Desert Locust Guidelines

2. Survey

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First edition – 1992
Second edition – 2001

Food and Agriculture Organization of the United Nations

Rome, 2001

PREFACE

The Desert Locust plague of 1986-89 and the subsequent upsurges in the 1990s demonstrate the continuing capacity of this historic pest to threaten agriculture and food security over large parts of Africa, the Near East and southwest Asia. They emphasize the need for a permanent system of well-organized surveys of areas that have recently received rains or been flooded, backed up by control capability to treat hoppers and adults efficiently in an environmentally safe and cost-effective manner.

The events of 1986-89 showed that, in many instances, the existing strategy of preventive control did not function well, for reasons including the inexperience of the field survey teams and campaign organizers, lack of understanding of ultra low volume spraying, insufficient or inappropriate resources and the inaccessibility of some important breeding areas. These reasons were compounded by the general tendency to allow survey and control capacity in locust-affected countries to deteriorate during locust recession periods. To address this, FAO has given high priority to a special programme, the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES), that will strengthen national capacities.

Given the certainty that there will be future Desert Locust upsurges, FAO produced a series of guidelines primarily for use by national and international organisations and institutions involved in Desert Locust survey and control. The guidelines comprise:

1. Biology and behaviour
2. Survey
3. Information and forecasting
4. Control
5. Campaign organization and execution
6. Safety and environmental precautions

Appendixes (including an index) are provided for easy reference by readers.

This second edition has been produced to update sections on technology and techniques that have undergone changes in the seven years since first publication, to modify presentation of the material, to make it easier to understand and to facilitate updates in the future. The revision was carried out by K. Cressman of FAO and H.M. Dobson of the Natural Resources Institute, United Kingdom, with input from many locust and locust-related specialists around the world. This edition will be available in the three key languages of the locust-affected countries, English, French and Arabic.

I would like to extend my gratitude to all those who have been involved in this important contribution to improved Desert Locust management.

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24 September 2001

Contents

ACKNOWLEDGEMENTS

FAO is grateful to P.M. Symmons who produced the first edition of the guidelines, to K. Cressman and H.M. Dobson who revised and updated it, and to S. Lauer who produced most of the illustrations. FAO would also like to thank T. Abate, B. Aston, F. Bahakim, L. Barrientos, T. Ben Halima, D. Brown, M. Butrous, M. Cherlet, J. Cooper, C. Dewhurst, J. Duranton, C. Elliott, A. Hafraoui, M. El Hani, T. Galledou, S. Ghaout, G. Hamilton, Z.A. Khan, M. Lecoq, J. Magor, G. Matthews, L. McCulloch, M. A. Ould Baba, J. Pender, (the late) G. Popov, T. Rachadi, J. Roffey, J. Roy, S. Simpson, P.M. Symmons and H. van der Valk for their comments and criticism on this new version. Acknowledgements are also due to R. Mitchell and C. Smith-Redfern for general editorial advice, K. Whitwell for indexing, Medway Design Team, University of Greenwich and Andrew Jones for production of digital artwork and to manufacturers for providing illustrations of their equipment. The Control guideline and parts of the Appendixes are outputs from a project funded by the United Kingdom's Department for International Development (DFID) for the benefit of developing countries and carried out by the Natural Resources Institute. The views expressed in these sections are not necessarily those of DFID.

INTRODUCTION

This guideline is intended mainly for use by field staff involved in locust survey operations. Some parts will be useful reference material for training new staff and providing refresher training to experienced locust officers. The information and reference data may also be useful for senior managers planning and overseeing surveys and for donor representatives assessing technical needs.

The guideline contains practical guidance on equipment and techniques used to carry out Desert Locust survey which is effective (monitors the habitat and locusts in the best possible way) and efficient (in terms of minimum time and cost).

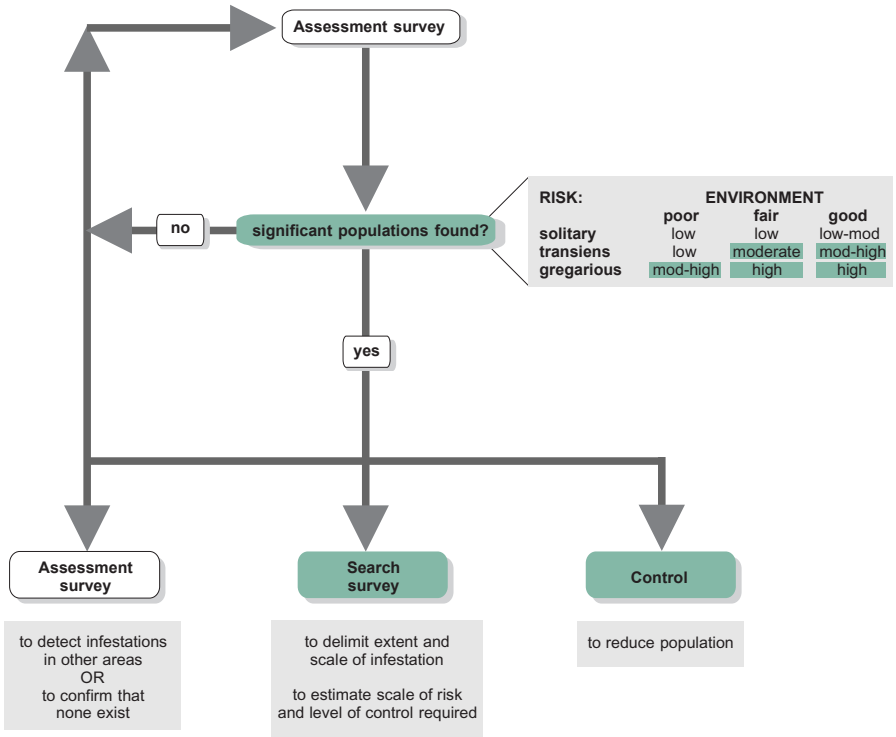
The basic principles of surveying are relatively simple and the advice given here should give good results in most cases. Locust survey staff in the field must also understand the theory explained in this guideline in order to make informed decisions on where to look for locusts and what data to collect and report in order to modify their technique to cope with the many different circumstances they will encounter.

Information, advice, procedures and explanations are given on the right-hand pages of the publication; illustrations and summaries are given on the left-hand pages. When appropriate, tips and warnings may appear on either side.

There is also a series of Frequently asked questions (FAQs). These deal with some of the common problems encountered by locust field staff. Answers are given where available, but further research is needed in some areas, and FAO welcomes feedback on new information and solutions.

Much of the information in this guideline is relevant to survey of other types of locust and some grasshoppers, but techniques may have to be adapted to match the particular characteristics and habitat of the target species.

Figure 1. Summary of the survey process.



RISK	
low	insignificant populations; unlikely to require any further assessment
moderate	significant populations; requires additional assessment
moderate-high and high	significant populations; requires substantial assessment and search

SURVEY PROCESS

A logical approach is required in monitoring Desert Locusts and their habitat in order to collect the maximum amount of information in the shortest possible time, using the minimum resources.

Surveys should be planned according to the locust situation, ecological conditions in the field and the risk that populations may develop further and require additional monitoring and perhaps control (see Fig. 1 and p. 4-5).

Step 1. Identify who will make a survey. Usually this will be a Locust Field Officer but it could be a local scout followed up by a Locust Field Officer to confirm findings – see p. 6-7.

Step 2. Determine where and when to make the survey. This should be in those places where and at times when you expect to find locusts; for example, in traditional locust habitats, in places where locusts were previously reported, or where rain has recently fallen – see p. 8-9.

Step 3. Decide which type of survey. In a recession, this will usually be assessment – see p. 10-11.

Step 4. Decide whether the survey is to be done by ground or by air. Aerial survey is more suitable for identifying areas of green vegetation after rainfall. It will not find solitarious locusts – see p. 10-21.

Step 5. Prepare the vehicles and make sure you have the necessary equipment – see p. 22-23.

Step 6. Make a rapid assessment survey unless you know that locusts are present. This is usually done by foot and vehicle transects at survey stops and by interviewing people along the route – see p. 10-17, 24-25 and 48-49.

Step 7. Collect the required information and record it on the survey forms – see p. 26-45.

Step 8. Transmit the survey results to the Locust Unit headquarters as quickly as possible – see p. 46-47.

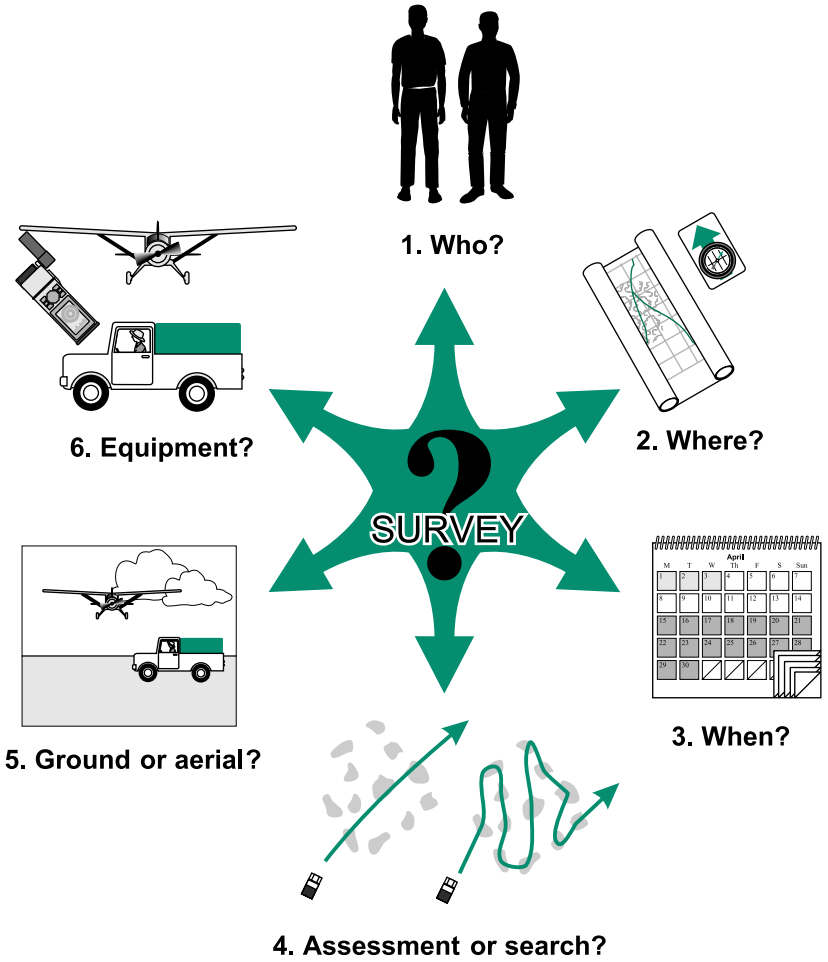
Step 9. If significant populations are found, make a search survey to identify as precisely as possible the extent and size of the infestations, and the control requirements – see p. 10-11.

Step 10. Based on the survey results, plan the timing and location of the next survey – see p. 8-9.

Summary of the purpose of surveys:

- to collect information to assess the locust situation and habitat conditions
- to collect information for planning
- to identify control targets

Figure 2. Some of the different decisions that should be made when planning a survey.



WHY MAKE SURVEYS?

Surveys are undertaken to collect information in order to assess the locust situation and habitat conditions in the field. Based on the results of a survey, the need for further surveys or the initiation of control operations can be determined. During surveys, control targets may be identified so that decisions can be made on the most suitable control method. Additional information can be collected during surveys from villagers, nomads and travellers (see Other sources of information on p. 47).

HOW TO PLAN A SURVEY

In order for surveys to be effective and to use resources as efficiently and economically as possible, they need to be well planned (see Fig. 2). Therefore you must decide:

- who should make a survey
- where to make a survey
- when to make a survey
- whether it is an assessment or a search survey
- whether it is a ground or aerial survey
- what equipment is required for the survey

Tip: plan surveys according to:

- ***the presence of significant populations***
- ***scientific knowledge or advice***
- ***the risk that populations will develop further***

Summary of those who should make surveys:

- qualified and experienced locust field officers supplemented by agricultural extension agents and scouts

Figure 3. A good locust monitoring programme involves qualified locust field officers as well as local scouts and extension agents.

Qualified locust field officers

Local scouts, extension agents and others

Who makes a survey

In most countries, qualified and experienced Locust Field Officers should undertake surveys to monitor habitat conditions and the locust situation (see Fig. 3). These officers may be based in a centralized Locust Unit in the capital or, in the case of larger countries, in field bases.

Local scouts may be employed to monitor small areas. Although information from these people may lack precise details, it can be used in planning surveys by the Locust Field Officers. For example, local scouts may be responsible for checking an area every month or after it rains. During one of these checks, they find some locusts. This is reported to the Locust Unit who then sends one of its Locust Field Officers to visit the area with the scout and make a survey to confirm the presence of locusts and collect the necessary details.

Agricultural Extension Agents can be used in a similar manner, although they are likely to have other duties. Information from these sources may not give you a complete picture of the situation, since extension agents are often confined only to agricultural zones and will not check desert areas.

A good locust monitoring programme should not rely solely on scouts or Extension Agents, but utilize all available information sources.

