Desert Locust Guidelines

3. Information and forecasting

K. Cressman

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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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Assistant Director-General
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24 September 2001

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INTRODUCTION

This guideline is intended mainly for use by those people in a locust-affected country who are responsible for managing the data and information received from survey and control teams as well as from other sources such as the National Meteorological Service and FAO. The term Locust Information Officer will be used throughout these guidelines for such persons. Although the contents are aimed at national Locust Information Officers, it may also be useful for similar officers at the regional and international levels. 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 campaigns and for donor representatives assessing technical needs.

The guideline contains practical guidance on equipment and techniques specific to the analysis of Desert Locust information and the forecasting of possible developments. The latest technology available at writing (summer, 2001) is considered and presented when appropriate to data transmission, management and analysis. It is necessary to mention that much of this is rapidly changing, especially in the fields of computers and communications. Although some affected countries may not yet have access to such technology, it is still worthwhile to introduce the reader to the possibilities that exist now or may be available in the near future.

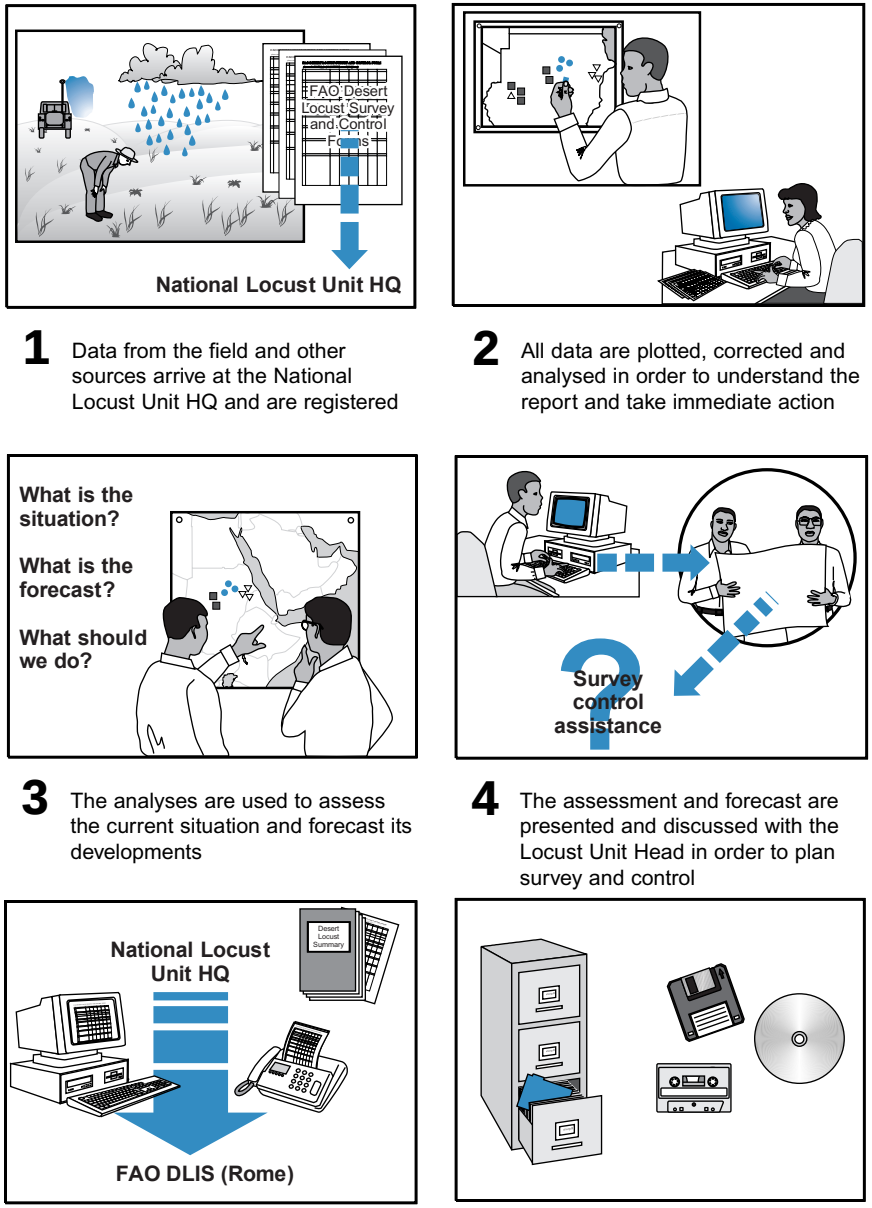
The basic principles of information and forecasting are relatively simple and the advice given here should give good results in most cases. However, individual situations vary widely in practice and precise analysis and forecasting will depend on the quality, frequency and timeliness of data received by the Locust Information Officer. Often these data may be incomplete or late and, therefore, officers will have to use their best judgement that may be based on equal parts of experience and intuition. It can be said that Desert Locust forecasting is still as much art as science. It is mostly experience, the way you fit evidence together, the way you get a feel for the behaviour of the locust and try to predict its next move. But more than experience, there is intuition. The two qualities work together until you cannot separate them in your own mind.

