REPORT ON WORKSHOP FOR IMPROVED SPRAYING TECHNIQUES AND NOVEL SURVEY METHODS FOR DESERT LOCUST

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Compiled by:
Fuad Bahakim
Rabie Khalil
Adel Al-Shaibani
Mohamed Abdallahi Ould Babah
Jagdesh Prasad
Fakharul-Zaman

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1. INTRODUCTION

In many countries inaccessible areas of DL habitat can not be covered by ground survey and control teams. This may be around 20 to 40 % of the breeding area. As result the DL breed unnoticed in these zones and cause sudden outbreaks. Therefore, a need was felt to conduct aerial survey in such regions. But due to non-availability of suitable, economical and efficient aircraft the problem could not be solved – a similar problem exists for available 4 wheel drive vehicles.

Hence, during the 22nd session of the SE Asia DL Commission it was recommended that microlight aircraft and efficient four wheels driven vehicles should be examined for DL survey for such areas. Therefore, FAO (Migratory Pests Group) started to execute this recommendation by organising a field workshop in Mauritania, 17 – 30 November 2001 to test microlight aircraft for DL aerial survey and a novel four wheel driven vehicle (GT) for ground survey, with the collaboration of CLAA and the Norwegian funded FAO project - GCP/INT/651/NOR in Mauritania.

At the same time a parallel idea for a workshop in Mauritania was proposed by the GTZ project working with EMPRES / CR in order to share the CLAA experience in survey and data management with other experts from the CR.

Therefore, a combined workshop was designed to cover those topics as well as other relevant techniques and novel survey methods such as the GCP project results on using new techniques (Metarhyzium and DGPS). All sessions were conducted during the workshop on the participatory approach, under assistance of the moderator. The details of the workshop activities are shown in the Appendix (Ia and Ib).

The participants were invited from India, Mauritania, Pakistan, Sudan, and Yemen (Appendix II). The participants from CR have to spend one week more for participating with ground survey teams in Mauritania in order to compare survey and data management in Mauritania with CR countries.

WORKSHOP FINDINGS

2. TRIAL OF MICROLIGHT AIRCRAFT FOR DESERT LOCUST SURVEY

2.1. Introduction

The definition of a microlight aircraft vary from country to country, but the basic rule is that they are aircraft below a maximum specified weight (usually 500 kg maximum take off weight). There may also be additional criteria – for example a maximum wing loading and maximum stall speed.

In general there are two types of microlight aircraft – weight shift (or flexi wing) and three axis. Weight shift microlights are developed from hang gliders; there is a flexible wing and the pilot and passenger are seated in an open cockpit (photo 1). The pilot controls the direction of the aircraft by means of a bar placed in front of him. The pilot moves the bar left or right (essentially shifting the weight underneath the wing) which causes it to turn.

Photo 1

A Weight Shift Microlight

A three axis microlight usually has rigid wings, and is configured much as a normal aircraft. The pilot controls the direction of flight by using a joystick or wheel and rudders, and the aircraft responds in the normal way to aileron, elevator and rudder movements.

The microlight under test is the Joker 300, a three-axis microlight of conventional design (photo 2). The specifications are shown in Appendix III.

Photo 2

The Joker 300 Microlight Shown with the GT

2.2. Approach taken

The approach taken was consisted of a first familiarization of the participant to the aircraft by flying few minutes each followed by a participatory discussion using ZOOP method and guided by a moderator CLAA Director (see Appendix IV). During the discussion a testing protocol of the Microlight Aircraft was drawn based on different flying height and speed for testing the possibility of detecting green vegetation, swarms and hopper bands (Appendix V, Va and Vb).

Fertilizer was used to simulate hopper bands on the ground. The participants were asked to search and check the visibility from different altitudes, speed and angels and, additionally, to record the co-ordinates and the degree of visibility. The distance of take-off and landing were measured with regard to wind speed, wind direction and temperature. Stability of the aircraft was tested at various heights, speed and time. Results of testing different parameters are listed in (Appendix V), whereas (Appendix VI) shows the participant's flying time.

2.3. Results of the discussion on Microlight Aircraft

As mentioned above, the airplane specifications were specifications were discussed in detail. Some of the key specifications are the autonomy of the airplane, its minimum and maximum speed and flying altitude and short airstrip.
An ideal survey aircraft should have the following specifications:

- Fast Aircraft for ferry (200 km/hr)
- Large flight autonomy (5 hours)
- Locust proof windscreen aircraft
- Reasonable Stability for observation

- High wings
- Flight altitude over 100 feet
- Big size of the aircraft windows
- Air strip <500 m
- Safety to pilot/observer (see below)
- Certified by recognized authority
- Potential to install GPS/Video/Camera
- Permanent contact to locust bases/centres by radio

➢ **Economics and availability of microlight aircrafts:**

In order to elucidate and judge economics, the ownership of the aircrafts must be clarified first. It can be owned either by national DL-services/centres or be hired from commercial companies. For both cases the following points must be considered:

1) National DL-services/centres:

In this case it is to calculate and discuss:
- Pilot and technicians, their training, salary, DSA
- Cost of the aircraft
- Cost of spare parts
- Cost of maintenance
- Cost of transport to locust areas
- Cost of logistics

2) Commercial companies:

Rental costs per flight hour or days in the field or per season
- What does these costs include?
- Salary and DSA for pilots and technicians?
- Cost for fuel, oil, spare parts
- Cost for maintenance
- Cost for logistics

In the 2nd case availability is to consider also regarding
- Which companies have and offer those aircrafts
- Where are the companies located

➢ **In-flight safety:**

To achieve sufficient safety for pilots and observers the aircraft's operations are restricted by:
- Wind speed and direction
- Too high temperatures causing convictions and wind changes
- Sun altitudes and its position in particular related to wind speed and direction
- Visibility and flying over sand dunes and valleys

➢ **Comparison between ground and aerial surveys:**

Comparison between both survey forms was undertaken and discussed but finally judged as unfair due to the difference in the information quality and quantity, which can be collected by the two survey methods. One of the differences between these two methods is that the ground survey can enable to collect more information than collected by airplane except in the inaccessible area. On the other hand, aircraft can cover much larger area in short time than the ground survey. Therefore the economical comparison should be done through the aerial or the ground type of information provided by each.