! **Do not depend solely on Agricultural Extension Agents for monitoring Desert Locusts because they are only likely to survey cropping areas. By the time locusts are seen in these areas, there may be large infestations which are beyond the control capacities of the National Locust Unit and an outbreak could quickly develop and threaten other areas.**

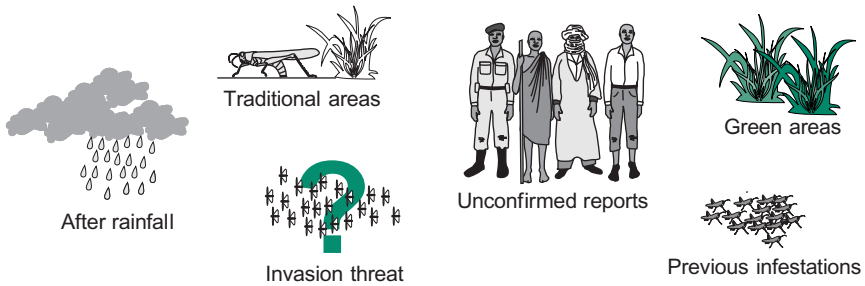
? **FAQ number 1 (see p. 54 for answers)**

Is it better to have a centralized or a decentralized programme for monitoring locusts?

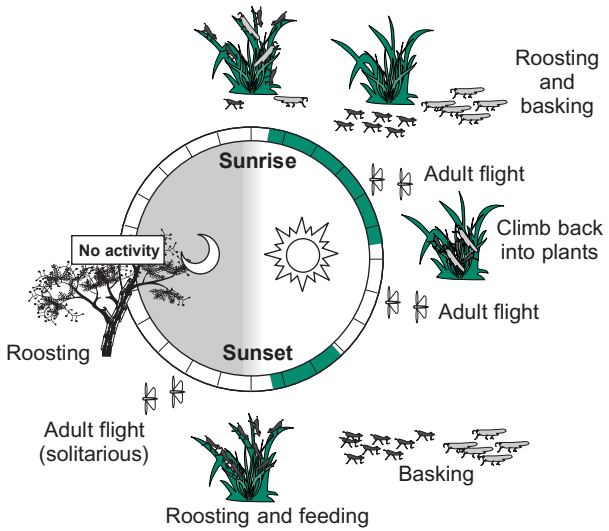
Summary of where and when to make surveys:

- in favourable habitats
- on a regular basis
- during the rainy season
- after reports of rainfall or locusts
- if there is a threat of an invasion

Figure 4. Locust surveys should be undertaken where and when locusts are most likely to be present.



Where and when to survey during the year



When to survey during the day (after sunrise to about midday + late afternoon)

Where and when to make a survey

Locust surveys should be undertaken in areas where locusts are most likely to be present (see Fig. 4). This depends on the distribution of rainfall, temperature and the presence of green vegetation in historical locust habitats within the country as well as in neighbouring countries. Results from an initial survey by air to identify green areas can be used to reduce the large areas required to be checked by ground. Remote sensing imagery and meteorological data may also be of help in identifying areas of green vegetation or where it may have rained (see the Information and forecasting guideline and the Appendixes).

Particular attention should be given to those habitats that are known to be especially attractive to locusts and those where infestations have frequently occurred in the past (refer to the *FAO Atlas of Desert Locust Habitats*). It is important to carry out surveys in these areas after rainfall occurs, usually waiting about two weeks to allow vegetation to become green.

Often there is no information from a certain area about rainfall, vegetation conditions or locusts. In this case, it may be useful to carry out a survey to collect the information required to assess the situation. Surveys should be carried out after rains have been reported or are thought to have fallen. They should be undertaken to confirm reports of green vegetation or locusts received from villagers, travellers, traders or nomads. Surveys should also be organized if there is a threat of locust invasion from a neighbouring area or country in order to detect the arrival of the incoming populations.

Survey itineraries should include those areas previously identified with green vegetation or locust infestations, areas that are known to have been favourite locust habitats in the past and areas in which there is no information. Survey routes should avoid roads and tracks and concentrate on areas where locust infestations are most likely to be found. An itinerary may be modified during the survey according to the results at each survey stop.

Surveys should be carried out during the day when locusts are most likely to be seen (see Fig. 4). The precise timing will depend on the temperature, weather and habitat. In general, it is best to undertake surveys from shortly after sunrise to about midday and again in the afternoon for a few hours just before sunset. At midday when the temperature is high (above 38°C), adults and hoppers are likely to seek shelter inside the vegetation and will, therefore, be difficult to see.

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FAQ number 2 (see p. 54 for answers)

Is it enough just to carry out surveys in agricultural areas such as farms?

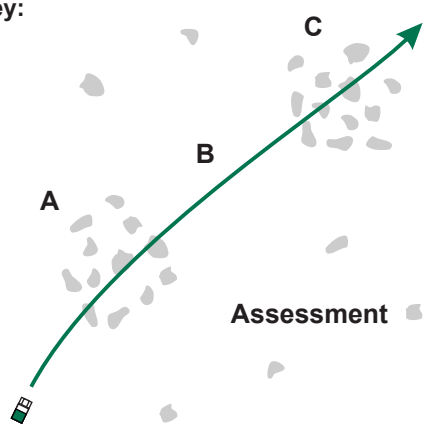
There are two types of surveys:

- assessment
- search

Figure 5. Assessment surveys are first undertaken to see if locusts are present. If significant populations are found, then the area is intensively searched (called a search survey) to estimate the total infested areas and delimit them for subsequent control operations.

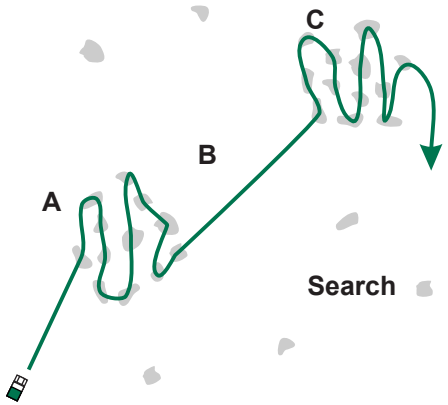
1. First, make an assessment survey:

Locusts present at A and C; nothing at B



2. If gregarious locusts, groups or high numbers of solitary locusts are found, make a search survey:

A and C are thoroughly searched, but there is no need to spend time at B



Locust infestations

What type of survey to make

Two basic types of surveys can be distinguished (see Fig. 5).

- *Assessment* surveys are conducted in areas that have a history of locust breeding or presence, or where rain has recently been reported or thought to have occurred, or where reports of locusts have been received from locals, nomads, scouts or agricultural extension agents. The purpose of assessment surveys is to (1) monitor locust populations and assess the suitability of the habitat for breeding, and (2) determine whether significant populations are present that may require control.

- *Search* surveys are conducted in areas known to contain significant populations in order to (1) estimate the total infested areas, and (2) delimit the areas that require control (see p. 51 in the Control guideline). Results from searching will allow decisions on if, when and how control should be conducted.

An assessment survey is generally the first type of survey to be undertaken in order to determine if locusts are present in an area or to identify areas of green vegetation. Estimates of locust densities made at each survey stop can be used to identify those areas where significant numbers of locusts (i.e. gregarious locusts, groups or high numbers of solitary locusts) are present.

If areas are identified that contain significant numbers of locusts, then a search survey is conducted in which the particular area is carefully checked to determine the geographical extent and size of the infestations. From this information, the scale of risk and level of required control can be estimated. If insignificant numbers of locusts are found during an assessment survey, then there is no need to carry out a search survey. Instead, another assessment survey should be conducted at a later date, depending on habitat conditions and rainfall.

If several survey teams are operating in the field at the same time, it is critical that some of the teams continue to make assessment surveys while others search in the area where significant locusts were found. Information from both survey types will provide a better and more complete picture of the overall locust situation.

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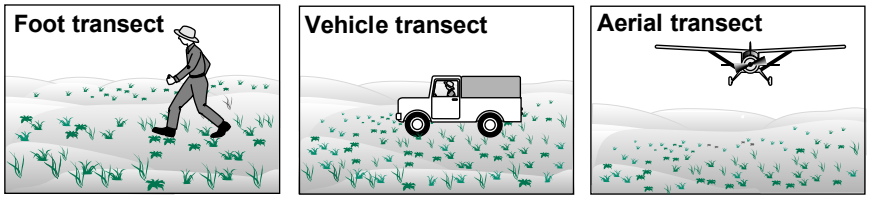
FAQ number 3 (see p. 54 for answers)

Is it possible to find all locust infestations during a survey?

Summary of survey methods:

- foot transect
- vehicle transect
- aerial transect

Figure 6. Examples of the three methods of surveys often used to monitor locusts.



Work rate of different survey methods

	Foot	Vehicle	Aerial [1]
Distance travelled/hour	4 km	30 km	200 km
Distance travelled/day	20 km	200 km	600 km
Width of search:			
low density populations	10 m	10 m	n.a.
hopper bands [2]	0.1-2 km	0.1-2 km	0-5 km
settled swarms [2]	0.1-2 km	0.1-2 km	0-10 km
flying swarms (range)	20 km (5-50 km)	20 km (5-50 km)	30 km (5-100 km)
Area of search:			
low density populations	0.2 km²	2 km²	n.a.
hopper bands [2]	2-40 km²	20-400 km²	0-3 000 km²
settled swarms [2]	2-40 km²	20-400 km²	0-6 000 km²
flying swarms (range)	400 km² (100-1 000 km²)	400 km² (1 000-10 000 km²)	18 000 km² (3 000-50 000 km²)

1 fixed-wing aircraft

2 including information from local inhabitants during foot and vehicle surveys

Source: Roffey, J. (1965)

Which survey method to use

There are three survey methods: foot transects, vehicle transects and aerial transects (see Fig. 6). These methods can be used when making assessment or search surveys.

The amount of time spent at each stop during a ground survey will determine how many stops can be made in a day. The more time spent at a single stop means fewer stops can be made. Usually 15-20 minutes at a single stop is enough time to collect the required information and still allows about six to ten stops to be made during a morning or afternoon of survey.

The results of locusts counted during foot and vehicle transects can be used to compare the relative numbers of locusts seen at different stops made during this or other surveys.

Surveys can also be carried out by air using a fixed-wing aircraft or a helicopter. Aircraft can be used during assessment surveys to identify areas of green vegetation at the beginning, middle and end of a rainy season. Aerial surveys can also be undertaken to assess locust infestations during periods of increased locust activity, for example when swarms or bands are present. Only experienced observers can detect these from the air.

Helicopters can be used to identify areas of green vegetation, swarms and large hopper bands from the air. By flying very close to the ground, the downdraft from a helicopter will usually disturb any solitarious or gregarious adults if present. A helicopter can also land where required to allow the Locust Field Officer to make a foot transect or mark an infestation for control.

Due to the high cost of using aircraft, a search survey is rarely made by air.

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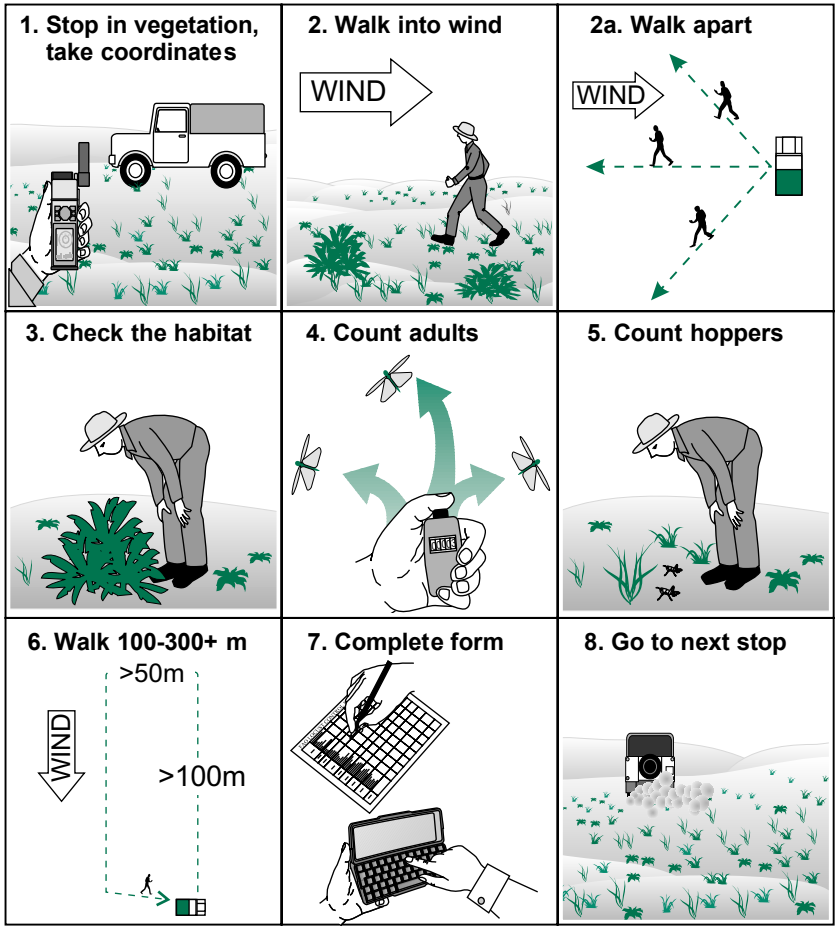
FAQ number 4 (see p. 54 for answers)

Are foot transects more accurate than vehicle transects for counting locusts?