Information, advice, procedures and explanations are given on the right-hand page of the publication; illustrations and summaries are given on the left-hand page. 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 given here is relevant to data management and forecasting of other types of locust and some grasshoppers, but techniques may have to be adapted to match the biology, behaviour and habitat of the particular species.

Figure 1. The information and forecasting process within a country.



INFORMATION PROCESS

A locust-affected country should have at least one person who is responsible for managing locust and environmental data. This person is usually known as a Locust Information Officer and should be based at a centralized Locust Unit headquarters. It is his/her role to analyse all available data and to provide the Head of the Unit with information, forecasts and technical advice about the locust situation and the resources needed to deal with it (see p. 4-9).

A logical approach is required in order to manage and analyse information at the national level so that it can be used for effective planning and decision-making (see Fig. 1).

Step 1. Locust, ecological and weather data from in-country survey and control operations, the National Meteorological Service and other countries and organizations, including FAO, should be collected in a centralized location, usually the National Locust Unit headquarters where the Locust Information Officer is based. These data are required for planning survey and control operations. Upon receipt, each piece of information should be registered so that it can be easily retrieved in the future – see p. 10-19.

Step 2. Data should be corrected and plotted either manually or by using a computerized information management system. Each report should be analysed in order to understand the significance of the survey and control results and to take immediate action – see p. 20-25.

Step 3. The analyses, combined with other habitat information, are used to assess the current situation and forecast its developments – see p. 26-31.

Step 4. The assessment and forecast, presented on maps and tables, should be discussed with the National Locust Unit Head on a daily or weekly basis in order to plan survey and control operations – see p. 6-7 and 32-33.

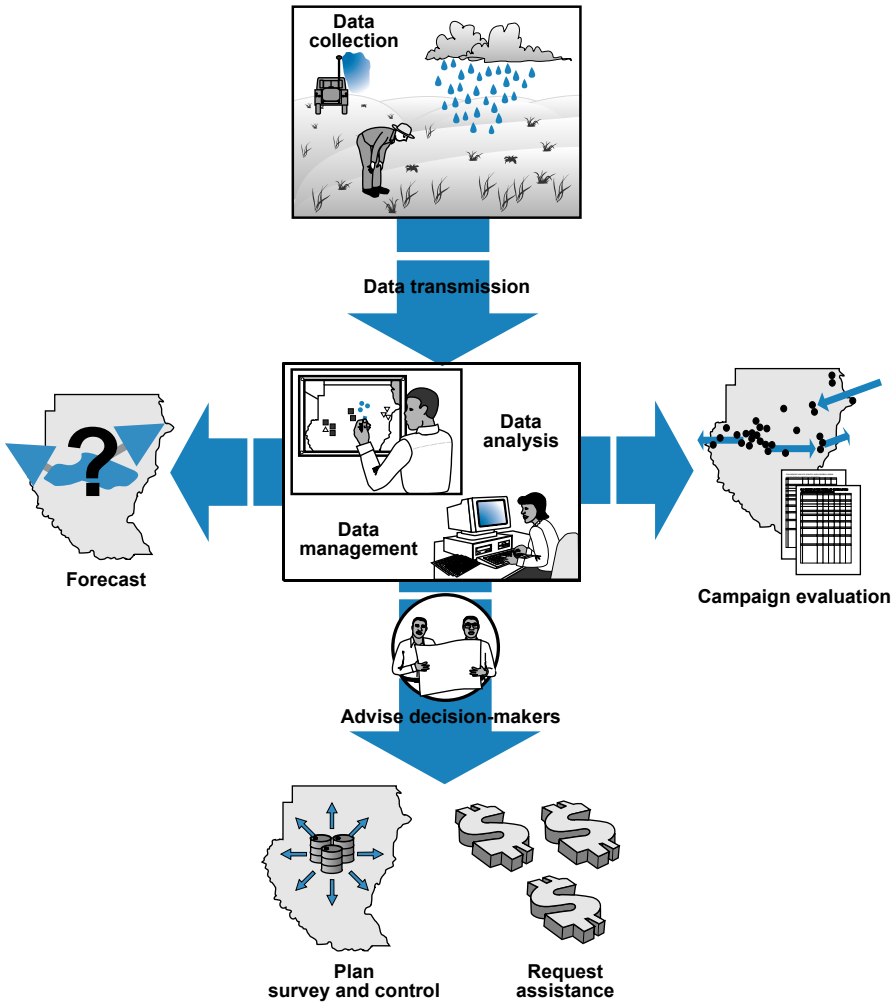
Step 5. Survey and control results, including a brief interpretation, should always be sent to the Desert Locust Information Service (DLIS) at FAO headquarters in Rome no later than five days after the end of the survey. A situation report and forecast should be prepared for the National Locust Unit Head and for the Donor Steering Committee. This may be updated with information received from DLIS. The report can be used for planning as well as to keep other countries informed – see p. 34-39.

Step 6. All original data, analysis, summaries and reports should be properly stored to allow easy retrieval in the future and for use in case studies – see p. 40-41.

Summary of the importance of information:

- to assess current situation
- to forecast breeding and migration
- to plan survey and control
- to request assistance
- to evaluate campaigns

Figure 2. Desert Locust information.



IS INFORMATION IMPORTANT?