2.4. Results of flight test

The observations recorded by the participants from various altitudes and speed of the aircraft at different daytimes, revealed that 100 - 200 feet height, 110 - 120 km/hour speed of the aircraft at a wind speed of 1 - 5m/second and 30 to 35° C temperature, were satisfactory for the visibility of vegetation (grasses and bushes), hopper bands and DL swarms. However the aircraft was not found stable exceeding wind speed 5m/second and high temperature <35° C (refer to Appendix V).

2.5. Economics and logistic feasibility

As compared with the other surveying aircraft, Microlight aircraft is definitely economically feasible due to the following features:

- less fuel consumption(13 Litres/hr)
- easy and cheap to maintain
- large autonomy (6 hours)
- short landing airstrip (200 m)
- low hiring cost (110 US$ per hour) - example in Mauritania – Ministry of Defence.

Disadvantages are as follows:

- Lack of stability in turbulent conditions
- Safety is not given by wind speeds exceeding 5 m/s
- Lack of information concerning the durability of aircraft under field conditions
- Only one seat is available for the DL officers
- Generally difficult to detect solitary hoppers and adults

The comparison of the various aircraft based on the participant's experience is given in the (Appendix VII).

2.6. Conclusion

The tested Microlight aircraft (Joker 300) was found suitable for aerial locust (hopper bands and swarms) and vegetation survey with the speed of 110 to 120 km per hour at altitudes of 100 to 200 feet, wind speed 1 to 5 m/second, temperature up to 35° C in inaccessible area in plains.
This aircraft has the advantage to take-off and land even in the plain area requiring short air strip of 200 meters length which can be found in the desert area and allow the locust officer to carry out ground survey, if necessary. The main economical advantages are endurance (autonomy) and low fuel consumption and maintenance costs. The aircraft was found not stable at high wind velocity (>20 km per hr) and high temperatures (>35° C).

More tests of Microlight aircraft on stability, durability and visibility in different topographical and climatic conditions are required in other DL affected countries by involving the national locust services or centres.

2.7. Recommendations

Before coming up with final recommendations the value of low cost aircrafts as part of preventative locust control strategies should be discussed considering in particular the thoughts, ideas, questions and outcomes of this field work shop. Furthermore, special equipment of those aircrafts should be discussed like elocust systems, digital cameras etc. should be regarded also.

- A three axis microlight should be assessed under operational conditions as soon as possible to assess durability in the DL affected countries. Moreover it should be tested in order to verify the results/observations given in this report. Alternative aerial observation platforms, for example, gyrocopters or paramotors should be tested as the opportunity arises. (See Photos 3 and 4).

Photo 3
A 2 Seat Gyrocopter

Photo 4

A Single Seat Paramotor

3. TRIAL OF GT 4 VEHICLE FOR DESERT LOCUST SURVEY AND CONTROL

3.1. Introduction

The GT (Getting there) was developed by a group in Norway as a low cost, low maintenance vehicle that can be used in difficult terrain. Originally the vehicle was constructed to link farms located in inaccessible areas with existing roads in order to allow farmers to transport their products to market places (see photo 2).

The inaccessibility of a significant proportion of potential locust habitat (up to 40 % at some time of the year in Sudan for example) means that these areas can not be surveyed. That can include the possibility of unnoticed build-up of DL populations. If those populations start to migrate and reproduce, upsurges or even outbreaks might occur requiring costly control operation.

A system to survey these difficult areas and to conduct limited control operation there would be a welcome development. Both the SE Asia Commission (22^{nd} session, 2001 and the EMPRES program as a whole expressed interest in the identification and testing of potential vehicles that could be used in this type of terrain.

The Norwegian funded FAO/EMPRES project in collaboration with the Agricultural University of Norway and the CLAA, have been involved in the development and testing of the GT do determine whether this vehicle offers the potential to enter those difficult areas.

The vehicle available in Mauritania is a proof of concept model, which has been built to assess the design capability. As such, the GT tested should not be considered as a final product, but one that can demonstrate the potential of those vehicles.

3.2. Description of the vehicle

The design of the GT4 is based on the principles of 2 axles (which may come from scrap vehicle), turned through 90° such that the drive train enters from the top. The 2 axles are connected by a drive shaft, which is mounted on top of the axles. Drive to the shaft is by a transfer box which transfers the power from a side mounted engine to the drive shaft, then to axles. All four wheels are steered which allows the rear wheels to follow the same track as the front wheels. This removes the need for differential on the rear axle.

The steering is supported by a hydraulic systems, operating through 2 swivel plates to which each axle is fixed. The current proof of concept vehicle is fitted with a Deutz 60HP oil cooled engine, connected to a six tractor gearbox. Connection of the gearbox to the transfer box is via universal joint. The tank volume comes up to 90 l. Tires fitted are 14 x 20 x 14 ply.

The vehicle has an open cab – protection in case of roll over is given by a steel rollover bar. Since the GT was not constructed to conduct spray operations the open cab does not lead to safety problems. In future, if this vehicle is used for spraying, the cab will be sealed.

A sprayer has been mounted on the machine, to estimate the vibration during driving in difficult terrain.

In order to keep the design as simple as possible, no shock absorbers are fitted; this limits the maximum speed of the GT to 40 km/h which is too less to cover long distances. However, future versions will be modified in order to increase road speed considerably.

The GT's weight comes up to 2.2 tons, and its load capacity to 4.8 tons.

3.2.1. Work in Progress

Trails in Mauritania have already demonstrated the needs for following improvements:

1. A smaller, lighter vehicle is required for travelling through sand dunes
2. The *floatation* on sand must be improved to allow travel on very soft sand areas
3. Weight balance between front and rear wheels must be changed

Test of the vehicle:

The GT was first introduced to the participants by a short vehicle's description presented by Bob Aston (CTA of the GCP Project). Afterwards each participant could drive the GT at different places for a couple of time. The vehicle's test was combined with the tests of car mounted DGPS that will be described in the following chapter.