Summary of how to make a foot transect:

- walk about 300 m
- count adults that fly up
- estimate transect width (locust disturbance)
- inspect at least 10 bushes or 10 one m^2 patches on the ground for hoppers
- check soil moisture
- count when temperature >20°C and wind <6 m/s

Figure 7. The steps in making a foot transect.



Foot transects

A foot transect consists of walking a certain distance in the desert and making observations in order to collect data about locusts, rainfall, vegetation and soil (see Fig. 7). While the distance does not always have to be the same or very precise, the observations should be detailed and thorough. The following method is suggested:

1. Stop in areas where locusts may be present, usually those that are sandy such as plains and dunes and close to seasonal rivers (wadis) where green annual vegetation is present. After stopping the vehicle, write down the date, the name and the latitude and longitude of the location using a global positioning system (GPS) (see Fig. 7.1). If you do not have a GPS, determine the approximate position using a map. It may be necessary to ask a local person the name of the place.
2. Walk into the wind (upwind) or crosswind (see Fig. 7.2). If more than one person is making a transect, each one should go in a different direction (see Fig. 7.2a). There is no need for two people to walk together. It is much better to go in different directions. Start by walking at least 100 m. Estimate this distance from the number of steps that you take (See Appendix 2.2).
3. As you walk, observe the greenness and density of the vegetation (see Fig. 7.3). Stop several times to check if the soil is moist. Count locusts that fly up in front and to the side, being careful not to count the same one more than once. A hand tally counter may be used (see Fig. 7.4). Note locust colour, behaviour and maturity. You may want to try to catch a few. Determine the width of your transect by estimating the distance in which adults are being disturbed when walking (usually about 1-4 m on either side, depending on the time of day, temperature and habitat).
4. Stop occasionally and closely inspect the ground and the vegetation for hoppers, noting what instar stage, colour, behaviour and number per bush or per square metre (see Fig. 7.5). Repeat this up to ten times. After walking at least 100 m, the Locust Field Officer should return to the vehicle by a different route at least 50 m away from the first route, continuing to count locusts (see Fig. 7.6). The results should be written down on the survey form or entered into a handheld computer before going to the next stop (see Fig. 7.7).

Foot transects should not be undertaken during the middle of the day when it is too hot and locusts are likely to be inside the vegetation and difficult to see. Transects should also not be undertaken when the wind is strong – more than about 6 m/s (20-25 km/h) – because it will be difficult to disturb adult locusts.

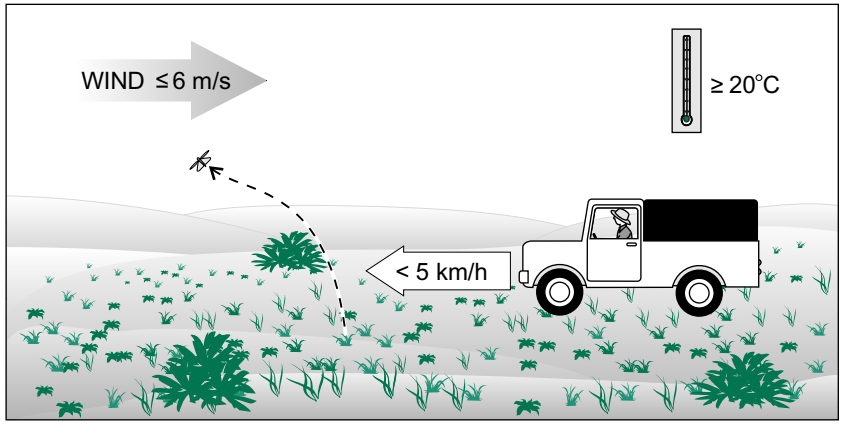
Tip: estimating transect length

- ***determine in advance how many of your steps equals 100 metres (see Appendix 2.2)***
- ***decide how far you want to walk, for example: if 110 steps/100 m, then a 300 m transect is: 110 x 3 = 330 steps***

Summary of how to make a vehicle survey:

- drive upwind or crosswind for at least 1 km
- drive at a walking pace in low (4WD) gear
- count adults that fly up in front of the vehicle's hood
- keep track of the distance driven using the odometer
- count only when the temperature is above 20°C and wind speed less than 6 m/s

Figure 8. How to make a locust survey by vehicle.



Vehicle transects

Vehicle transects are a useful method to determine if adults are present over a large area such as a sandy plain or within large areas of green vegetation. By counting the adults, an estimate can be made of how many are present in the transect. It is very difficult to see hoppers from a moving vehicle and therefore it is better to do this using the foot transect method.

Estimates of adults can be made from a vehicle by looking out of the front window and counting adults that fly up in front of the vehicle in a strip equal to the width of the vehicle, about 1.5 m in most cases (see Fig. 8). The vehicle must be driven at a walking pace in low gear. It should be driven upwind or crosswind to reduce the number of adults that are counted more than once. Most of the adults in the strip will fly up if it is sunny and warmer than 20°C and wind speed is less than 6 m/s (20-25 km/h). If you drive too fast (more than 5 km/h), the adults will not fly up and you will think that there are no locusts present. The transect distance should be measured using the odometer. Vehicle transects should be at least one km in length.

Results from vehicle transects should be noted in the comments section of the next survey stop on the *FAO Desert Locust Survey and Control Form*, simply stating the number of locusts seen in the distance (km) travelled, for example 10 locusts/1 km.

Vehicles can also be used to measure the sizes of settled swarms and large hopper bands (see the Band and swarm sizes section on p. 43) and to delimit target blocks of bands or a scattered swarm for control (see p. 51 in the Control guideline).

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FAQ number 5. (see page 54 for answers)

Vehicle transects sound much easier and faster to make, so why not just use this method for making locust surveys?

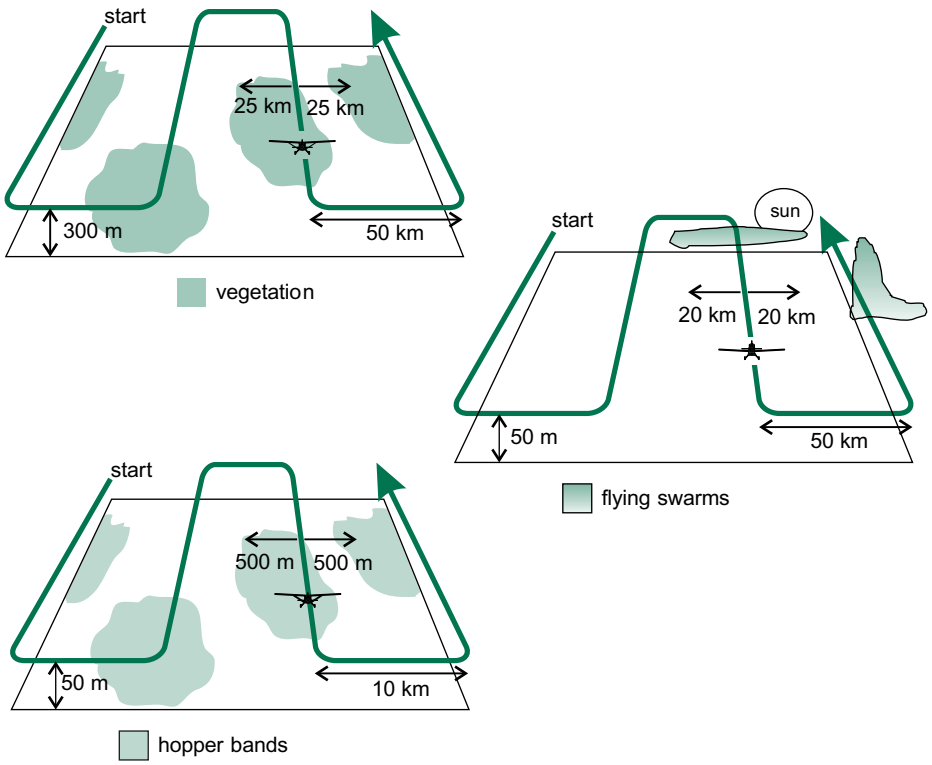
Desert Locust Guidelines

Summary of how to make a survey by aircraft:

For finding green vegetation:
- fly about 300 m above the ground
- use a track spacing of 50 km
- survey at beginning, middle and end of rainy season

For swarms and hopper bands:
- fly about 50 m above the ground
- use a track spacing of 10 km (bands) to 50 km (swarms)
- do not survey for more than 3 hours at a time

Figure 9. How to make a survey by a fixed-wing aircraft.



Information to be collected

- coordinates of green vegetation
- coordinates of any swarms or bands

Fixed-wing aircraft surveys

Fixed-wing aircraft can be used mainly to identify areas of green vegetation from the air (see Fig. 9). They can also be used to identify swarms and hopper bands during periods of increased locust activity. The most suitable fixed-wing aircraft for green vegetation and hopper band surveys are those with high wings to allow better visibility. A low wing configuration is more appropriate for swarm surveys when the observer must look above the horizon. Flights of more than three hours should be avoided, otherwise search efficiency will decline. Experienced pilots are required who know the terrain and are trained in how to make locust surveys by air.

Surveys for vegetation should be undertaken at the beginning of the rainy season to identify those areas that are first becoming green. Surveys may be repeated midway through the season and once again at the end of the season. Results from such surveys can be used to determine what areas need to be checked by ground surveys. Areas of green vegetation can be mapped by flying about 300 metres above the ground in a straight line. During clear atmospheric conditions, it is possible to see up to about 25 km on each side of the aircraft at this height. The pilot should fly in a straight line up to a predetermined point, then turn 90 degrees right (or left), fly for 50 km and then turn 90 degrees right (or left) to start the second pass. In this way, the track spacing is 50 km or about every half degree square.

Surveys for flying swarms should be undertaken when they are most likely to be seen, i.e. from about 1000hrs to about 1700hrs. The pilot should fly about 50 m above the ground so that the maximum number of locusts are above the horizon and will look similar to smoke. If the pilot flies higher, swarms may be visible when looking downwards into the sun. Medium density swarms can be seen up to about 10-20 km from the aircraft or up to 120 km in optimal conditions when flying higher. In order not to miss swarms, the same area should be surveyed every three to four days and adjacent areas checked on successive days.

Hopper band surveys should be undertaken in the early morning and in late afternoon. Bands are easiest to see from the air if they are in dense groups. The observer should look ahead and to the side of the aircraft. It will be difficult to see bands in continuous or substantial vegetation cover such as trees, bushes, shrubs and tussock grasses. Otherwise, bands should be visible up to about 500 m or more from the aircraft when there is little ground vegetation or in areas of scattered trees and shrubs. Marching and early instar bands are less conspicuous than grouping or late instar bands. It may be useful to undertake a preliminary flight to determine if bands can be seen from the air. When searching for bands, the pilot should fly in parallel lines about 10 km apart.

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FAQ number 6 (see p. 54 for answers)

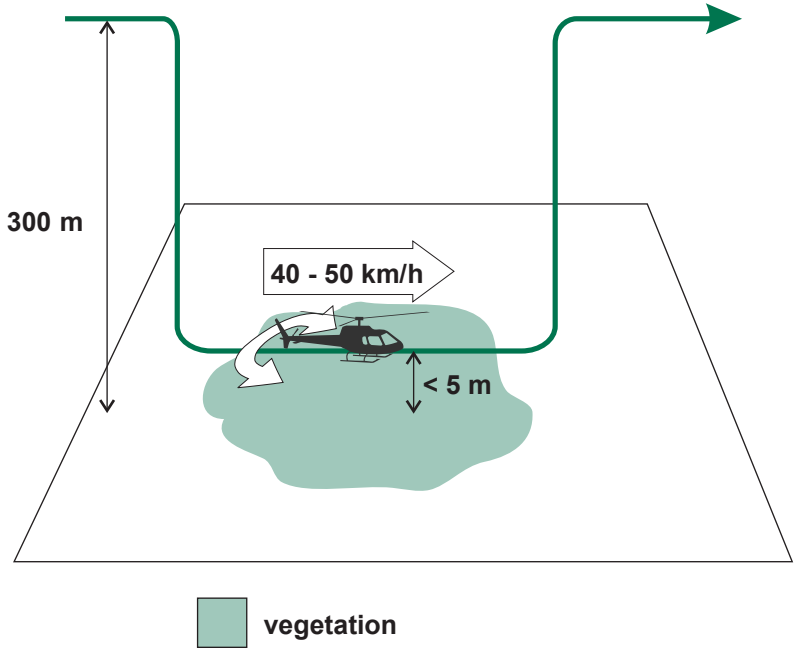
What logistical support and additional equipment are required for aerial surveys using fixed-wing aircraft?

Summary of how to make a survey by helicopter:

For finding green vegetation and locusts:

- fly about 300 m above the ground
- use a track spacing of 50 km
- fly towards green vegetation and level out at 5 m or less above the ground
- reduce speed to 40-50 km/h and swing the tail from side to side
- look towards the rear of the helicopter for flying locusts
- use a skilled pilot with agricultural experience

Figure 10. How to make a survey by helicopter.