Information from Desert Locust survey and control operations is used to assess the current situation and to forecast future developments. From such assessments and forecasts, further survey and control operations can be planned and external assistance can be requested (see Fig. 2). Information is crucial and can be considered the basis for all decisions and assessments. If the information is irregular, late or of poor quality, proper decisions will not be able to be made by those in positions of authority. Poor decisions can lead to the inefficient use of resources, to crop damage and loss, and to the continuation of locust breeding and migration. Good information is linked to good decision-making and good use of resources to combat the Desert Locust effectively. Therefore, National Locust Unit Heads, Plant Protection Department (PPD) Directors, regional organizations, donors, FAO staff, DLIS forecasters and other decision-makers all require good timely information.

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FAQ number 1 (see p. 44 for answers)

What information does FAO DLIS provide to affected countries and donors, and how can I receive it?

Figure 3. The role of international and national information units.

DLIS (International level)	NATIONAL INFORMATION UNIT (National level)
Purpose	
● global view of locust situation ● medium- and long-term forecasts	● overview of locust situation within country ● short-term operational forecasts
Available data	
● national reports ● global meteorological data ● global satellite imagery ● global historical data	● detailed field data ● national meteorological data ● national historical data
Provide advice to	
● affected countries ● donor community	● Locust Unit Head ● Donor Steering Committee
Advice is used for	
● planning surveys ● preparing control campaigns ● determining emergency assistance ● assisting in long-term development ● preparing information for media	● planning surveys and control ● prioritizing operations ● positioning resources ● requesting additional assistance ● preparing information for media

REGIONAL ORGANIZATIONS AND COMMISSIONS (Regional level)

- rely on member countries for information and data
- limited role in operational reporting and forecasting
- keep countries and DLIS informed
- assist in the transmission of information and data
- strengthen national capacities in reporting

THE ROLE OF INTERNATIONAL AND NATIONAL UNITS

Information units exist at the national level within a country's Locust Unit and at the international level within the Locust Group at FAO in Rome. The latter is referred to as the Desert Locust Information Service (DLIS). Although units at both levels provide information and advice to decision-makers, each unit will have different quantities and types of data available and the decisions that have to be made will be different (see Fig. 3).

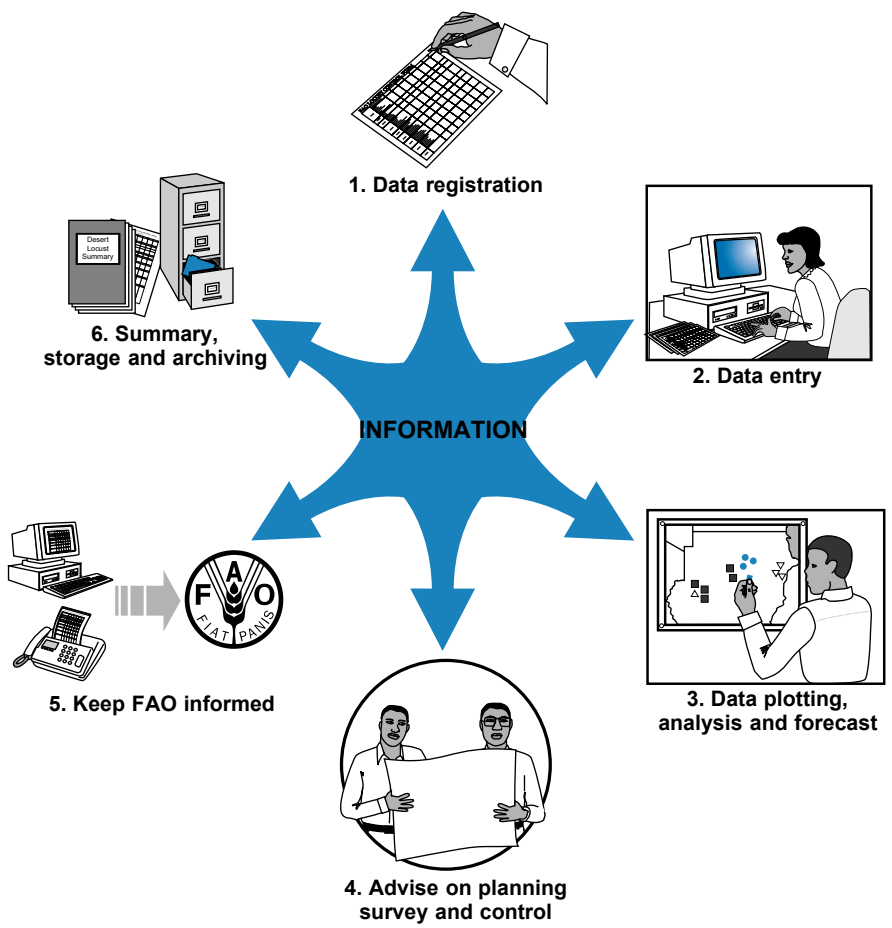
At the international level, DLIS maintains a global overview and prepares medium- to long-term forecasts for all countries and regions within the distribution area of the Desert Locust. This is very important when dealing with a highly migratory pest such as the Desert Locust that can move quickly between countries and regions, and that requires quick action from countries and donors. DLIS receives and analyses data from locust-affected countries and has access to additional data that may not be available within countries, such as meteorological data and satellite imagery that cover the entire distribution area of the Desert Locust. The role of DLIS is to provide forecasts and early warning of favourable conditions and locust buildup to affected countries and donors so that they can make the necessary preparations. Countries and donors are kept informed by monthly summaries of the locust situation and forecasts for the following six weeks. These are supplemented by alerts and warnings during periods of increased locust activity.