Participant's comments

After driving the GT the participants discussed their impressions and came up with the following comments, conclusions and recommendations:
The participants in general agreed the concept of GT 4 (axles and drive shaft). However, after testing the GT 4 in the field, the following modifications are required additionally to the Mauritanian test results for making the vehicle suitable for DL survey and control operations:

- **The cab must be sealed**
- **Vibrations during surveying, spraying and travelling must be minimized.**
- **The gearbox should be reconstructed to allow four and two wheel drive.**
- **The GT should be equipped with shock absorber or adequate constructions**
- **Decrease the empty weight**
- **The high noise level should be reduced**
- **DGPS and radio should be installed**

4. TRACK GUIDANCE SYSTEMS (DGPS)

4.1. Introduction

The use of appropriate equipment and a commercial correction signal increases the accuracy of conventional GPS units from up to 30 m to about 1 m. By linking a Differential GPS receiver to appropriate software and a display (usually a lightbar), the system can be used to guide a driver or pilot accurately on successive spray tracks. The project successfully demonstrated the use of an aerial system in Sudan in 1998. Based on the results of this work, the 36th Session of the DLCC recommended that all aircraft used in Desert Locust control operations should be equipped with a DGPS track guidance and recording system.

The obstacle to the use of this equipment for ground spraying vehicles is the capital cost (about US$ 6000), plus the recurrent costs of the correction signal (up to US$ 2000 per year). However, ground conditions during locust spraying mean that the need for a highly accurate system is less critical than for an aircraft, and a system with a lower accuracy is acceptable. The project, together with a company in the UK, is developing a simple system based on a conventional GPS unit linked to a Palm hand held computer. Initial tests on the prototype system indicate that such a system is viable. Further software refinement is required before a low cost system (with a target price of less than US$ 1000) becomes widely available.

In order to reduce the amount of chemicals used in DL control operations, and to increase the accuracy of application, DGPS was introduced as track guidance system for vehicle. Moreover, it gives operation manager more control on his teams during control operations.

4.2. Equipment tested

The vehicle mounted DGPS consist of receiver, control box, light bar and external antenna.
This set of the DGPS was mounted in GT 4 vehicle.
The expert of the GCP explained the general background and description regarding the principles and operation of the system. In addition, the participants were taught about how to run and enter the information required such as first pass and track spacing. Then they were allowed to drive the vehicle with the DGPS to search out the predetermined track space and pass.

Due to the expensive cost of the DGPS unit for vehicle (6000 US$ excluding the charge of signal correction), the project GCP is in the process of developing a new system using conventional GPS. The prototype of this system was shown to the participants.

4.3. Conclusion

All the participants are agreed on the importance of using DGPS in vehicles during control operations, it can reduce the error in blanket application leading to reduction in pesticides, if used properly. Participant’s comments and recommendation can be summarized as follow:

- Easy to operate.
- Expensive (current one).
- Development of the conventional GPS should be accomplished in order to reduce the cost.

5. DATA TRANSMISSION SYSTEMS

The project, in collaboration with EMPRES CR and FAO HQ, has developed a system of transmitting data from the field to the operations centre by use of a Codan HF radio equipped with modems.

As the system is currently configured, the radio used is the Codan 9360 configured to accept the Codan 9002 data Modem. Data is collected onto the Psion hand held computer using the custom “elocust” programme. To transmit data, the Psion is connected using the Psion cable to the modem. In order to run the Codan data transmission software, a Dos emulator is required to be installed on the Psion. The emulator currently used is “XTM”, which is shareware downloadable from the internet (registration cost is US$20). Once the data from “elocust” has been exported to a DBF file (using the “elocust” menu command); the XTM programme is entered and the command “9102x XXXX c:\elocust.dbf” is entered. These uses the 9102x programme as supplied with the modem to automatically connect to the station whose address is XXXX and send the file c:\elocust.dbf. Once the file has been sent successfully the software automatically disconnects the modem from the radio and closes the link.

The base station is running (in the background) the Codan software 9102. The computer is connected permanently to the radio by supplied cable. When the base radio detects an incoming call directed to it (the self address being XXXX), it also connects and receives the data. The file is stored under a user defined directory, and incoming files with the same name are renamed in ascending order to a maximum of 10. Successive elocust files would be renamed elocust.001, elocust.002 etc.

The outstanding issue is one of simplifying the log on procedure. The author of the elocust software is currently writing a small routine programme to be included in elocust so that a single button from an elocust menu would automatically run XTM, and send the file to the base station. Two further actions are required to be verified in the Psion before data transmission – firstly that the remote link is set to off and secondly that the auto shutoff is disabled. Both of these actions will be undertaken as part of the software routine currently being written for elocust.

Once this is done, the system is ready for a use by a survey team to check operational use under field conditions.

6. METARHIZIUM ANISOPLIAE (GREEN MUSCLE) DEMONSTRATION

6.1. Introduction

This activity started with a short introduction given by Mr Kpindou from LUBILOSA, which covers the following points:

1) How to come to a biopesticide (spores-production)
2) Formulations available of Green Muscle
3) Differences between formulations and spores in term of shelf life
4) Dose recommended per hectare
5) Effect of weather on the product (UV radiation and temperature)
6) Efficacy and duration to achieve mortality
7) Strains of Metarhizium
8) Trails and registration (trails conducted and registration which was done in South Africa and Australia)
9) Economic studies on Metarhizium
10) Eco toxicology consideration

The details of the above points are:

1) Sporae material (strain: *Metarhizium anisopliae var. acridium* – Maa) is produced at IITA, Cotonou, by using dry fermentation with rice as breeding medium
2) a) Dried sporae material available at IITA which must be suspended in a mixture of vegetable oil/diesel (30:70)
   b) Oil formulations containing 500 gm spores/l provided by CABI, Ascot, which must be diluted to 2.5 x 10^{12} spores/l
3) Shelf life of **dried sporae**:
   >12 month, storage temp: 10 to 14° C
   Up to 6 month, storage temp: 30 to 40° C
   Oil formulation:
   Up to 8 month, storage temp: 15 to 20° C
   3 to 4 weeks, storage temp: 25 to 30° C
4) For the time being 50 gm/ha are recommended, however, sufficient results were obtained in Australian plague locust control with 25 gm/ha and future trials are planned with 10 gm/ha.