Helicopter surveys

Helicopters can be used to identify areas of green vegetation and locust infestations such as swarms and hopper bands from the air. They can be used to flush out moderate to high numbers of individual adults from vegetation. Helicopters can also be used to verify unconfirmed reports of infestations and visit areas that are difficult to access by vehicle. The main advantage of using a helicopter when compared to fixed-wing aircraft is its ability to land almost anywhere and allow the Locust Field Officer to get out and make a foot transect in the area of interest.

For identifying areas of green vegetation, the helicopter should fly about 300 metres above the ground in a straight line, similar to that for fixed-wing aircraft. Settled swarms and large hopper bands should also be visible by looking down at an angle from this height. To determine whether an area of green vegetation contains individual locust adults, the pilot should first identify the green area, then drop down to just a few metres above the ground (as low as safely possible and not higher than 5 metres above the ground), reduce the speed to 40-50 km/h and fly over the vegetation and swing the tail from side to side (see Fig. 10). This will disturb any locusts that may be present and they will fly up from about midpoint under the helicopter. The observer should look out of the window towards the rear to see if locusts fly up behind the helicopter. Upon reaching the end of the green vegetation, the pilot should increase altitude and speed.

Information to be collected

- coordinates of green vegetation
- coordinates of any swarms, bands or adults

?

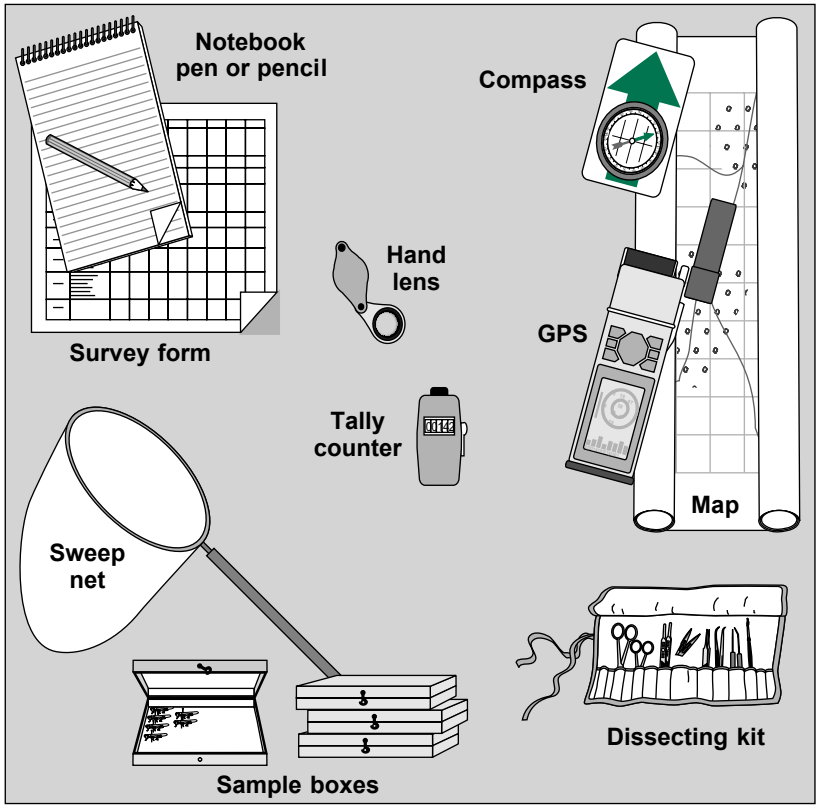
FAQ number 7 (see p. 54 for answers)

What support is required for helicopters engaged in aerial survey and are there certain advantages of using helicopters?

Summary of equipment to take on a survey:

- compass
- hand lens
- hand tally counter
- map of 1:500 000 scale or less
- notebook, pen or pencil
- global positioning system (GPS)
- *FAO Desert Locust Survey and Control Form*
- dissecting kit, sweep net, sample boxes

Figure 11. Some essential items that should always be taken when going on a survey.



What equipment to take on a survey

A limited amount of equipment is needed by the Locust Field Officer to use during the survey to assist in collecting information such as the precise coordinates of a location, the number of locusts and their maturity (see Fig. 11). This equipment should be assigned to the Locust Field Officer so he or she always has access to it and can use it whenever surveys are undertaken.

Equipment must be properly maintained and checked to ensure it is in good operating condition. Defective equipment should be repaired or replaced as required.

?

FAQ number 8 (see p. 54 for answers)

Is it better to keep this expensive equipment in storage and use it only during control operations or during locust plagues?

Summary of survey organization:

- one vehicle
- one Locust Field Officer per vehicle
- remote areas: two vehicles
- possibility of seasonal base camp
- check green vegetation areas
- two vehicles: use leapfrog method

Figure 12. It is best to stop in those places which are most favourable for Desert Locusts, i.e. sandy areas with green vegetation.

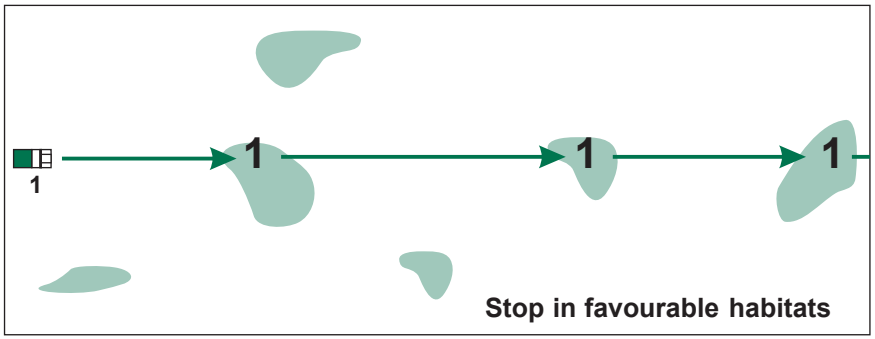
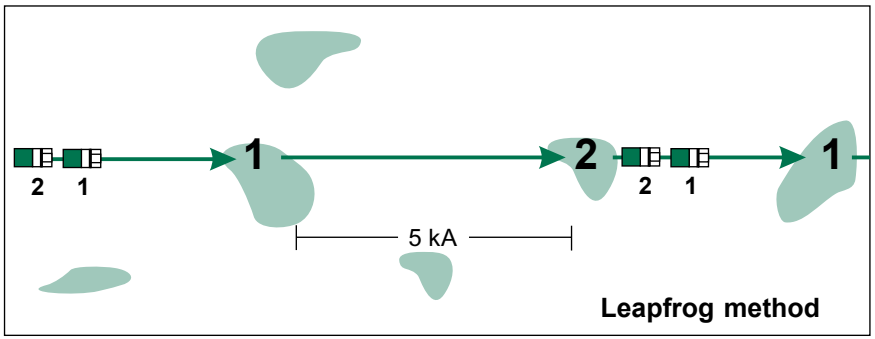


Figure 13. A leapfrog method can be used when two vehicles are used for survey. In this way, nearly double the area can be covered.



HOW TO ORGANIZE A SURVEY

The survey team should be as small as possible to allow maximum autonomy and mobility. In areas that are close to villages, one vehicle and one Locust Field Officer are probably sufficient. In areas that are difficult to access, an additional vehicle and officer may be required. In areas where water and fuel are not available, a support vehicle will be needed. In remote or insecure areas or areas where land mines may be present, it may be necessary for a local guide or security officer to accompany the survey team.

If many surveys are to be undertaken in a remote area during a breeding season, a small base camp may need to be established for several months where heavier equipment and extra staff can be located. Teams could then survey the surrounding areas for several days at a time before returning to the base camp for additional supplies. This is much more efficient than driving long distances to the nearest village at the end of every day.

Surveys should stop in favourable locust habitats which is usually in sandy areas where there is green vegetation (see Fig. 12). If two vehicles are available, a leapfrog method of surveying can be used (see Fig. 13). The first vehicle stops in green vegetation and surveys a site while the second vehicle drives ahead for about five kilometres where it stops in green vegetation and makes a survey. After the first vehicle is finished, it drives ahead to meet the second vehicle. Both vehicles proceed together until the first one stops again to survey while the second one continues for another five or so kilometres before it stops and makes a survey. In this way, nearly double the area can be surveyed than if both vehicles were to stop at the same place.

Summary of data to be collected:

- date and location
- ecology (rain, vegetation, soil)
- locust
- control

Figure 14. An example of a completed *FAO Desert Locust Survey and Control Form* used for recording information.

FAO DESERT LOCUST SURVEY AND CONTROL FORM page ___ of ___

please send to FAO HQ by fax (+39-06-57055271) or email (eclo@fao.org)

(indicate appropriate information as required)

		1	2	3	4	5	6
1	**SURVEY STOP**						
1-1	date	29.07.99	29.07.99	30.07.99	31.07.99	31.07.99	31.07.99
1-2	name	Wadi Hamid	Berika	Khor Amer	Bir Bou Ali	Shardi	Abu Qashim
1-3	latitude (N)	210255	210544	203149	200411	200159	194842
1-4	longitude (E or W)	331218	340122	342402	335512	334536	331514
2	**ECOLOGY**						
2-1	area (ha) of survey	100	250	20	100	200	50
2-2	habitat (wadi, plains, dunes, crops)	wadi	dunes	wadi	plains	plains	dunes
2-3	date of last rain	15.07.99	2 weeks ago	12.07.99	about 1 month	13.07.99	13.07.99
2-4	rain amount (mm, Low Moderate High, ?)	(L) M H ?	L (M) H ?	L (M) H ?	L M H (?)	(L) M H ?	(L) M H ?
2-5	vegetation (dry, greening, green, drying)	greening	green	green	drying	green	greening
2-6	vegetation density (Low Medium Dense)	(L) M D	L M (D)	(L) M D	(L) M D	(L) M D	(L) M D
2-7	soil moisture (wet/dry)	(W) D	(W) D	(W) D	W (D)	(W) D	(W) D
3	**LOCUSTS**						
3-1	present or absent	P (A)	(P) A	P (A)	(P) A	(P) A	P (A)
3-2	area infested (ha)		100		100	200	
4	**HOPPERS**						
4-1	hopper stages (H123456F)	H 1 2 3 4 5 6 F	H 1 2 3 4 (5) 6 F	H 1 2 3 4 5 6 F	H 1 2 3 4 5 6 F	H 1 2 3 4 5 6 F	H 1 2 3 4 5 6 F
4-2	appearance (solitary, transiens, gregarious)	S T G	(S) T G	S T G	S T G	S T G	S T G
4-3	behaviour (isolated, scattered, groups)	I S G	(I) S G	I S G	I S G	I S G	I S G
4-4	hopper density (/site, /m2, Low Med High)		L				
5	**BANDS**						
5-1	band stage (H12345F)	H 1 2 3 4 5 F	H 1 2 3 4 5 F	H 1 2 3 4 5 F	H 1 2 3 4 (5) F	H 1 2 3 4 5 F	H 1 2 3 4 5 F
5-2	band density (/m2 or Low Medium High)				5/m2		
5-3	band sizes (m2 or ha)				10 m2		
5-4	number of bands				5		
6	**ADULTS**						
6-1	maturity (immature, mature)	I M	I M	I M	I M	(I) M	I M
6-2	appearance (solitary, transiens, gregarious)	S T G	S T G	S T G	S T G	(S) T G	S T G
6-3	behaviour (isolated, scattered, groups)	I S G	I S G	I S G	I S G	(I) S G	I S G
6-4	adult density (/transect, /ha, L M H)					25/300x4m	
6-5	breeding (copulating, laying)	C L	C L	C L	C L	C L	C L
7	**SWARMS**						
7-1	maturity (immature, mature)	I M	I M	I M	I (M)	I M	I M
7-2	swarm density (/m2 or Low Medium High)				50/m2		
7-3	swarm size (km2 or ha)				1 ha		
7-4	number of swarms				1		
7-5	breeding (copulating, laying)	C L	C L	C L	C (L)	C L	C L
7-6	flying (direction, time passing)						
7-7	flying height (Low Medium High)	L M H	L M H	L M H	L M H	L M H	L M H
8	**CONTROL**						
8-1	pesticide name & formulation				Feni 96%		
8-2	application rate (l/ha or kg/ha))				0.4		
8-3	quantity (l)				25		
8-4	area treated (ha)				100		
8-5	ground or air	G A	G A	G A	(G) A	G A	G A
8-6	estimated % kill				80		
9	**COMMENTS**						
			area between Hamid & Berika is dry with no DL habitats	swarm seen by farmer flying southwest 2 days ago in the early morning	Control form completed	adults seen in sorghum crops; no DL outside of crops	good DL habitat which should be checked after 1 week

kc 99.03

Was a GPS used to determine locations? (yes) no

Is a brief interpretation or analysis of the results included? yes (no)

Country: Sudan

Locust Officer : Mohamed Abu El Hassan date : 31.7.99

cleared by : Ben Osman El Kif date : 1.8.99

WHAT INFORMATION TO COLLECT

The Locust Field Officer is expected to make a note of his/her observations at the survey stop before proceeding to the next stop. This can be done by completing the *FAO Desert Locust Survey and Control Form* (see Fig. 14 and Appendixes 2.1 and 4.1) or an equivalent form, or by entering the information into a database on a handheld computer. He/she should record information regarding the location, ecology (rainfall, vegetation and soil moisture) and the locusts.