At the regional level, reporting and forecasting have limited roles since member countries must be relied upon to supply information. This makes it difficult for regional organizations to have access to the data required for forecasting. Regional organizations are not likely to have information from other regions. Nevertheless, they can be instrumental in keeping countries and DLIS informed as well as assisting countries in reporting.

At the national level, National Locust Units will have detailed locust and habitat data for their own country. They rarely have access to data from other countries or to satellite imagery on a regular basis. It is the role of the Information Section at the National Locust Unit headquarters to analyse all available data and to provide the Head of the Unit with information, forecasts and technical advice about the locust situation and the resources needed to deal with it. The Locust Unit Head is likely to be faced with several operational decisions when locusts are present:

- should surveys be organized and, if so, when, where and which type?
- is there a need for search to identify control targets?
- should control be undertaken immediately and, if so, on what scale and which type?
- should control be planned for the future (a month or more ahead) and on what scale?
- should PPD directors be alerted and request external assistance?

Figure 4. The job of the Locust Information Officer.



Tip: the key to successful data analysis and forecasting at both national and international levels is the organization and presentation of information from all possible sources. There are no firm rules for this because every country will have differing types and amounts of information available, some of which may arrive late or may be of very poor quality and unreliable.

WHAT IS THE JOB OF THE LOCUST INFORMATION OFFICER?

Because of the need for accurate information for every aspect of survey and control, a locust-affected country should have at least one person who is responsible for managing locust and environmental data. This person is usually known as a Locust Information Officer and should be based at the Locust Unit headquarters (see Fig. 4). The duties of the Locust Information Officer are to:

- register data received from survey and control operations and from other sources such as meteorological services and FAO
- enter data into a computerized information management system, if available
- check and correct data received from the field – this may require contacting Locust Field Officers
- plot data on maps
- analyse locust and environmental information
- forecast locust breeding and migration
- summarize the current situation
- provide information and advice to the Locust Unit Head
- send data and reports to FAO and other countries
- prepare summaries and reports to advise the Locust Unit Head on planning survey routes and prioritizing control
- archive all information that is received
- develop case studies of a particular situation
- maintain regular contact with Locust Unit Head, Locust Field Officers and Officer-in-charge of campaigns

The ideal officer should have a sound working knowledge of data management and analysis combined with experience in locust operations. A person with good analytical skills who can assess data in different ways is most valuable. Computer experience is generally required as most data management, analysis and transmission are being computerized. The officer should know how to use word-processing programs, spreadsheets, databases, graphics and e-mail applications, and fully understand the concepts and use of GPS, maps and compasses. Previous experience or training in the fields of geography, remote-sensing or general research often helps.

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FAQ number 2 (see p. 44 for answers)

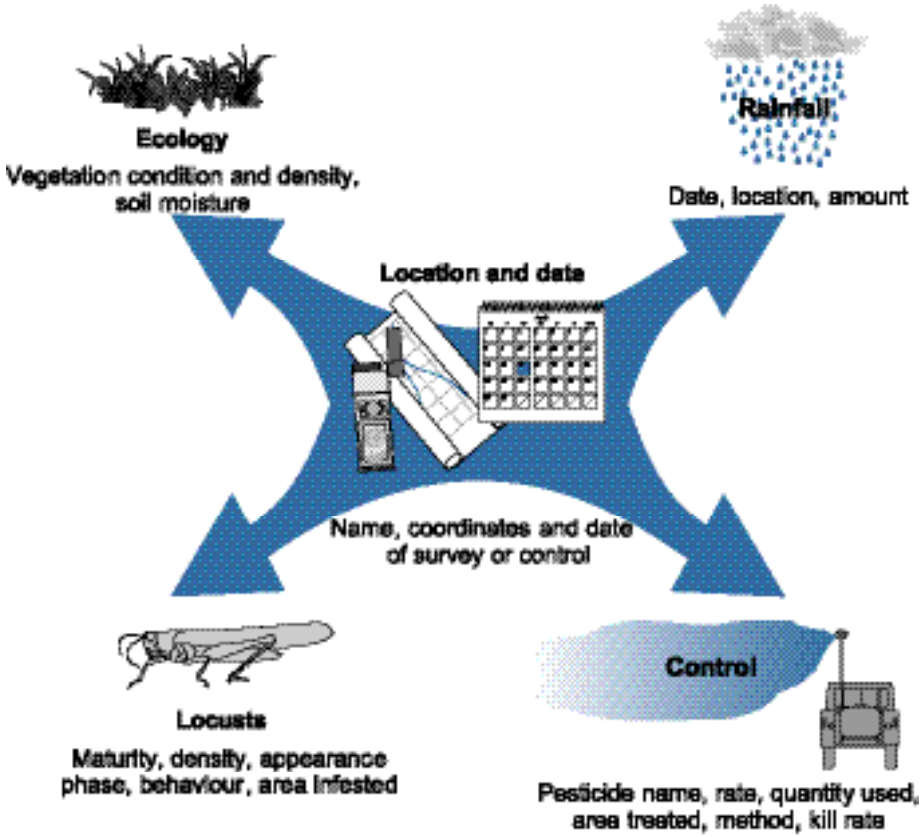
How many Locust Information Officers should a country have?