5 to 7) Mortality rates caused by incubation time of Maa depend on weather conditions in particular on temperatures. Longer lasting exposure to temperatures above 35° C decreases mortality rates, exposure to temperatures below 20° C increase incubation time. (More details are available in attached report on Green Muscle Trail)

8) Large scale field trials on various locusts and grasshopper were conducted so far in Australia, South Africa, Niger and Mali. First trials on DL-hopper bands were carried out in Mauritania 1993 and 1994. Maa is registered in Australia, South Africa, West Africa (CILLS – member countries) and registration is either under the way or discussed in various other states (see: Lomer, 2001, and follow up outcomes of FAO expert panel held in Rome Dec, 2001)
9) At the moment product costs of Maa formulations came up to 10 US$/ha
10) Ecotoxicology studies demonstrating less or no side effects were carried out on various insects, mostly pollinators and predators and on lizards (see Lit:)

6.2. Demonstration

6.2.1. Material

Metarhizium anisopliae var. *acridium* oil based formulation (50 oil: 50 spores) see were bred
Target insects were 1st to 5th gregarious instar hoppers of DL
Sprayers used: Micro ULVA+, hand held with 5 Batteries size D, 6324 and 6341 rpm and red nozzle
Diesel formulation
GPS GARMIN 12XL
Funnel and measuring cylinders, Tape, Tachometer
Wooden cages for collecting samples (30 x 30 x 30 cm)
Clothing cages: size 70 X 70 X 80 cm
Electronic Hygrometer, Thermometer and Anemometer
Oil sensitive paper fixed on iron sticks

6.2.2. Methodology

Record co-ordinates of location (N 19 37 45.7 – W 014 45 49.4)
Average temperature 25° C
R H 23%, averaged wind speed during application 4.65 m/s
Ready to use formulation was obtained by diluting 100 ml of Maa stock formulation with 1.9 l diesel. Application volume 2 l/ha. Application rate 50 gm/ha
Calibration of sprayers (red nozzle) shows a flow rate of 70 ml/min.
Demarcations of one hectare and release of hoppers
Spinning disk rotations came up to 6324 rpm and 6341 rpm respectively.
Two field officers using hand held Micro ULVA+ conducted treatment. The total spry time was 22 min 6 s.
To estimate the mortality rates obtained samples of hoppers were collected from the plot treated and transferred into cages. To verify the secondary pick up, three clothing cages were set up in the treated area and 20 hoppers were released inside each. One cage was placed on untreated vegetation as control.

6.2.3. Samples collected

a) Direct treatment

- First samples were collected after 2 hrs, in total 4 cages each with 20 hoppers,
- Second samples were collected after 72 hrs and
- third samples were collected after 144 hrs with the same number of cages and hoppers

b) Secondary pick up

Four cages were placed in the treated area after two hours, and 20 untreated insects were released in each cage to investigate the secondary pick-up and persistence of spores. The insects collected after three days to check the effect of the Metarhizium. The method was repeated after three, six, nine and twelve days at different places in the treated area.

6.2.4. Germination test

In Order to control the spores' viability two spores sample were taken and incubated. The first sample immediately after dilution of the stock formulation (500 gm/l); the second one after the application was conducted. Both samples were transferred to sterilized Petri dishes containing Sabouraud Dextrose Agar (SDA). Half of the both samples were incubated at 26° C for 24 hrs the other half was kept at room temperature for the same time that varied between 18 to 22° C (day-night temperature). None of these spores germinated whereas the germination rate of the samples incubated at 26° C came up to 93% (after dilution) and 87% (after application) respectively.

6.3. RESULTS

The average number of droplets counted on the cards was 16.9 per cm2. This is lower than expected and probably results from the fading of the deposit. For operational reasons, it was not possible to analyse the oil sensitive paper until some days after the treatment, and although diesel marks the paper clearly, the stain does fade after a time. It is likely that this has led to an underestimate of the drops actually deposited.

6.3.1. Mortality – Insects present in Plot at Time of Application

6.3.1.1. Insects Collected 2 hours after treatment:

15 days after treatment, the insects which were present during spraying and collected 2 hours after treatment showed a mortality of 92.5 %. However, control mortality was high at 44..3%. As discussed above, this high mortality probably resulted from stress due to transport. Fifteen days after treatment, 37% of the insects were showing signs of sporulation.

6.3.1.2. Insects Collected 3 days after treatment:

It should be noted that the control data used in this will include those insects which had died as a result of stress during transport. However, for those insects collected three days after treatment (DAT), only those that survived for after release will have been collected. However, by 8 DAT the mortality in the treated insects began to exceed that of the controls, and reached 77.5% by 18 DAT. Sporulation was evident from 7 DAT and reached 48.5% by 18 DAT.

6.3.2. Persistence of GM

6.3.2.1. Insects Exposed Immediately After Application (0 D):

The total mortality of the insects exposed to the deposit immediately after treatment is lower than those exposed during treatment reaching 57%. However, in terms of sporulation, there was little difference between those on present during treatment and those exposed immediately after (about 37% in both cases).

6.3.2.2. Insects Exposed 3 Days After Application (3 DAT):

The results are similar to 0 D; with the maximum mortality reaching 59% and 37% showing signs of sporulation 21 DAT – which is equivalent to 18 days after first exposure of these insects to the treated plot, and 15 days after removal from it.

6.3.2.3. Insects Exposed 6 Days After Application (6 DAT):

A new control batch was used in at this time. Mortality reached 51% 24 DAT, while sporultation had fallen to 14%.

6.3.2.4. nsects Exposed 9 Days After Application (9 DAT):

The difference in mortality between the control and treated insects was about 10% (26% in the control and 36% in the treated 27 DAT). Interestingly, about 10% of the insects showed signs of sporulation.

6.3.2.5. Insects Exposed 12 Days After Application (12 DAT):

There was no difference between the control and treated insects. No sporulation was evident 30 DAT.

The results are summarised.