Tip: relative humidity changes throughout the day. It is often higher in the early morning and decreases throughout the day. It usually varies from day to day depending on atmospheric conditions. Relative humidity has very little effect on locust behaviour. Therefore, it is not usually important to record relative humidity during locust surveys.

?

FAQ number 9 (see p. 54 for answers)

Is it necessary to collect and report information from those places where no locusts were found?

Summary of rainfall and vegetation information to note:

- date of last rainfall and quantity
- vegetation greenness and density

Figure 15. The greenness of vegetation.

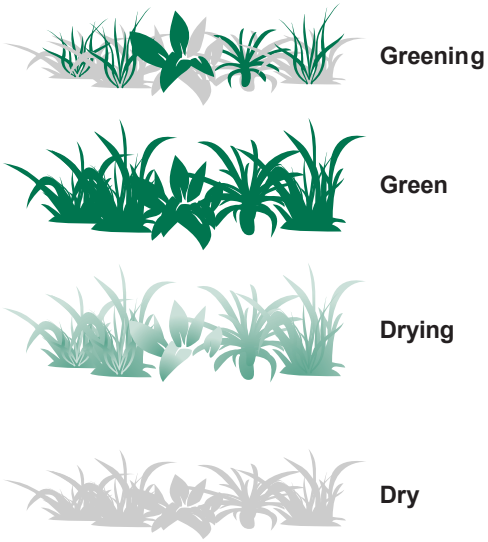
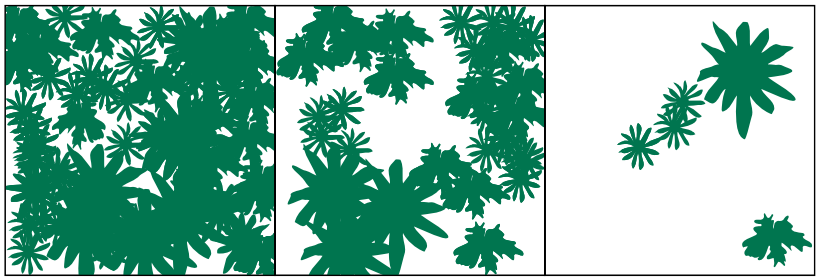


Figure 16. Estimating the density of vegetation.



High (vegetation > bare ground)

Medium (vegetation = bare ground)

Low (vegetation < bare ground)

Rainfall

It is useful to find out when the last rainfall occurred. This can be done during the survey by asking the local people or observing to what depth the soil is moist. Sometimes it may not be possible to find out the exact date or amount of rain. In this case, a rough indication can still be useful. It is important to remember that different people have different concepts of rainfall quantity. Some may say heavy while others may say light for the same rainfall. In general, light rainfall is defined as up to 20 mm, moderate from 21-50 mm and heavy as more than 50 mm. Rainfall quantity (how much rain fell?) may be confused with intensity (how hard did it rain within a given period of time?). Further questioning of the source of information should clarify this.

Vegetation

Observations should be made on the greenness of the vegetation (see Fig. 15). If there is some brown vegetation but new growth is seen, this should be noted as *greening*. If there is mixed dry and green vegetation without any signs of new growth, this should be noted as *drying*. If only brown vegetation exists, this is noted as *dry*.

The relative density of the vegetation can be estimated by comparing it to bare ground (see Fig. 16). Low (L) density should be indicated when there is more bare ground visible than vegetation. Medium (M), density is when there are about equal parts of vegetation and bare ground visible. High (H) density should be indicated when there is a lot of vegetation and hardly any bare ground can be seen. In some cases, both perennial and annual vegetation may be present at the same site and their greenness can differ. This should be noted in the comments section of the *FAO Desert Locust Survey and Control Form*.

A rough estimate of the size of the survey site and its surrounding area should be made although this can be quite difficult. This can be done by calculating the size of the area of your survey site plus that which you can see has similar conditions to the survey site. If the area is very large, a second sample (survey) should be taken in a different part of the area. The area could also be estimated by driving around two sides of it and multiplying the distances together but this takes time and is probably not worth the effort unless there are significant infestations present.

The type of habitat should be noted, such as the main soil types (sandy, clay) and topography (such as wadi, dunes, plains, interdunes).

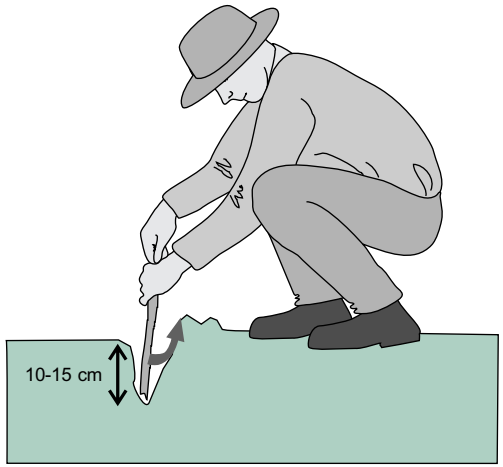
Rainfall quantities

Light	1-20 mm
Moderate	21-50 mm
Heavy	50+ mm

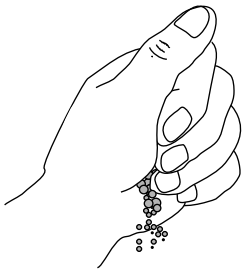
Summary of soil moisture information to note:

- wet or dry

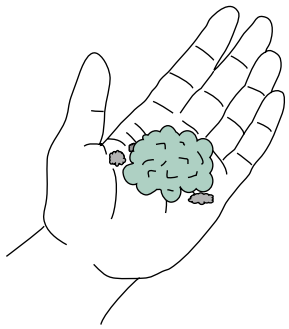
Figure 17. How to check for soil moisture.



1. Dig into the soil



2. Squeeze some soil in your hand



3. If it stays together, the soil is moist

Soil moisture

The Locust Field Officer should check the soil to determine if there is adequate moisture available for breeding to occur (see Fig. 17). One easy method is to dig into the soil until about half of your shoe is buried or about 10-12 cm. Alternatively, a stick, stone or shovel can be used. Then take a handful of soil and squeeze it; if it holds together it should be considered as moist (it should also be darker than dry soil). Note if it is suitable or not for egg laying, indicating wet (W) or dry (D) on the *FAO Desert Locust Survey and Control Form*.

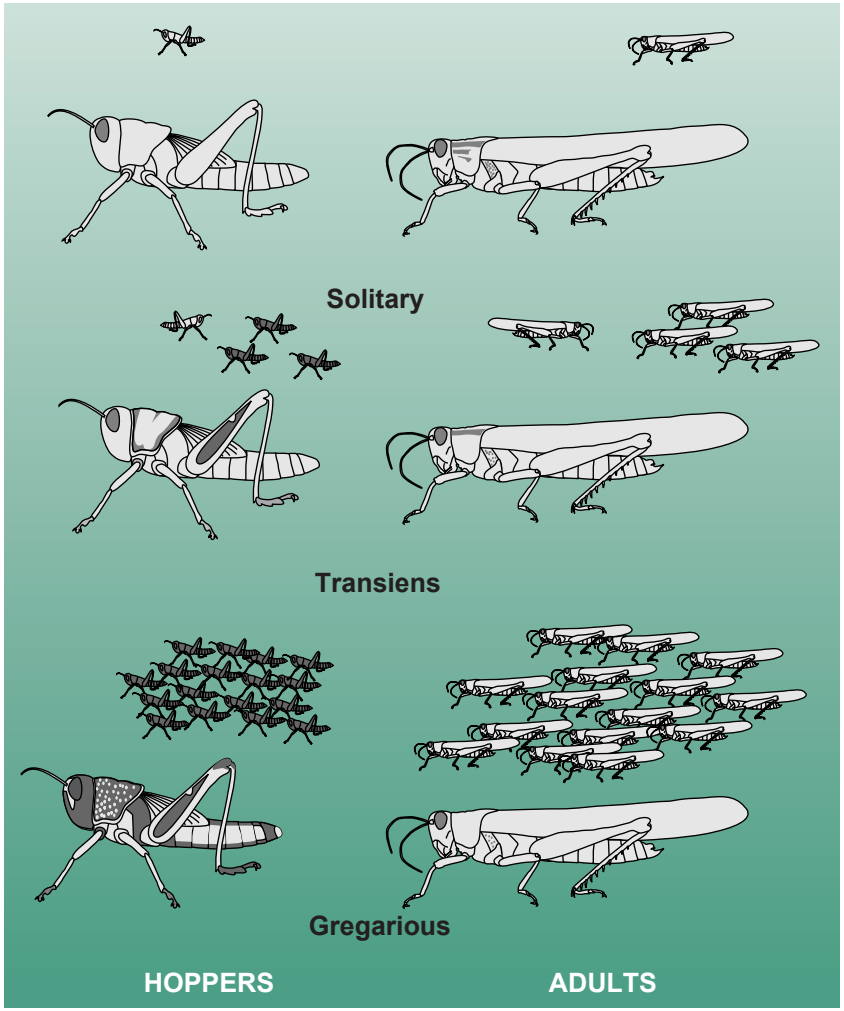
Tip: checking soil moisture

- ***dig into the soil about 10-15 cm***
- ***take a handful of soil and squeeze it; if it holds together it should be considered as moist (it should also be darker than dry soil)***

Summary of locust data to collect:

- presence/absence
- appearance
- behaviour
- maturity
- density and size

Figure 18. The three phases of Desert Locust hoppers and adults.



Locust

The Locust Field Officer should collect basic data about the locusts at each survey site. This includes locust presence/absence, appearance, behaviour, maturity, density and size.

Presence

Note whether locusts are present or absent at the survey site by recording this on the *FAO Desert Locust Survey and Control Form*. Even if locusts are not present at the survey location, it is still important to record this information.

Appearance

If locusts are found at a survey site, note whether the hoppers and adults are in the solitary, transiens or gregarious phase (see Fig. 18). This can be partially determined by observing their colour. Solitary adults are generally brownish while gregarious adults are red or pink if they are immature and yellow if they are mature. Adults that are pink/grey-brown or yellow/grey-brown are probably *transiens*. Solitary hoppers are green while gregarious hoppers are black in the early instars, becoming yellow/black in later instars. Hoppers that are green/black or green/yellow are probably *transiens*.

As changes in colour and shape take more time than behavioural changes, colour should not be the only determining factor of locust phase. Locust behaviour should be observed in addition to colour (see the next section).

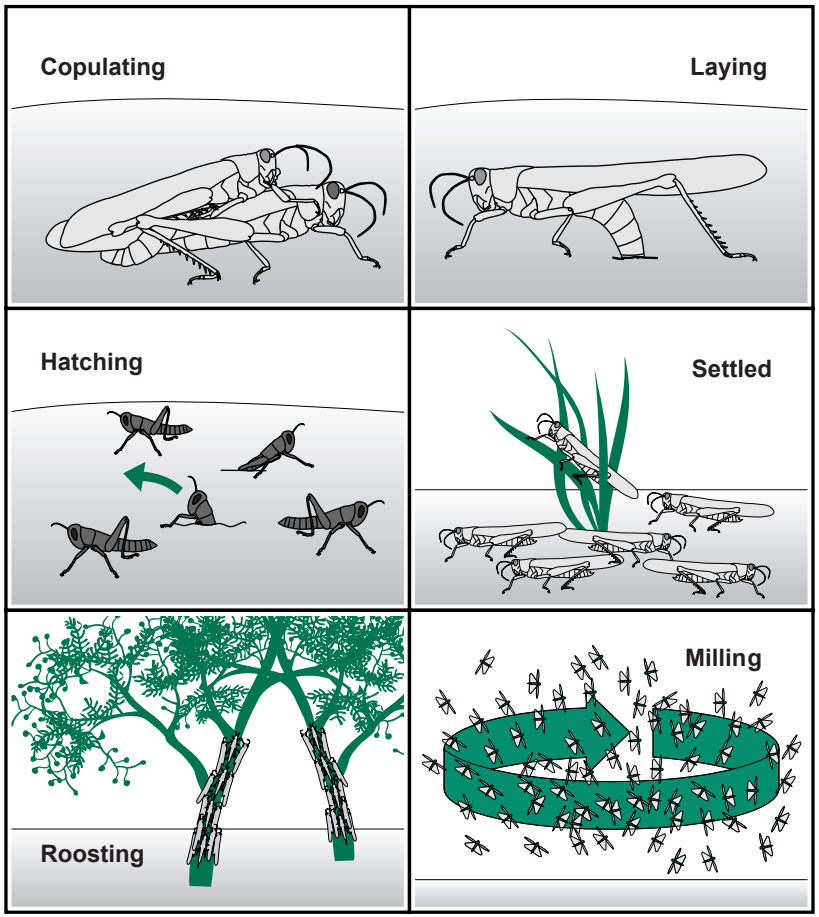
***Tip: how to tell if locusts are* transiens**

- ***colour – a combination of solitarious and gregarious colouring***
- ***behaviour – if some are moving in the same direction together***

Summary of locust behaviour to note:

hoppers and adults	adults and swarms
● isolated	● copulating
● scattered	● laying
● groups	● flying

Figure 19. Some common types of Desert Locust behaviour.



Behaviour

The Locust Field Officer should record if the hoppers and adults are behaving as isolated or scattered individuals or as groups. Locusts that are acting individually are usually solitary; many locusts acting as a single unit are gregarious. It is possible to find more than one phase at a location.