Summary of required data:

- ecology
- rainfall
- locust details
- control

Each of the above should include the date, name and coordinates

Figure 5. Data used for assessment and forecasting.



WHICH DATA ARE REQUIRED?

In order to assess the current locust situation properly and prepare an accurate forecast, four primary types of data are required: ecology, rainfall, locusts and control (see Fig. 5). The location and date should be associated with each of these data types.

The location is the name of the place where the survey or control was undertaken, its latitude and longitude coordinates obtained from a map or a GPS. The date is the day, month and year that corresponds to the specific data type. In the case of ecological, locust and control data, this will be the date of observation or when the control was undertaken. In the case of rainfall, it should be the date when the rain actually fell rather than the date when it was reported. For example, it was learned on 12 May that heavy rains fell on 5 May. The latter date should be reported.

Ecological data consist of an estimate of the size of the area (in hectares) in which each survey or control was undertaken, a one- or two-word description of the habitat (such as wadi, plains, dunes, crops) and, for each location, the condition (dry, greening, green, drying) and density of the vegetation, and an indication as to whether the soil is moist enough for locust breeding. Additional data on vegetation species, size and coverage may be useful for calibrating remote-sensing imagery but this requires experienced Locust Field Officers and takes time to collect.

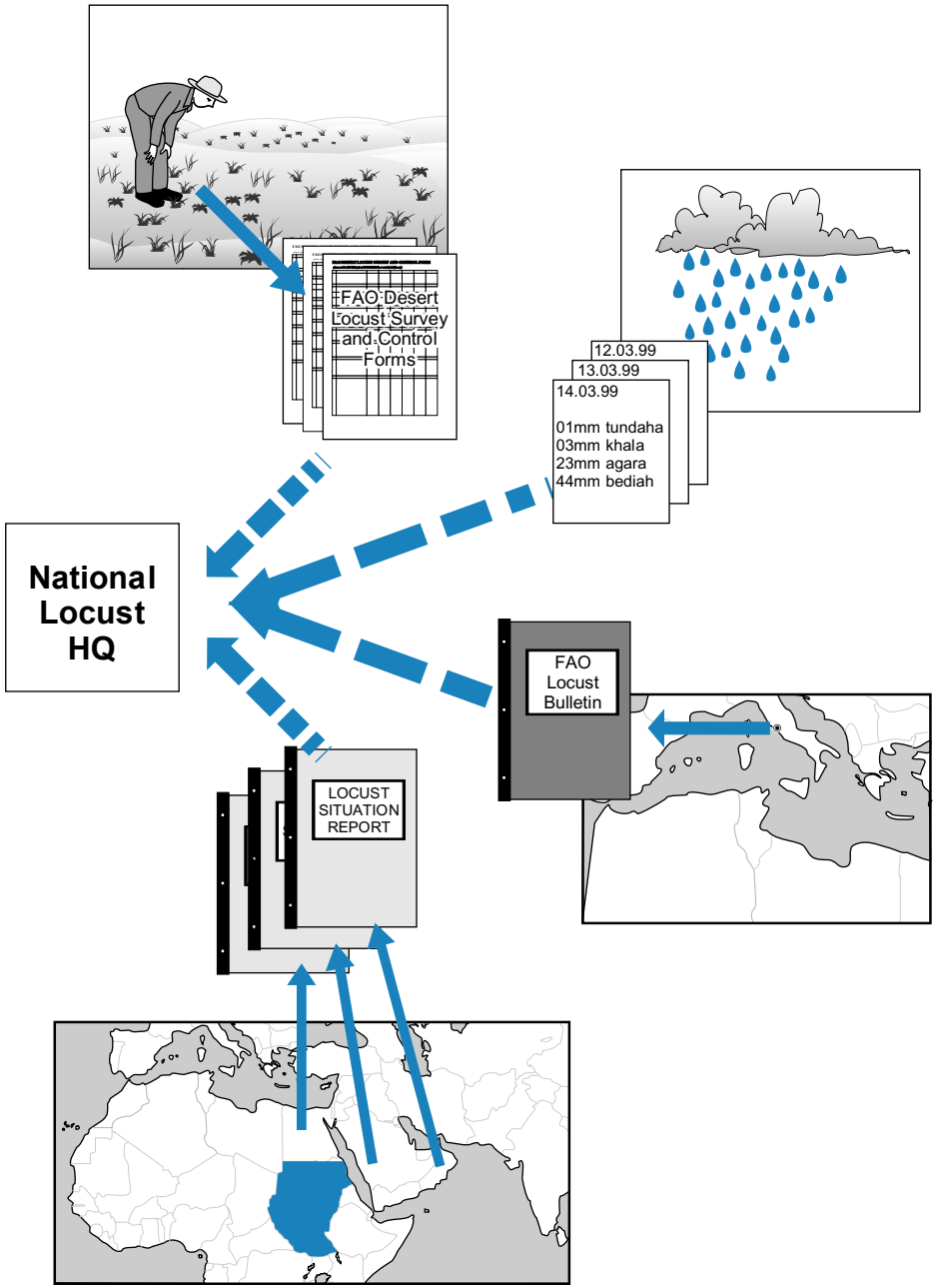
Rainfall data consist of the date and amount of the last rain that fell. A rough estimate can often be obtained by asking locals during a survey. The date and quantity of the first rains of the season can also be useful. Additional data, such as temperature, pressure and wind, are usually available from the national meteorological service (see the following pages).