6.3.3. Temperature and Relative Humidity

Temperature and relative humidity were recorded at 2 hourly intervals in both the laboratory (where the insects were kept after collection) and exterior (as an indication of the conditions in the field). These data have been analysed on a frequency basis as an indication of the temperature and relative humidity variation throughout the daytime. It is clear that there is less variation in the laboratory, where over 75% of the readings were between 25 ^{o}C and 29 ^{o}C; this compares to 50% for the field readings. Similarly, the relative humidity stayed more constant in the laboratory, with 85% of the readings between 21 and 24% RH, compared to 65% for the field.
(For more information and to see figures please see the attached report on "Results of GM trials")

7. VISITS DURING THE MISSION

7.1. Visit of the GCP project:

The GCP project prepared a detailed program for the participant's visit during the days of 25th 27th and 28th of November 2001. The project's activities during the period 1996 to 2001 were presented in a short lecture given by the project leader Bob Aston. The introduction regarded the results already obtained and the ongoing activities as well.
Main subjects the project dealt and deals with up to now are as follows:

1) Side effects on non-target organisms including non-target insects, wild life, life stocks and human beings
   - Blood investigation of application personnel (Acetyl Cholin Esterase activity)
   - Blood investigations of life stocks (e. g. camels) in frequently treated areas
2) Monitoring environmental impacts of team operations in terms of waste left, fire wood, pesticide contaminated material, washing water, empty batteries, etc.
3) Development spray models regarding physical and biological parameters to reduce pesticide dosages. These goals were approached by:
   - Studies on droplet size, distribution and number per target (DL-hopper) required to obtain sufficient mortality rates (LD_{50}-studies)
   - Studies on pesticides diluted with other products e.g. vegetable oil
   - Studies on droplet size and droplet distribution depending on various sprayer types (Air blast and Spinning disk sprayers).
4) Demonstration and explanation of the equipment to collect and transfer survey and operation data (GPS, DGPS, Psion, elocust system).
5) Demonstration of locust breeding and laboratory facilities.

7.2. Visit to the Mauritanian Locust Centre:

The head of the Mauritanian Locust Centre CLAA (Centre de Lutte Antiacridienne), Mr. A. M. ould Babah, introduced the participants into its organization, tasks and operations including CLAA's position on national level and its relationships/collaboration with international DL services and organisations. Moreover, the state of the art and the mode of action of CLAA was presented regarding planning, preparation and executions of surveys and control operations and its information and data management system as well. Main emphasize was laid on the following already conducted and still ongoing activities:
1) Film on control operations to combat the DL upsurge in Mauritania during 1993 to 1995.
2) History and development of DL management in Mauritania.
3) Summary of applied research work conducted in Mauritania.
4) Disposal measures of obsolete pesticides (Dieldrin) originating from former DL control operations.
5) Demonstration of the database Ramses and the elocust system (presented by Ba Kalidou and M. L. Ahmedou, NPO WR).
6) Introduction and presentation of GIS (Geographic Information System) and the pest data management system (given by Mrs. J. Pender, FAO consultant).

In addition to that, the participants visited library, information unit and workshop for sprayers maintenance.

8. FIELD VISIT

The EMPRES CR DL-experts conducted a survey in Mauritania and visited three Mauritanian survey teams. They were accompanied by M. L. Ahmedou (NPO-EMPRES W) and Dr. A. ould Hadj (CP of the Norwegian project). The whole itinerary was as follows:
Thursday 29 Nov Nouakchott to Akjoujt
Friday 30 Nov Akjoujt to Team 1 at (N 19 10 24.3 W 014 19 15.9)
Saturday 01 Dec from Team 1 to Team 2 at Tamassoumit (N 18 31 39.1 W 012 40 26.8)
Sunday 02 Dec from Team 2 to Team 3 at Tarhat Elgadam (N 18 51 40.5 W 012 04 23.9)
Monday 03 Dec from Team 3 to Nouakchott

The team travelled 1806 km crossing regions of INCHIRI, TRARZA, BRAKNA and TAGANT. The CR team jointly conducted surveys with each team in order to become informed about the Mauritanian survey system, data collection and data transfer. The detail of DL and ecology situations was recorded in survey forms in (Appendix VIII).

8.1. General Observations:

Teams from CLAA HQ have been sent according to prepared plan to their locations at the beginning of the rainy seasons. Each team has certain area to be covered during such period that limited by DL presence and ecological conditions at the area.
Each team composed of one officer, two drivers and two labour.
It is clear that locust officers have a good experience concerning travelling in harsh and tough topography, identifying plant species and survey methods. Due to the good relation between DL officers and other information sources, make valuable information available. This lead to plan their surveys accordingly.
It is observed that field officers recording the data in notebook following a message structure adopted by CLAA instead of using the FAO Survey and Control Form. It is worth and necessary to use the current FAO Survey and Control Form in recording, sending and receiving data.
Before each DL breeding season CLAA usually conduct workshop for evaluating the last season and determine needs for the new season. This workshop conducted with CLAA staff and team leaders to:

- Check equipment / materials available
- Check needs for repair or maintenance purchase
- Identify number of teams, leaders and other staff member in the team
- Define survey areas and the teams distribution in those areas

Each team of survey should spend at least 2 months in his area provide information on DL and habitat on a daily basis. They collect all information mentioned in the FAO Survey and Control Form and some more details on the types of the vegetation and the percentage of green vegetation related to the surveyed area. Since the teams are staying all the time in the field, each team proceed in his area following the green vegetation and rainfall information. They also make use of information provided to them by nomads in the area regarding the green vegetation and rainfall.

There are only two main differences between Mauritania and the countries in CR (Sudan and Yemen). The first is conducting workshop before each rainy season for the purpose of preparedness, this is not happened in the CR countries. The second is survey teams spending all time in the field, which help in providing DL information to HQ continuously during the season. Therefore, the key countries in the CR should have this system in DL management.