Behaviour associated with breeding, such as copulating or laying by adults and swarms, and hatching should be noted. If swarms are seen flying, estimate the direction they are flying from and to, the time it took the swarm to pass by and the approximate height either in metres or a general indication such as low, medium or high. This may only give very rough results which should be interpreted with caution. Other behaviour such as settled, roosting and milling can be indicated (see Fig. 19).

Non-gregarious adult and hopper terms

Isolated (few)

- very few present and no mutual reaction occurring
- 0-1 adult/400 m^2 foot transect (or less than 25/ha)

Scattered (some, low numbers)

- enough present for mutual reaction to be possible but no ground or basking groups seen
- 1-20 adults/400 m^2 foot transect (or 25-500/ha)

Group

- forming ground or basking groups
- 20+ adults/400 m^2 foot transect (or 500+/ha)

Note: The actual length and width of a foot tranfoot will vary according to the characteristics of the locust and the habitat.

?

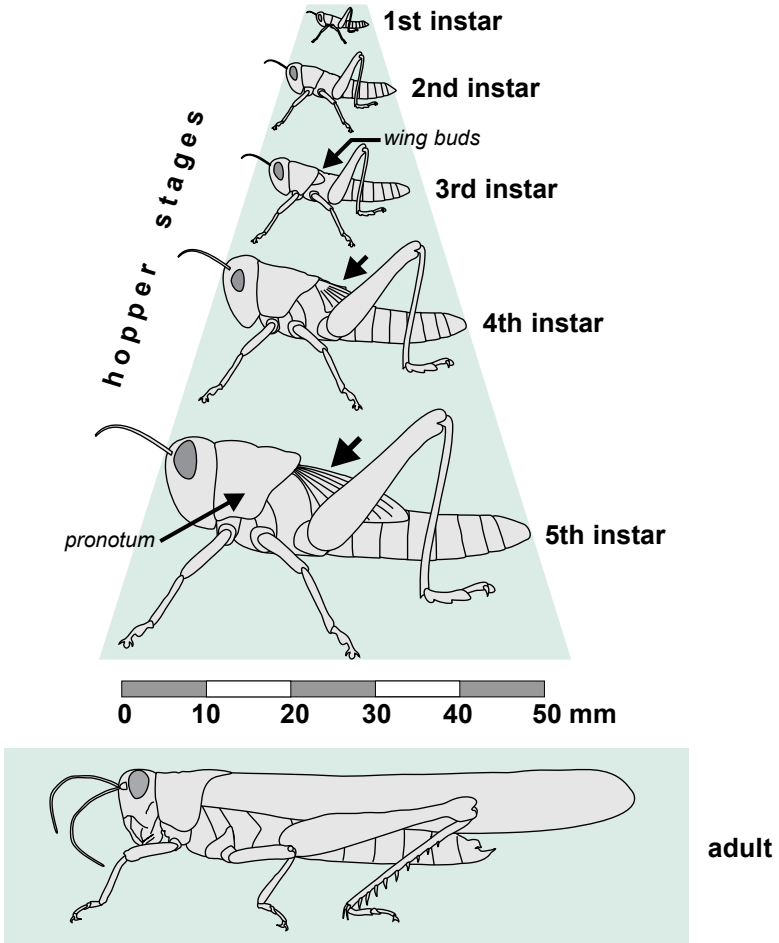
FAQ number 11 (see p. 54 for answers)

Why is it important to collect information on locust behaviour and who will use this?

Summary of locust stages to note:

- hopper instars
- fledgling
- immature, maturing, mature adult

Figure 20. The different stages of the Desert Locust. The arrow on the third to fifth instar hoppers indicates wing bud development.



adult size varies: 60-75 mm (male), 70-90 mm (female)

Maturity

The stages of the locusts that are present should be recorded for hoppers, adults, bands and swarms (see Fig. 20). Again it is possible that different hopper instars or both immature and mature adults will be present. Write down all stages, noting which pertain to solitary and which to gregarious if both types are present. Hopper instars can be differentiated by the presence and relative length of wing buds and the number of eye stripes where each stripe corresponds to an instar (this is only possible for solitarious hoppers). The Locust Field Officer may want to try to catch an adult locust to confirm its sex, maturity or phase. As it may be difficult to catch them, there is no need to spend a lot of time and energy in trying to do so.

Hopper instar identification

1st	Initially white, turning green (solitarious) or black (gregarious) after 1-2 hours; approx. length = 7 mm.
2nd	Larger head, colour is more obvious, no sign of wing buds; approx. length = 15 mm.
3rd	Two pairs of wing buds on each side of the thorax; approx. length = 20 mm.
4th	Wing buds are larger but remain shorter than pronotum length; approx. length = 33 mm.
5th	Wing buds longer than pronotum; approx. length = 45-50 mm.

Summary of sex determination:

- female – with two black hooks
- male – no hooks

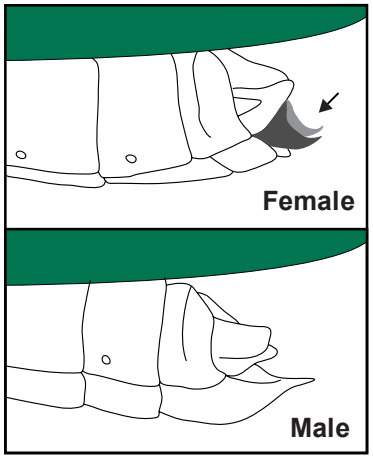


Figure 21. Females have two hook-shaped ovipositors at the rear of the abdomen; males do not.

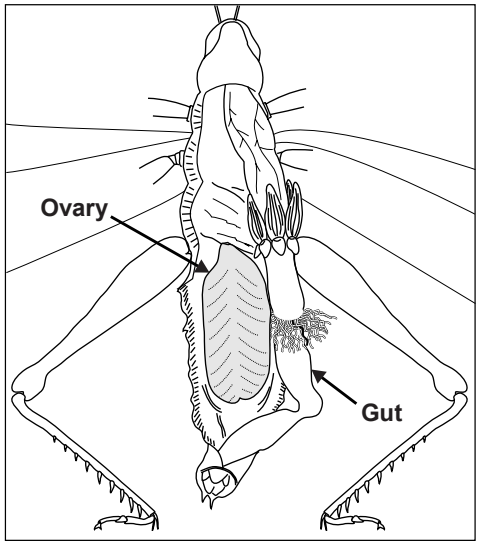


Figure 22. Dissected female showing ovaries.

Sex determination of adults

The sex of an adult locust can be determined by examining the rear end of its abdomen. In the female, there are two short black hooks. These are the ovipositors that are used to dig a hole in which to lay eggs. The male has no hooks. The difference is shown in Figure 21.

Egg maturation

In order to determine whether or not females at a site are developing eggs, it is necessary to catch several and dissect them. First, kill the female by removing the head. Next, lay the insect on its back and slit open the abdomen working from the rear. Dissecting scissors are best but a razor blade is adequate. This will show the ovaries laid out as shown in Figure 22. It is important to decide whether or not egg development has started. If the ovary is expanded (and threadlike) and contains recognizable eggs with yellow yolk, egg development is underway.

Tip: In order to determine the maturity, sex and phase, it may be useful to catch a locust. A few commonly used methods:

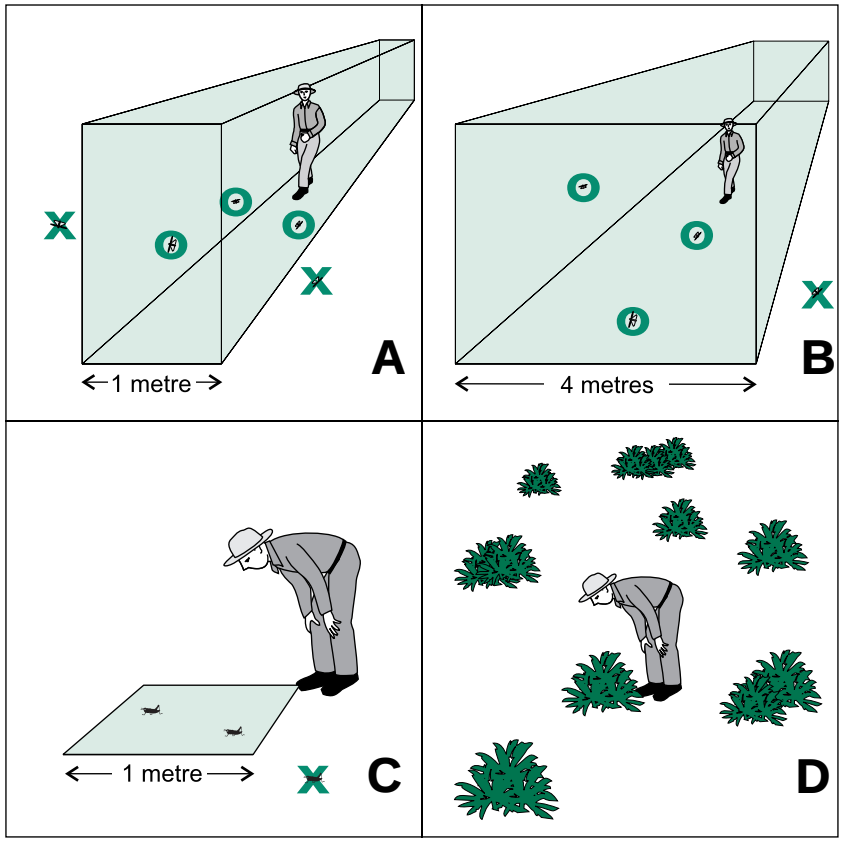
- ***slowly waving a stick from side to side over the locust and gently lowering it until in a final swift movement the locust is pinned down by the abdomen***
- ***swatting the locust with a small bush or a branch***
- ***using an insect net***
- ***trapping it in vegetation***

These methods may be easier when the Locust Field Officer is facing upwind.

Summary of locust density to note:

- adults/m² OR adults/transect (length x width)
- hoppers/m² OR hoppers/bush

Figure 23. To estimate the density of adults: (A) count the number of locusts that fly up in a standard one metre wide strip while walking at least 100 m, or (B) try to estimate the width in which you are disturbing adults (i.e. 4 m) and count these along the length of your transect. The transect length and width will vary according to conditions at the survey site.



To estimate the density of hoppers: (C) stop about every 10 paces and count the number of hoppers in 1 m², or (D) or examine a clump of vegetation every 10 paces and count the number of hoppers.

Density

Adults. The number of adults seen during a foot transect should be recorded, indicating the length and width of the transect. A standard width of one metre can be used during a foot transect (see Fig. 23A). This may not be practical in conditions when locusts are less easily disturbed such as low or very high temperatures or in dense vegetation. If this is the case, the transect width should be determined by the distance on either side of the Locust Field Officer in which adults fly up. For example, 36 locusts seen while walking 300 metres with locusts flying up to about 2 metres on either side of the officer (or 4 metres in total, see Fig. 23B) should be recorded as 36 locusts per 300 m x 4 m (or 36 locusts/1 200 m²). If more than one Locust Field Officer made a transect, the distance that each officer walked should be added up including those of officers that did not see any locusts. Then the total number of locusts in the total distance walked should be recorded, assuming that the width of each transect is the same. In cases when only very few locusts are present, the officer may simply wish to record the total number seen at the site.

Some Locust Field Officers may want to convert this result into number of locusts per hectare. This is **not** advised. It is too easy to make an error when converting that will result in an incorrect density and not accurately reflect the locust situation at the survey stop. It is important to realize that locusts are not generally evenly distributed over a specific area whether it is a hectare or a square kilometre. To someone who is not familiar with locust behaviour, results recorded as locusts per hectare or square kilometre may give the wrong picture of the situation. Therefore, it is better to report locust counts exactly as you carried them out and let the Locust Unit headquarters convert your results for comparing infestation levels at different locations.

Hoppers. During the foot transect, the Locust Field Officer should stop at about ten places (samples) and carefully inspect one square metre of ground or a bush for any hoppers that may be present (see Fig. 23C and D). The minimum and maximum number of hoppers seen in the samples should be recorded as well as the number of samples that contained hoppers. These results should **not** be converted to numbers of hoppers per hectare or square kilometre.

Bands and swarms. The relative density of bands and swarms can be estimated by comparing these to the amount of bare ground that is visible. Low (L) density should be indicated when there is more bare ground visible than the band or swarm. Medium (M), density is when there are about equal parts of bare ground and band or swarm visible. High (H) density should be indicated when hardly any bare ground can be seen. This method can also be used to estimate the density of vegetation.

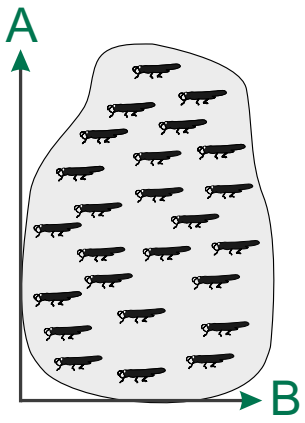
Tip: when counting hoppers, record the minimum and maximum number of hoppers seen, and the number of samples that contained hoppers. For example: 3-12 hoppers/m² in 4/10 samples (no hoppers were seen in the other six samples).