Locust data consist of details on hopper and adult maturity, density, appearance, phase, behaviour, laying and area infested at each survey or control location.

Control data consist of the name, application rate and quantity of the pesticide used, the area treated (in hectares), the method of application and a rough estimate of the efficacy of the operations in terms of percent kill. If control is being carried out after a survey team has identified the target infestation, then this should be linked to the survey report. This should help to overcome the difficulty of knowing which of the infestations have been controlled.

Tip: requesting extra data that are not directly used for assessment, forecasting and planning purposes may not be desirable because they take additional time to collect and analyse.

Figure 6. Obtaining locust and weather information from field surveys, national meteorological services, FAO and other affected countries.



How to get Desert Locust data

The majority of the data that a Locust Information Officer receives should come from experienced Locust Field Officers who undertake survey and control operations in the field (see Survey and Control guidelines). Each Locust Field Officer should complete the *FAO Desert Locust Survey and Control Form* (or similar form) in the field at the survey site (see How to report survey results on p. 47 of the Survey guideline and Appendixes 2.1 and 4.1). If control is undertaken, then the *FAO Spray Monitoring Form* should be completed as well and attached to the survey form (see Monitoring control operations on p. 71 of the Control guideline and Appendix 4.2). These forms should be sent by fax, e-mail, radio or hand-carried to the National Locust headquarters (see Fig. 6). If they arrive by radio, the radio officer should complete a duplicate form.

Additional information will come from less experienced people such as agricultural extension agents and scouts as well as from non-locust experts such as travellers, truck drivers, farmers, government agents, villagers and nomads. Often this information will not be specific or complete. Therefore, these data should be treated as unconfirmed until they can be checked by qualified Locust Field Officers.

Locust situation reports may arrive from other affected countries or regional organizations. In addition, information will also come from the FAO DLIS in Rome which prepares a bulletin every month that contains a summary of the current situation and a forecast. This is supplemented by updates, warnings and alerts to specific countries during periods of increased locust activity.

Tip: the most reliable locust reports come from experienced Locust Field Officers. Reports from other sources should be confirmed by a Locust Field Officer whenever possible.

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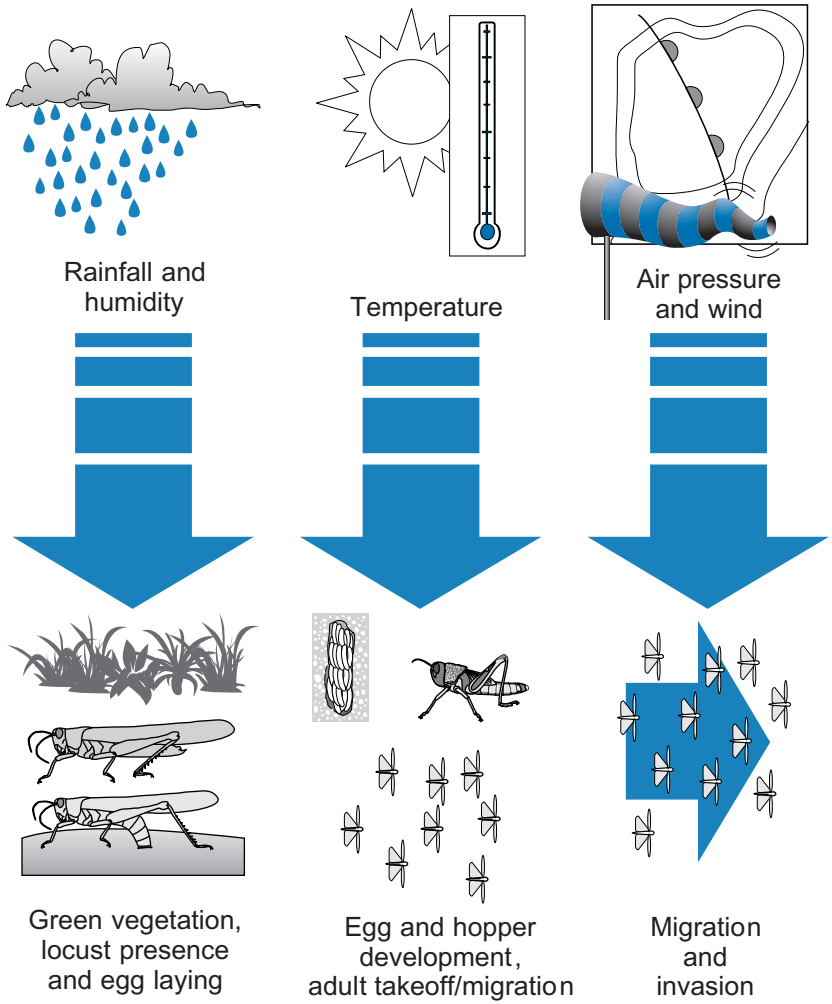
FAQ number 3 (see p. 44 for answers)

Does every locust-affected country collect the same data?