9. GENERAL DISCUSSION AND AGREEMENTS OF ALL PARTICIPANTS (EMPRES WEST, CENTRAL AND EAST)

The workshop on "Improved Techniques and Novel Survey Methods" held during 17 – 30 November 2001 IN Akjoujt – Nouakchott was a good occasion to exchange experience and knowledge between participants from the DL affected countries of all regions. The specific comments and recommendations for the topics covered during the workshop were mentioned under each section. However, some recommendations raised from the general discussion among the participants and organizers were summarized hereunder:

- **Before introduction of Microlight Aircraft in daily survey activities, it should be tested again in various DL breeding areas. In particularly, in sand dunes areas like in Mauritania and Sudan.**

- **Before improvement of the GT4 it must be clarified:**

  - **Cost-benefit relationships including cost of purchase, maintenance, cost availability of spare parts (without a commercial company behind, it becomes difficult), although it should be noted that the idea behind the GT is that it is simple to maintain and that it can be constructed form locally available materials.**

- **The participants felt that the development of cheaper alternative methods to DGPS should be continued and like to ask FAO/EMPRES or other donors for support and funds.**
- **The participant agreed on the importance of searching on the new biopesticides for DL control after the results of Green Muscle Trail. They emphasized on conducting similar trails throughout the Desert Locust area during DL outbreaks in collaboration with LUBILOSA or any other institutions with good experience and DL staff in the affected countries.**

- **To improve and standardize the DL information system all DL countries should be requested to use the FAO survey and control form**

- **The GCP project obtained remarkable research results regarding proper and safe application of pesticides and environmental impact of pesticides (see page 18). One should take into consideration how and to what extend these results should be implemented in CR countries also.**

- **The participants felt, in general, very satisfied with the field-workshop regarding its content, organisation and execution. Therefore, they like to express their wishes to conduct similar workshops in the EMPRES region in which participants of all EMPRES areas (WR, CR, and ER) are involved to strengthen and increase the links, activities and collaboration between the DL experts of the different regions. However, the following important for future workshops are liked:**

- **The time frame to evaluate and discuss the various activities should be enlarged**
- **The workshop's programme should be distributed in advance in order to leave sufficient time to the participants to prepare themselves.**

10. ACKNOWLEDGEMENT

The participants would like to express their thanks to the CLAA of Ministry of Rural Development and Environment of the Islamic Republic of Mauritania and GCP Project for their great help supporting the workshop. In addition, the participants are especially grateful to Mr. Mohamed Abdullah Ould Babah CLAA Director, Robert Aston Chief Technical Advisor of GCP Project, Mohamed Lemine Ould Ahmed NPO EMPRES- West for much of the information and help during the workshop.

Participants would also like to extend their sincerely thank to Mrs Rose Aston, Environmental Impact Assessment Expert, Dr. Ahmed Ould El-Hadj, NPO UNV Control, Dr. Mohamed El-Hadi Ould Taleb, NPO UNV Biology, Amar O Amar Admin, Assistant, and CLAA and GCP other staff for their sincere help and co-operation.

Our great thanks is extend to GCP Project / FAO, Dr. Hans Wilps, Co-ordinator of GTZ project in CR, and Dr. Christian Pantenius, EMPRES Co-ordinator, for providing fund to cover the cost of the workshop and participants expenses.

Appendix Ia

Improved Spraying Techniques and Novel Survey Methods for Desert Locust Control On 17 – 30 November 2001

Date	Time	Activity
17 Nov	11 am	Travel to Akjoujt
	4 pm	Introduction to workshop
18th Nov	7 30 am – 10 30 am	Familiarization Flights
	11 30 am – 4 pm	Planning workshop on testing protocol of aircraft
	5 pm – 6 30 pm	Test Flights
	Evening	Debrief and discussion / planning
19th Nov	7 30 am – 10 30 am	Test flights
	11 am – 12 noon	Debrief and discussion / planning
	1 pm – 4 pm	Planning Workshop on testing protocol – vehicle
	5 pm – 6 30 pm	Test flights
	5 30 pm – 6 30 pm	Vehicle testing
	Evening	Debrief on flights and discussion / planning
20th Nov	As above	Same as the day before
21st Nov	7 30 am – 12 noon	Application of Metarhizium
		Back to Nouakchott
22nd Nov		Collection and caging of treated insects
23rd Nov		Rest Day
24th Nov	9 am – 3 pm	Preparation of Aircraft and vehicle trails report
25th Nov	9 am – 3 pm	GCP project results
26th Nov	9 am – 3 pm	CLAA – Data management
27th Nov	9 am – 3 pm	GCP Project
	4 pm	Discuss the *Metarhizium* trail results
28th Nov		Evaluation of effect *Metarhizium*
29th Nov	9 am – 3 pm	Finalization of trails report and workshop evaluation
30th Nov		Departure Nouakchott for the SW Asia participants

Appendix Ib

Field workshop – MAURITANIA

Introduction

The aim of this initial workshop is to bring together a few experts from DL affected countries in order to demonstrate new technologies in application of pesticides. Three principal topics will be covered:

1. Field use of the fungus Metarhizium for control of DL
2. The use of Ultralight aircraft for DL survey operations
3. The results of the Norwegian funded project “Improving Pesticides Application Techniques for DL control”, and innovations in the Centre de Lutte Anitacridiennes (CLAA). The results will include a demonstration of the prototype “ Difficult terrain” vehicle developed by the Agricultural University of Norway for use in locust survey and ground spraying.

The experiences gained in implementing this workshop will be used to plan a larger scale workshop involving all the member countries of EMPRES Western Region, plus some participants from EMPRES CR, probably to be held in March 2002. The holding of the larger workshop will depend on the extension of the Norwegian funded project into 2002.

Trail with *Metarhizium*

The EMPRES program is keen to promote the use of Metzrhizium in DL control because of its relative environmental friendliness. In order to increase the awareness of the potential of this control agent, a field trail will be organized in which participants can be involved in the application and monitoring of this agent under field conditions.

The field trail will be undertaken on wild populations of DL, if no suitable population are available, insect from the locust-rearing facility will be used to simulate a larval band. Application will be by handheld sprayer or vehicle mounted sprayer as necessary.

A specialist in the use of this agent will be present to explain and demonstrate the various techniques involved in its use.

Use of Microlight Aircraft for survey

Following a number of requests to FAO, Microlight aircraft will be used to assess its potential as a platform for aerial survey. It is expected that participants will be able to fly in the aircraft to gain practical experience and make judgements as to its suitability in their own conditions.

Results of the project GCP/INT/651/NOR and CLAA

Participants will be able to see and get experience of a number of technologies developed by the project which may be of use in their own countries. This will include DGPS and GPS for track guidance, operator and livestock monitoring methods, data management systems, field trails results and the prototype spraying / transport vehicle.

Organization

It is intend edthat this workshop will be largely based in the field, and will involve a number of nights camping.