Summary of sizes to note:

- hopper groups and bands
- adult groups and swarms

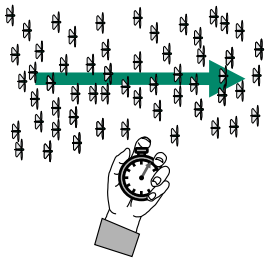
Figure 24. Estimating the size of bands and swarms.

How to measure bands or settled swarms

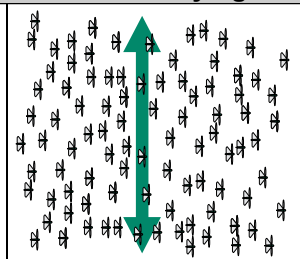


A (m) x B (m) = size (m^2)

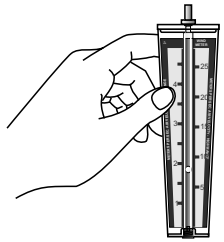
How to measure flying swarms



Estimate time for swarm to pass overhead



Estimate the width of swarm



Measure wind speed with anemometer

time (sec) x width (m) x windspeed (m/sec) = size of swarm (m^2)

(use with caution as this may overestimate the swarm size)

Band and swarm sizes

If hopper bands, groups or swarms are found, the Locust Field Officer should try to estimate their size by walking along two sides of the infestation at right angles while measuring the distance travelled (see Fig. 24). For settled swarms or very large bands, it may be necessary to do this with a vehicle. Simply multiple the two values to obtain a rough approximation of the area.

It is usually easier to make estimates early in the morning or at dusk when bands and swarms are generally less active.

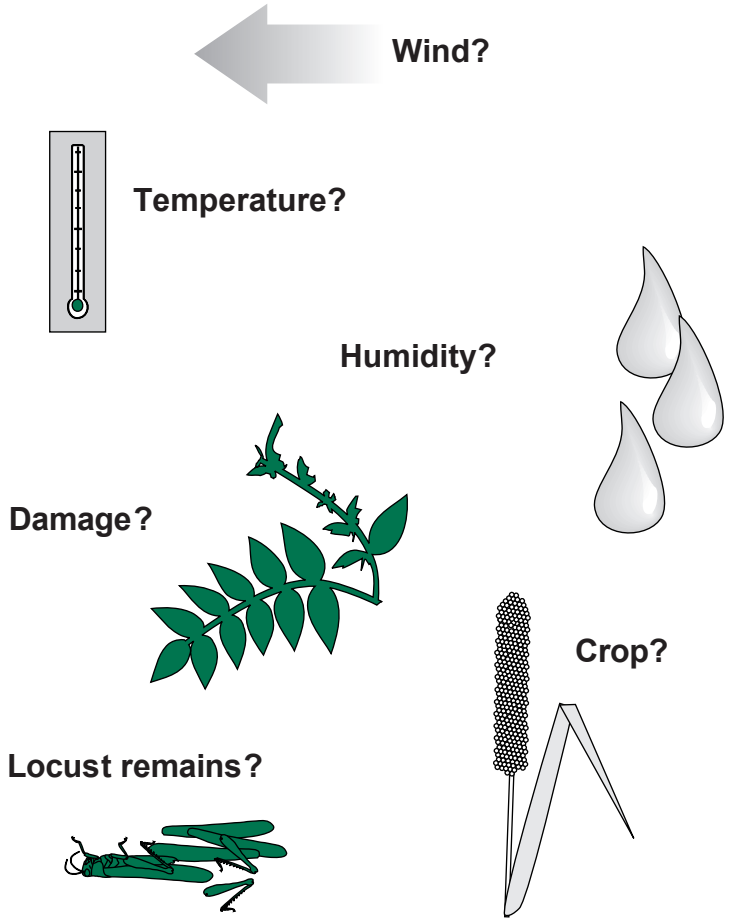
It is nearly impossible to determine with any precision the size of flying swarms from the ground. A very rough estimate can be made by measuring the time that it takes for a swarm to pass overhead, estimating the width of the swarm, and measuring the wind speed with an anemometer (see Fig. 24). The results should be used with extreme caution.

	Hopper bands	Adult swarms
Very small	1-25 m^2	< 1 km^2
Small	26-2 500 m^2	1-10 km^2
Medium	2 501 m^2-10 ha	11-100 km^2
Large	11-50 ha	101-500 km^2
Very large	50+ ha	500+ km^2

Summary of other comments to note:

- wind speed and direction
- temperature and humidity
- crop damage
- types of nearby crops
- evidence of previous locusts (remains)

Figure 25. Other comments which should be recorded on *FAO Desert Locust Survey and Control Form.*



Control operations

If control operations were carried out at the survey location, write down as much detail as possible. In addition, the *FAO Spray Monitoring Form* should be completed and attached to the survey form (see Monitoring control operations on p. 71 in the Control guideline and Appendix 4.2).

Other comments

Other comments should be recorded as appropriate (see Fig. 25). These could include wind speed and direction, when locusts were last present at the location or indications (frass, corpses, wings, damage) that they were present, or the types and stages of nearby crops. Some Locust Field Officers may also want to estimate the relative humidity and temperature at a location using a whirling hygrometer although this is probably not necessary. These results should be written in the comments sections.

Tip: estimating wind direction

- ***turn around until you feel the wind on your face***
- ***align compass to north***
- ***read the direction you are facing***

Wind direction is always reported as the direction that the wind is coming from, not going to.

?

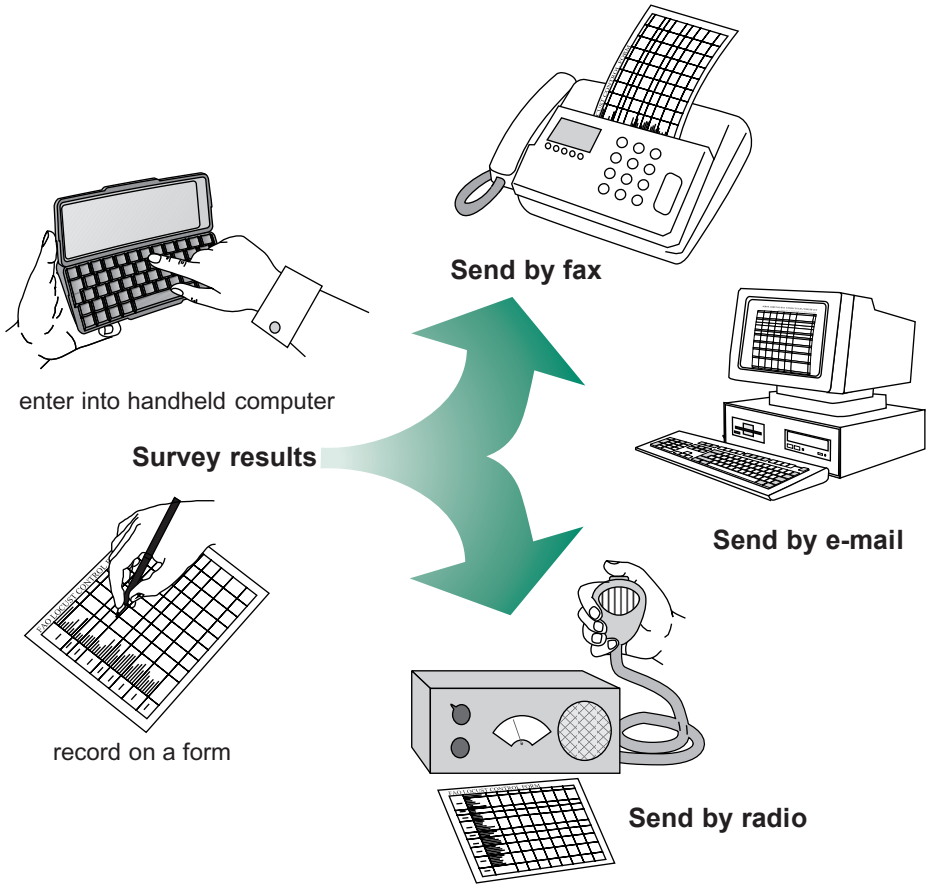
FAQ number 12 (see p. 54 for answers)

How do I know which comments are important and should be reported?

Summary of how to report survey results:

- complete the *FAO Survey and Control Form* in the field (or use a handheld computer)
- transmit it to the National Locust Unit HQ by radio, fax or e-mail
- keep a copy for reference

Figure 26. How to record and send survey and control results to the National Locust Unit headquarters.



HOW TO REPORT SURVEY RESULTS

During ground or aerial surveys, information should be recorded on the *FAO Desert Locust Survey and Control Form* or its equivalent by hand or entered into a handheld computer. As soon as the Locust Field Officer returns to the field base or office, the completed form with the officer's own assessment of the results should be transmitted immediately to the National Locust Unit headquarters by facsimile or radio (see Fig. 26). If the officer is using a handheld computer, the data may be transferred via HF radio modem or downloaded to a computer.

It is critical that the information is complete and sent very quickly to allow decisions to be made by the proper authorities as well as to send the information to FAO headquarters for further assessment. The form has been designed to allow completion in the field and transmission by facsimile or by radio (see Appendix 2.1). If the information is sent by radio, each section and item can be referred to by the appropriate reference number on the survey form. It is not necessary to retype the results from the survey or prepare a long report because this takes time and often the information becomes summarized or mistakes are made. The Locust Field Officer should keep a copy of the report for reference.

Other sources of locust, rainfall and vegetation information:

- nomads
- villagers
- security forces
- traders
- travellers

Figure 27. Use all possible sources of information to find out about locusts, rainfall and green vegetation.

OTHER SOURCES OF INFORMATION

Nomads can be a very important source of information since they often know where rain has fallen and areas of green vegetation in the desert. To a certain extent, villagers, security forces, traders and travellers can provide information on vegetation conditions, rainfall and locust infestations (see Fig. 27). It is important for the Locust Field Officer to try to verify information from these sources. For example, showing pictures or specimens of different locust species can help to identify correctly the particular species seen by the informant. In order to take advantage of these potential sources of information, the Locust Field Officer must establish and maintain a good working relationship with each of them.

Tip: good relations with nomads

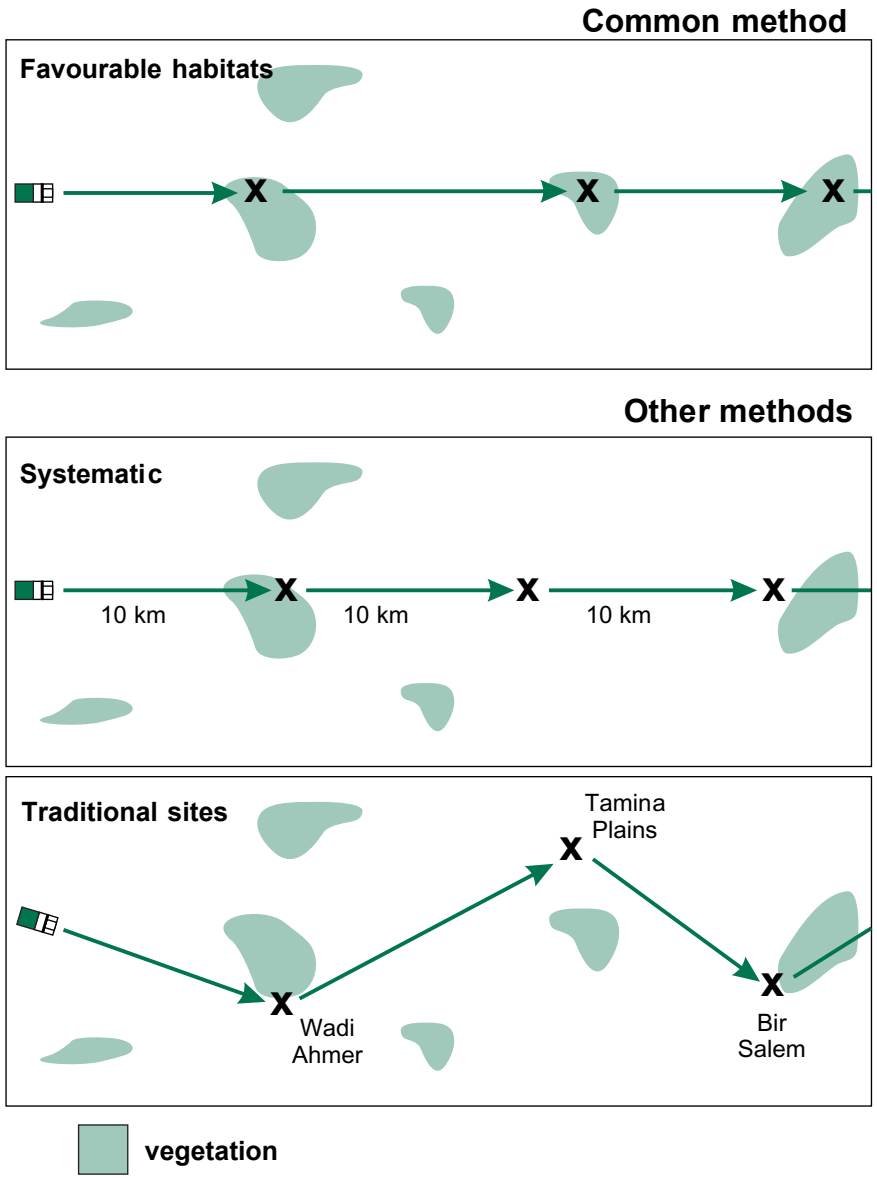
- ***tactfully try not to accept meals which will affect the family's limited resources, especially if the survey team is large – but offer grateful thanks***
- ***provide assistance whenever possible such as stopping to fill up water containers at wells that are on your way***
- ***explain that locust survey and control help protect pastures***
- ***explain that locust pesticides are not harmful to animals or humans when used properly and if the local people cooperate***

?