Summary of meteorological data:

- rainfall
- temperature
- wind speed and direction

Figure 7. The importance of meteorological data.



Meteorological data

Rainfall, temperature, relative humidity, wind and atmospheric pressure data are usually available from national meteorological services. These data are important for assessing the locust situation and forecasting its developments (see Fig. 7). Rainfall data can be used to identify which areas may be suitable for breeding or where green vegetation and locusts may be present. Temperature data can be used for estimating the development rate of eggs and hoppers as well as indicating whether it is warm enough for adults to take off. Wind and synoptic data are useful during periods when adults are likely to be migrating or if there is an invasion threat from a neighbouring country.

The number of active meteorological stations in a locust-affected country is likely to be limited and probably will not give a sufficiently accurate picture of conditions in all locust areas. Nevertheless, the data can provide useful estimates for planning, analysing and forecasting. The National Meteorological Service may be able to provide the Locust Unit with data on a daily, weekly, decadal (ten-day), fortnightly or monthly basis but this may require a formal agreement and it may not be a free service. Daily rainfall and temperature data supplied on a decadal or fortnightly basis during recession and plague periods are usually sufficient. During periods when adults may be migrating or there is an invasion threat, wind, synoptic and temperature data may be required on a daily basis. However, this could be difficult to arrange at short notice. Locust Units are encouraged to contact their National Meteorological Service for more details.

In addition to national meteorological services, data may be available from other sources such as irrigation and other agricultural projects, or from regional and district authorities. It may be useful to investigate the possibility of collaborating with these sources.

Tip: if you are requested to pay for meteorological data, you should decide whether the data are worth paying for. The data should be received in a timely manner on a regular basis. Request only data that are useful to you; otherwise, you may receive too much data or data you will never use.

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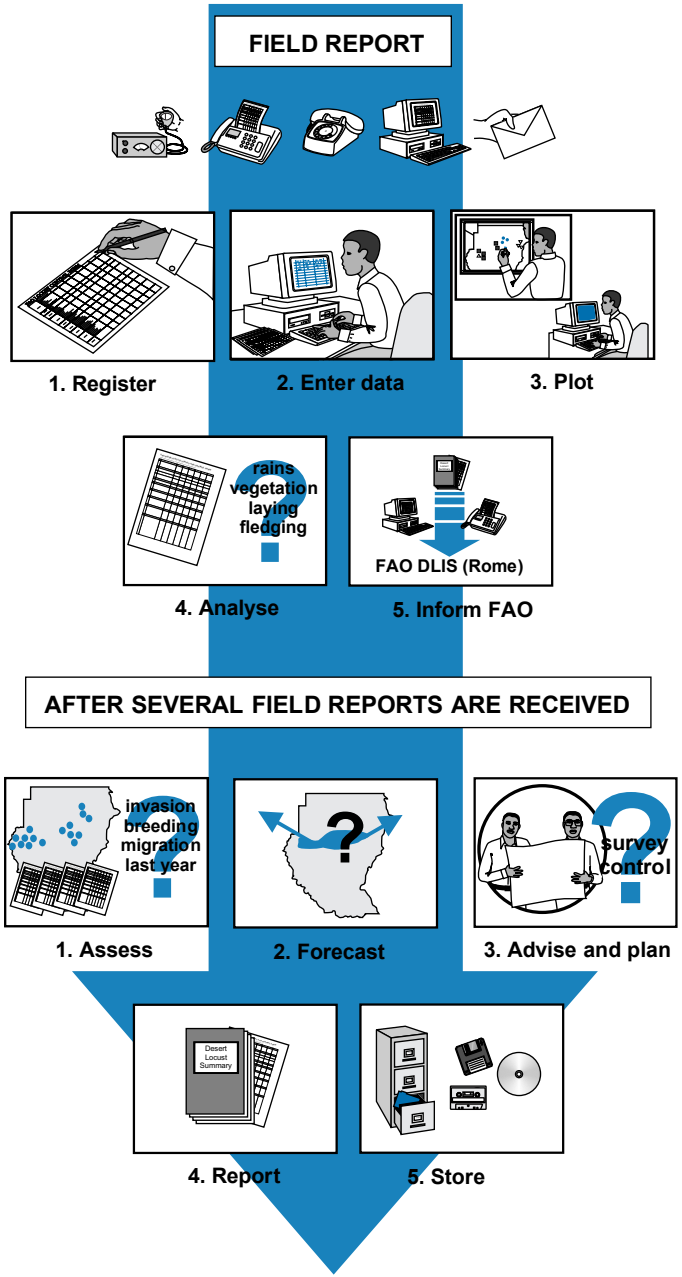
FAQ number 4 (see p. 44 for answers)

What do I need to know about meteorology in order to understand and use meteorological data?