Appendix II

List of the participants names and addresses

Name	Country	Address
Dr Jagdesh Prasad	India	Deputy Director Locust Warning Organisation Directorate of Plant Protection, Quarantine and Storage Department of Agriculture Government of India Jodhpur, Rajastan Tel/Fax : 00 291 439749
Fakharul-Zaman	Pakistan	Entomologist Department of Plant Protection Government of Pakistan Ministry of Food, Agriculture and Livestock Anti-Locust Division Bahawalpur Tel : 00 92 621 80236 Fax : 00 92 21 924 8673 Email : locust@fastcom.com
Rabi Abdel-Hamed Khalil	Sudan	Head, Locust Section ELO Sudan PPD, Khartoum North PO Box 14 Sudan Tel/Fax : 00 249 1333 7495 Email : ppdlocust@sudanmail.net
Adel Al-Shaibani	Yemen	Desert Locust Information Officer ELO Yemen Ministry of Agriculture and Irrigation PPD Desert Locust Control Centre PO Box 26 Sanaa Republic of Yemen Tel: 00 967 1 250 956 Tel/Fax : 00 967 1 250 980 Email : Adel_Alshaibana@hotmail.com
Fouad M. Bahakim	Central Region	NPO Survey EMPRES CR Sanaa PO Box 1867 Yemen Tel/Fax : 00 967 120 50980 Mobile : 00 967 711 24046 Email : empr-fao-ye@y.net.ye

		Email: bahakimfuad@hotmail.com
Douro Kpindou	Republic of Benin	Expert – LUBILOSA 08 B.P. 0932 Tri Postal, Cotonou Republic of Benin Tel : 00229 350118, 350600 Fax: 00229 350556 E-mail: dkpindou@cgiar.org
Robert Aston	Mauritania	Chief Technical Advisor GCP/INT/651/NOR BP 665 Nouakchott Mauritania Tel : 00 22 2 5258342 Email : faonorim@toptechnology.mr
Mohamed Abdallahi Ould Babah	Mauritania	Director Centre de Lutte Antiacridienne BP: 3759 Nouakchott, Mauritania Tel. And Fax : 00 222 5259815 00222 5291929 claa@toptechnology.mr
Mohamed Lemine O. Ahmedou	Mauritania	EMPRES WR NPO FAO P. O. Box 665 Nouakchott, Mauritanian Tel. and Fax :00 222 5259815 mohamedlemine@toptechnology.mr
Mohamed Elhadi O. Taleb	Mauritania	National Expert – Locust Biology GCP/INT/651/NOR BP 665 Nouakchott Mauritania Tel : 00 22 2 5258342 Email : faonorim@toptechnology.mr

Dr. Ahmed O. El Haj	Mauritania	National Expert – Locust Biology GCP/INT/651/NOR BP 665 Nouakchott Mauritania Tel : 00 22 2 5258342 Email : faonorim@toptechnology.mr
Ahmed Salem	Mauritania	Centre de Lutte Antiacridienne BP: 3759 Nouakchott, Mauritania Tel. and Fax :00 222 5259815 00222 5291929 claa@toptechnology.mr
Diallo Amadou	Mauritania	Survey Officer Centre de Lutte Antiacridienne BP: 3759 Nouakchott, Mauritania Tel. and Fax :00 222 5259815 00222 5291929 claa@toptechnology.mr
Ahmed Salem O Meme	Mauritania	Garde Nationale Détachement Aérien
Diakité Ousmane		
Hademine Pedro		
Salem O M'bareck		

Appendix III

Microlight Aircraft specifications

- Joker 300 (registration 5T - SAB)
- Motor :Rotax 4 stroke 80 HP
- Dual Ignition
- Maximum speed : 150 Km /hour
- Speed : 120 km /h
- Autonomy : 6 Hours
- Tank capacity : 110 Litres
- Fuel :AVGAS
- Consumption : 13 Litres/100 Km
- Transport capacity : 2 persons (including the pilot)
- Total weight : 450 Kg
- Take off Distance : 200 m
- Landing strip : 200 m

Maintenance :

After 50 hours :

- Change Oil, Oil cartridge, cleaning

After 200 flying hours

- same maintenance plus changing the tyres

After 300 flying hours

- Change : air filter, the spark plugs, fuel filter, motor cylinder-blocs, motor oil

After 600 flying hours

Change : air filter, the spark plugs, fuel filter, motor oil, cable for accelerator and the starter,

- After 800 flying Hours : Engine inspection at the manufacturer.

Appendix IV

Survey requirements

Types of survey
Recession ? Outbreak ?

DATA COLLECTED

Invasion « outbreak »

Swarm

Aircraft requirements

Flying swarm

⇒

-Fast Aircraft for ferry 2 00 KM

1. **LARGE SPEED RANGE**

70 –200 KM/hour
-Big flight autonomy (5 hours)
-Locust proof aircraft
-stability
-High wing
-flight height 100 to <500m
- size of the aircraft windows
- Air strip 500 m
-safety to pilot /observer
-certified by recognised authority
-potential to record GPS/Video/Camera
-Permanent contact Radio

Cost : 500 USD

Settled swarm

Hopper Bands

Flying Height 50 –100 feet

Topography

To identify the difficult areas for vehicles

Recession

It was not defined

-Habitat and Vegetation
-safety & accessibility

Information provided by air /Fixed wing	Information provided by ground survey team
1. Area viewed (seen) Green vegetation& habitat 2. Give information on rainfall trace 3. Covering Inaccessible area 4. Topography 5. Find more locust bands per unit time ? 6. Surveying big size of area in short time 7. area infested by swarm Used during heavy rain 8. Guide the Ground team 9. though knowledge of area by air	1. D locust Behaviour 2. Determine soil moisture 3. Provide clear DL situation 4. Habitat 5. Soil moisture 6. Accessibility 7. Solitary populations 8. Possibility to collect information from others resources (nomads ,militaries…..) 9. Information on rainfall and the last date 10. Density of DL 11. Area surveyed &infested

N.B:The aircraft requirements for , settled and flying swarms are same as for hopper bands

Appendix V

Comparison of visibility from Microlight aircraft between naked eye and binocular by the participants

	500 Feet		200 Feet		100 Feet		50 Feet	
Surveyor	***Naked Eye***	***Binocular***	***Naked Eye***	***Binocular***	***Naked Eye***	***Binocular***	***Naked Eye***	***Binocular***
Rabie	N.A	N.A	+	+++	++	+++	+++	N.A
Prasad	++	++	+	+++	+	++	N.A	N.A
Adel sheibany	N.A	N.A	+	+++	++	++	+	N.A
FakhrAzeman	N.A	N.A	+	+++	+	+++	**	**
Fouad Bahakim	N.A	N.A	+	+++	+	N.A	N.A	N.A

Legend
+ Good
++ Very Good
+++ Exellent
NA :Not applicable.

