - Contact TANAPA Arusha

Afternoon
13.00 to 15.00 hrs: Interviewed Mr. Peter Spurgin, International Red Locust expert (FAO**)**
15.00 to 16.00 Hrs: interviewed: Mr Fabian Mkondo, coordinator migratory pests, MAFSC Tanzania

11th September 2009
Morning: 8.30 to 15.00 hrs

- Dr Francisca Kategile, Acting Assistant Director, PHS
- Mr Damian Gasana, migratory pests, PHS
- Mr. Ayub Nchimbi, migratory pests, PHS

16.00 to 17.00 hrs
Debriefing and discussions with Dr Louise L. Setshwaelo, FAO Representative Tanzania

12th September 2009
Preparation of summary report
Sunday 13th September-resting
Monday 14th September 2009
Morning

- Debriefing –Olivier Cossée, Evaluation Officer PBEE
- 9.00 to 10.00: Telephone interview with Mr Ramadhani Chomba, national Red Locust consultant Kigoma

Afternoon

- Organise team and venue for stakeholders' debriefing on 18th September in collaboration with FAO-TZ, and Ministry of Agriculture (Olivier and Brigitte)
- Finalize travel logistics arrangements to Ikuu-Katavi
  15.30 to 16.00: tel interview with Mr. Allan Hurbet Kijazi, Tanzania National Parks Authority (TANAPA) H/Q Arusha Tanzania
- 17.00 hours: discussion meeting with Mrs Sophia Kaduma, Deputy Permanent Secretary, MAFSC (Olivier, Alex and Brigitte)
  Present: Dr. M.M.Msolla, inputs Department,MAFSC
- Alex travel back to the USA

Evening: A. Latchininsky travel Dar-es-Salaam - Laramie

15th September: travel Dar-Tabora-Mpanda, night in Mpanda (Olivier and Brigitte)
Morning: Dar-Tabora by air, arriving at around 12.50 hrs
13-14 hours: Meeting discussion with Mr Mathias Kahyolo, Field Officer Tabora Base, IRLCO-CSA
16.00 hrs: Travel Tabora-Mpanda by road

16th September
9.00 to 9.30 hours: Courtesy call to Mr. Fabian Kashindye, District Agricultural and Livestock Officer (DALDO) Mpanda
9.30 to 14.00 hrs: Ikuu-Katavi National Park briefing meetings and development of a work plan

- Interviews
  - Mr John Ignace Gara, Chief warden
  - Mr Elisa Palanchyo Manase, Park ecologist
  - Mr Saidi Seki, Park ranger, Ikuu rangers' post

14.00 to 18.00 hrs: Focused group discussion meeting with Kibaoni villagers, south of Katisunga plains Ikuu
18.00 to 20.00 hrs: drive back to Ikuu-Katavi head quarters. Night in park facilities

17th September
7.30 to 10.30 hrs: visit to Katisunga Red locust outbreak site/ Green Muscle® sprayed areas; Rapid assessment of residual adult locust populations over a 3.00km distance
11.00 12.00 hours: Focused group discussion meeting with Sitalike villagers (bordering main park entrance).
13.45 to 22.30 hrs: Road travel, Mpanda to Tabora, night in Tabora

18th September
Morning:
7.00 to 13.00 hrs: Fly back to Dar
Afternoon:
17 00 to 19.00 hours: Stakeholder debriefing chaired by Mrs S. Kaduma, Deputy PS MAFSC

19th September
Morning: report writing
Afternoon: travel back to Nairobi
20th to 25th: report writing

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