FAQ number 13 (see p. 54 for answers)

Is it easier and less expensive to wait for nomads, villagers, traders and others to report locusts rather than carrying out ground surveys by a specialized Locust Unit?

Figure 28. Other sampling techniques to determine where to stop and make locust surveys.



OTHER SAMPLING METHODS

In addition to the common surveying method of stopping in favourable habitats and undertaking foot transects, there are other sampling methods that are worth mentioning for those interested in sampling techniques. These are not often used when surveying for Desert Locust.

Alternative sampling techniques to favourable habitat stops (see Fig. 28)

Systematic

Suitability: fair

Methodology: divide the habitat into classes based on their suitability for locusts; for example *likely*, *maybe* and *unlikely*. Note the habitat class at a fixed interval (i.e. every 10 km) and make a foot transect in every *likely* habitat, every fifth *maybe* habitat and never in the *unlikely* habitat.

Comments: the result is less biased than only surveying in green vegetation and can be used to estimate the proportion of suitable locust habitats within an area. However, it can be time consuming and difficult to implement; therefore, it may be more suitable for researchers.

Traditional sites

Suitability: fair

Methodology: visit traditional breeding areas and undertake surveys there.

Comments: the result is biased since you are only concentrating on those areas that are thought to be regularly infested by Desert Locusts. There is a risk that this may exclude non-traditional habitats that could become favourable due to a change in rainfall distribution and quantity.

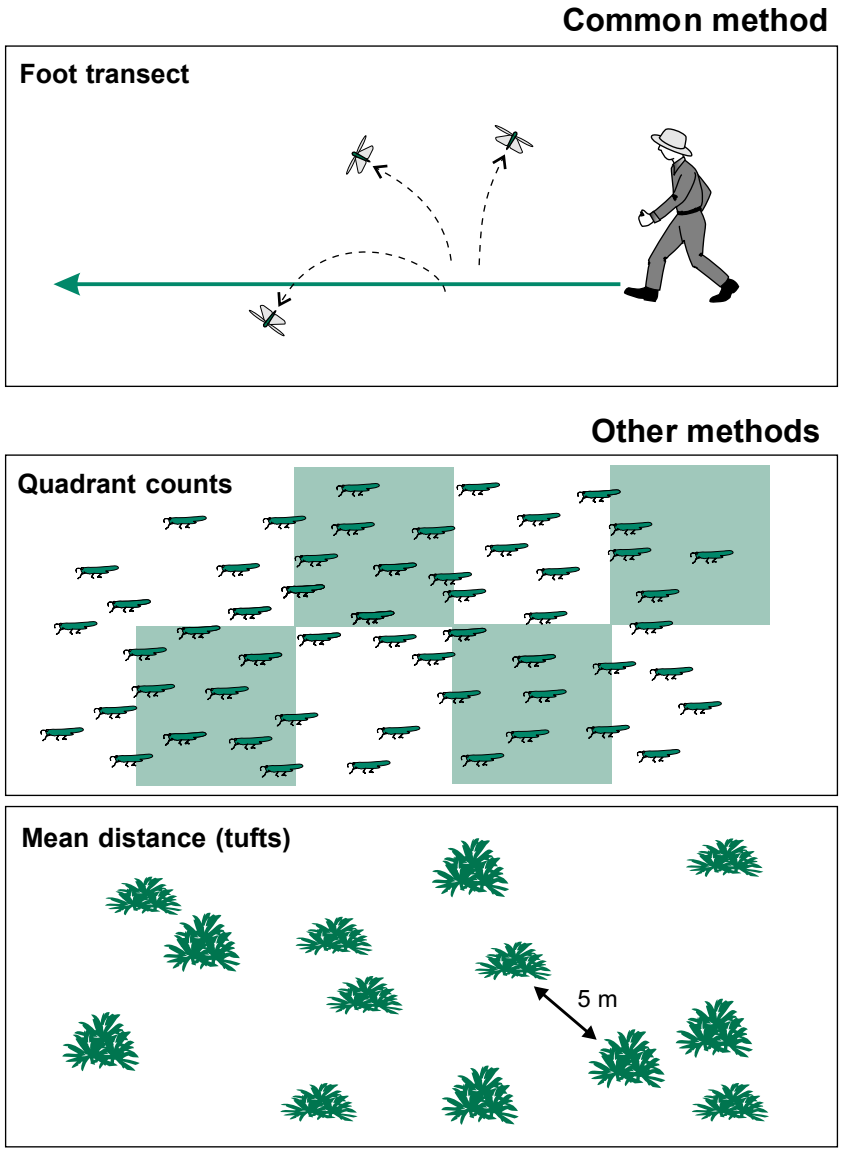
Remote sensing and aerial surveys

Suitability: fair

Methodology: identify areas of green vegetation using remote sensing imagery, confirmed by aerial surveys, as a way to guide ground surveys.

Comments: SPOT-VEG remote sensing imagery could be a useful tool for identifying areas of green vegetation. Although it may not provide enough detail to locate favourable habitats precisely, when used in combination with aerial surveys, it could help to delimit the relatively large areas that need to be checked on the ground. Imagery interpretation requires a high degree of skill and experience. The images or their analysed by-products must be available to users in real time.

Figure 29. Other sampling techniques that can be undertaken at the survey site.



Alternative sampling techniques to foot transects (see Fig. 29)

Quadrat counts

Suitability: generally not suitable for Desert Locust except when there may be hoppers; mainly for Grasshopper infestations

Methodology: mentally divide the sample area into a number of one-square-metre quadrants from a distance and count the number of adults.

Comments: impossible to use when adults are moving. Best done in low temperatures when locusts are inactive or after spraying to determine mortality. A modified form of this method can be used for estimating Desert Locust hopper densities on bushes or on open ground.

Mean distance

Suitability: not suitable for estimating Desert Locust densities but can be used to estimate plant density in habitats of clumped vegetation such as tufts of grass.

Methodology: take several measurements to determine the average distance, in metres, between the individual tufts of grass. The number of tufts/ha = $(100/ADI)^2$. Determine the average number of locusts per tuft, then multiple this by the number of tufts per ha to calculate the locust density.

Comments: also known as *average distance between individuals* (ADI) or, in French, *distance moyenne inter-individuelle* (DMI) or *inter-touffe*. This method cannot be used on Desert Locust individuals alone because locusts are not distributed completely uniformly and there is no such thing as an average distance between individuals. Further difficulties are encountered for copulating pairs of adults which result in a zero value, and it is impossible to use when adults are moving.

FREQUENTLY ASKED QUESTIONS (FAQS)

1. Is it better to have a centralized or a decentralized programme for monitoring locusts?

Answer: Because Desert Locusts can easily and quickly move across administrative boundaries in a country, it is difficult to decentralize a monitoring programme and still ensure that it is effective. Often, poor communications between the different provinces or regions within a country hamper effective planning. Some provinces may carry out surveys and send reports to the capital while others do not. Therefore, a small centralized Locust Unit that can easily respond to environmental conditions and locust threat by undertaking a survey anywhere in the country is probably much better.

2. Is it enough just to carry out surveys in agricultural areas such as farms?

Answer: Absolutely not! Desert Locusts by their nature are more often present in the desert than in cropping areas. As their numbers increase and as natural vegetation becomes dry, they may then move into cropping areas. Therefore, if surveys are only conducted in agricultural areas as a means of monitoring the situation, the early stages of a buildup in the locust populations will be missed and you may find yourself suddenly facing an outbreak or upsurge situation.

3. Is it possible to find all locust infestations during a survey?

Answer: It is practically impossible to find every single locust or locust infestation during a survey, regardless if it is done by ground or air. This is because it is not possible to survey every square metre of locust habitat. Therefore, survey results should be considered as samples which are used to estimate the real situation. Experienced officers in locust-affected countries and other researchers suggest that perhaps about half of the locust infestations present in a given area are detected during surveys, depending on the habitat, accessibility and locust infestations in surrounding areas.

4. Are foot transects more accurate than vehicle transects for counting locusts?

Answer: Both are types of sampling methods that estimate the number of locusts present in a specific area. Foot transects may give a more accurate representation of the locust population at a particular spot but they can cover only a small area while vehicle transects may provide a better estimate of the extent of the locust infestation.

5. Vehicle transects sound much easier and faster to make, so why not just use this method for making locust surveys?

Answer: Vehicle transects can be a useful method of surveying over large areas such as plains. However, it is not possible to check for hoppers which means that it may be easy to miss breeding that could be in progress. This can only be done by foot. To make a good transect, the vehicle must be driven very slowly and the Locust Field Officer must concentrate and watch carefully for any adults that are disturbed.

6. What logistical support and additional equipment are required for aerial surveys using fixed-wing aircraft?

Answer: Fixed-wing aircraft require landing strips and often the prepositioning of special fuel, either AVGAS or JET-A1, especially if surveys are being conducted in remote areas. Fuel pumps and safety equipment will also be required. The areas that can be surveyed may be limited by the presence of existing landing strips or the availability of fuel or trucks to transport the fuel. Secure ground facilities will be needed for the aircraft and fuel.

7. What support is required for helicopters engaged in aerial survey and are there certain advantages of using helicopters?

Answer: As with fixed-wing aircraft, there will be a need to ensure that the proper type of fuel is available. In remote areas, this may have to be prepositioned. Fuel pumps and safety equipment will also be required. One of the main advantages of helicopters, compared to fixed wing aircraft, is that they do not require a landing strip. They can also be used more easily when surveying narrow areas such as canyons, and it is possible to land quickly and check an area on foot. Secure ground facilities will also be needed for the aircraft and fuel.

8. Is it better to keep expensive equipment in storage and use it only during control operations or during locust plagues?

Answer: The basic equipment used for surveys is relatively cheap considering the high cost of purchasing and applying pesticides. Keeping the equipment in storage and not using it makes the job of the Locust Field Officer much harder. As a result, he/she will not be able to collect some information with precision, for example, the coordinates of the survey. It is much better to use the equipment on a regular basis and to replace it when it wears out or breaks. This is also a good way to keep field officers familiar with using and maintaining equipment such as GPS and compasses. If it is necessary tokeep electrical equipment in storage for any length of time, batteries should be removed.

9. Is it necessary to collect and report information from those places where no locusts were found?

Answer: Yes. This helps the national Locust Information Officer as well as FAO Desert Locust Information Service (DLIS) in Rome to analyse the current situation better by understanding where surveys were conducted and where locusts were not found even though the habitat is favourable for them. If this information is not reported, it is difficult to plan follow-up surveys and to forecast future developments.

10. At a survey stop, how many times do I have to check the soil moisture?

Answer: This depends on the topography at the survey site. If it is fairly homogenous, in other words much the same throughout, such as flat plains, then checking the soil

moisture a few times is sufficient. On the other hand, if the site consists of some plains interrupted by a small wadi or low sand dunes, then it is probably a good idea to check the soil in several different places such as in the wadi, along its edge, on the plains, at the base of the sand dunes and on the dunes themselves. Often, there may be small localized spots within a survey site that are favourable for breeding that can only be detected by checking several times. Each check should only take about a minute.

11. Why is it important to collect information on locust behaviour and who will use this?

Answer: By carefully observing locust behaviour, the experienced Locust Field Officer can often see the first signs of the change in locust phase; that is, from solitarious to gregarious and vice versa. This can be seen by watching how the locusts behave individually and together; for example, are they starting to behave similarly, concentrate or form groups? This is important in deciding which infestations are significant, which pose a threat and which should be controlled.

12. How do I know which comments are important enough to write down?

Answer: You should write down your observations or interpretation of the situation, especially anything related to locust behaviour such as changes in the population from solitarious to gregarious, and those concerning breeding or migration. The comments section is a good place to write down general observations about the habitat in between the survey stops. Lastly, you can note details of the last time locusts were present at the survey stop, indicating the dates and the types of infestations.

13. Is it easier and less expensive to wait for nomads, villagers, traders and others to report locusts rather than carrying out ground surveys by a specialized Locust Unit?

Answer: This may be true but it will usually mean that you will be late in reacting to the situation, and before you know it, you may be faced with large locust infestations and an emergency. As Desert Locust numbers normally first increase in desert areas before moving into cropping areas, by the time they are reported by farmers or agricultural extension agents, the numbers will often be so high that immediate action is required. This does not allow enough time for planning or responding in a calm manner. If surveys are done more proactively with specialized teams visiting desert areas and checking for green vegetation and locusts, then it is more likely that the early signs of a population buildup will be detected and you will not be surprised with unexpected reports of locusts. These areas can then be monitored and control measures taken before numbers increase to such an extent that large areas have to be treated or crops are threatened. Again, this approach requires an active Locust Unit that is highly mobile with the ability to undertake regular surveys and control outside cropping areas.