**** The air plane have not flown at this height due to the wind**

Appendix V - Cont

Observations of the participants regarding visibility of vegetation and simulated hopper band from Microlight aircraft

	500 Feet		200 Feet		100 Feet		50 Feet	
Surveyor	***Hopper band***	***Vegetation***	***Hopper band***	***Vegetation***	***Hopper band***	***Vegetation***	***Hopper band***	***Vegetation***
Rabie			+++	+++				
Prasad	N	++	N	+++	N	*		
Adel sheibany	+	++	+++	+++	+++	+++		
FakhrAzeman	++	++	+++	+++	+++	+++		
Fouad Bahakim	+	++	++	++	+++	+++		
Med Abdallahi	++	++	++	++	++	++	++	++

Legend
+ Good
++ VERY Good
+++ EXCELLENT
N :Not visited
* Microlight could not come down below 200 fleet due to turbulence

Appendix VI

Flight time duration of the workshop participants

Name	17-nov	18-nov	19-nov	20-nov
Rabbi	10mn /pm		45mn/am 42MN/pm	
Prasad	10 mn /pm	30 mn/pm		60 mn/am
Fuad	10 mn /pm		40mn/pm	
Adel		25mn/am	20mn/am	30 mn/am
Fakhar Zaman		15mn/am	40mn/am	30mn/am
Diallo		25mn/am		
Ahmed		20mn+C8/am	30mn	
Rose				4Omn/pm
Med Abdallahi				40 mn/am
Total	30 mn	120mn	210mn	180mn

Appendix VII

Comparison of various type of aircraft for desert locust survey based on the experiences of the participants in the workshop:

Parameters	Microlight	Cessna	Pawnee	PA 28	Antonov	HelicopterB206
Wing	High	High	Low	High	Low&high	Rotor
Radio	✔	✔	✔	✔	✔	✔
Autonomy	6h	5h	3h	4h	4h	3h
Min Flying Height	50 Feet	50 Feet	50 Feet	50 Feet	30Feets	0feet
Speed ferry	120 km/h	170 km./h	150 km/h	160 km/h	120km/h	120km/h
Visibility/Windows	+++	++	+++	++	++	+++
Stability	+	++	++	++	+++	+++
Air strip	200m	800 m	300 m	?	350 m	0 m
Maintenance	easy	difficult	Difficult	difficult	easy	difficult
FUEL/h	13 L	65L	60L	60L	200L	100 L
fuel Type	avgas	avgas	Avgas	avgas	avgas	kerosene
Hiring cost/h	100 $	500 $	400 $	240 $	800 $	1500 $

Legend:

\+ **:Good**
++ **:Very good**
+++ **:Excellent**

Appendix VIII

				(indicate appropriate information as required)			
1	**SURVEY STOP**	**6**					**6**
1-1	date	12.01.2001	12.01.2001	12.02.2001	12.02.2001	12.03.2001	
1-2	name	Maguour	5P	Khat Elmouinan	T Gudom	H ojool	
1-3	latitude (N)	18 59 48.9N	18 27 58.1N	18 52 18.7N	18 52 22.3N	18 42 43.5N	
1-4	longitude (E or W)	014 08 26.8W	012 50 25.5W	012 07 51.5W	012 10 43.9W	012 02 35.7W	
2	**ECOLOGY**						
2-1	area (ha) of survey	20 ha	30 ha	?	100 ha	5 ha	
2-2	habitat (wadi, plains, dunes, crops)	Dunes	Dunes	plain	plain	Wadi	
2-3	date of last rain	28/11/01	28/11/01	28/11/01	28/11/01	28/11/01	
2-4	rain amount (mm, Low Moderate High, ?)	Low	M	Low	M	Low	
2-5	vegetation (dry, greening, green, drying)	green	green	Greening	Greening	Greening	
2-6	vegetation density (Low Medium Dense)	M	D	Low	Low	Low	
2-7	soil moisture (wet/dry)	W	W	W	W	W	
3	**LOCUSTS**						
3-1	present or absent	Present	Present	Absent	Absent	Absent	
3-2	area infested (ha)	10 ha	3 ha				
4	**HOPPERS**						
4-1	hopper stages (H123456F)		1st , 2 nd				
4-2	appearance (solitary, transiens, gregarious)		Solitary				
4-3	behaviour (isolated, scattered, groups)		Isolated				
4-4	hopper density (/site, /m2, Low Med High)		L				
5	**BANDS**						
5-1	band stage (H12345F)						
5-2	band density (/m2 or Low Medium High)						
5-3	band sizes (m2 or ha)						
5-4	number of bands						
6	**ADULTS**						
6-1	maturity (immature, mature)	M					
6-2	appearance (solitary, transiens, gregarious)	Solitary					
6-3	behaviour (isolated, scattered, groups)	Isolated					
6-4	adult density (/transect, /ha, L M H)	1/ 100 m2 (L)					
6-5	breeding (copulating, laying)						
7	**SWARMS**						

7-1	maturity (immature, mature)						
7-2	swarm density (/m2 or Low Medium High)						
7-3	swarm size (km2 or ha)						
7-4	number of swarms						
7-5	breeding (copulating, laying)						
7-6	flying (direction, time passing)						
7-7	flying height (Low Medium High)						
8	**CONTROL**						
8-1	pesticide name & formulation						
8-2	application rate (l/ha or kg/ha))						
8-3	quantity (l)						
8-4	area treated (ha)						
8-5	ground or air						
8-6	estimated % kill						
9	**COMMENTS**						
							kc 99.03
Was a GPS used to determine locations? yes			Is a brief interpretation or analysis of the results included? yes				
						date :	
						date :	