Figure 8. Processing field reports in a locust-affected country.



WHAT TO DO WHEN A FIELD REPORT ARRIVES

Any report received from the field, another organization or country, or from FAO should be systematically processed at the National Locust Unit headquarters (see Fig. 8):

1. Give the report a unique identification code, write it on the top corner and record it on a registration form.
2. Enter the data into a computerized database, if available. During this process, check the data to make sure that they are correct and complete. Indicate on the report that they have been entered into a database to prevent a duplicate entry.
3. Plot survey and control results on a map either by hand or using a computerized program.
4. Analyse the ecology, weather, locusts and control data to try to understand what they mean and what immediate action is required. Experienced officers with a good understanding of locust behaviour and the area where the report comes from should be able to analyse the report in a sensible manner. Write a short sentence or two on the report itself, indicating its interpretation and significance. If it is important, you may want to discuss it with the Locust Unit Head.
5. Inform FAO in a timely manner by sending field reports of surveys and control results directly to DLIS as soon as they are received, corrected and analysed (steps 1-4). This means that FAO should be informed by the next day and certainly no later than five days after the end of the survey.

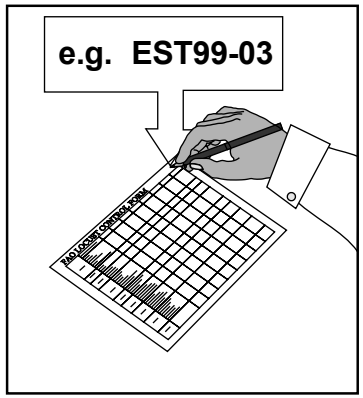
Using this report and other reports that have recently been received:

1. Assess the current situation by combining the analysis of all the recent survey and control results with available meteorological and habitat information. Compare this with previous reports and historical data to understand how the current situation has developed and changed over time.
2. Prepare a forecast based on the assessment of the current situation. A forecast may be very simple or complex, depending on the situation and time of year. It should be updated as new information is received.
3. Present the assessment and forecast to the Locust Unit Head and discuss what further survey and control operations are required, including locations and timing.
4. Prepare and distribute weekly, decadal, fortnightly or monthly summaries as required. The type of summary and its contents will vary from country to country. Each summary should contain at least some information about the current weather, habitat conditions, locust situation and a forecast. Send a copy to FAO. Reports should also be prepared and presented to the Donor Steering Committee.
5. Save and store every field report after it has been registered, entered, plotted, analysed, sent to FAO and included as part of a summary. Do this in an organized way so that reports are not lost and can be easily found for future reference.

The following pages will go into further detail on each of these steps.

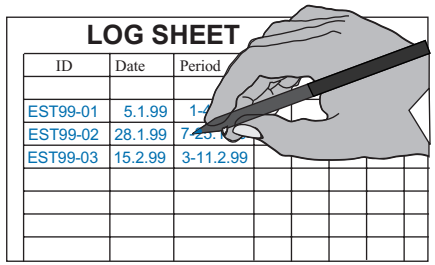
Figure 9. The first step in organizing locust, rainfall or weather data that has been received from the field is to register it.

1 Give the report its own unique identification code and write it in the top corner

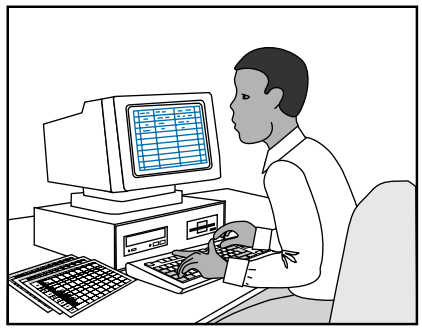


2 Enter this ID code and basic information (date received, period of coverage, locusts, rain, ecology, control) on to a log sheet.

A separate log sheet should be used for each year. You may also want to use a separate one for each province if you receive many reports.



3 Log sheets can also be maintained on the computer and printed when needed.



4 Field reports should be filed in an organized manner: one folder per country, region, province or district per year.

Registration: how to organize data

Many affected countries will often receive a large quantity of survey and control reports from the field either on a regular basis or during a locust outbreak, upsurge or plague. Locust Units may also receive other information such as meteorological data, reports from other countries and FAO bulletins. Therefore, it is necessary to have a simple but effective system to organize this information so that any single report can be easily found and no report is lost.

One suggested method is to use a registration form or log sheet (see Fig. 9). In this system, each report that is received from the field is given a unique identification code. For example, the code could consist of an abbreviation, the year and the report number. The fifth Bulletin received from FAO in 1999 may be given the code FAO99-05 or the third report in 1999 from the eastern region or province in your country may be indicated by EST99-03. A registration form should be made for each country, region or district from which reports are received. A new form should be started for each year.

Once the report has been given its identification code, some basic information should be entered on the registration form. This could include the date the report was received; its identification code; the period the report covers; whether the report contains any information about swarms, bands, adults, hoppers, laying or hatching, control, ecology and rainfall; if the report has been entered into a database; if the report has been sent to FAO; and in which decadal, fortnightly or monthly summary does information from the report appear.

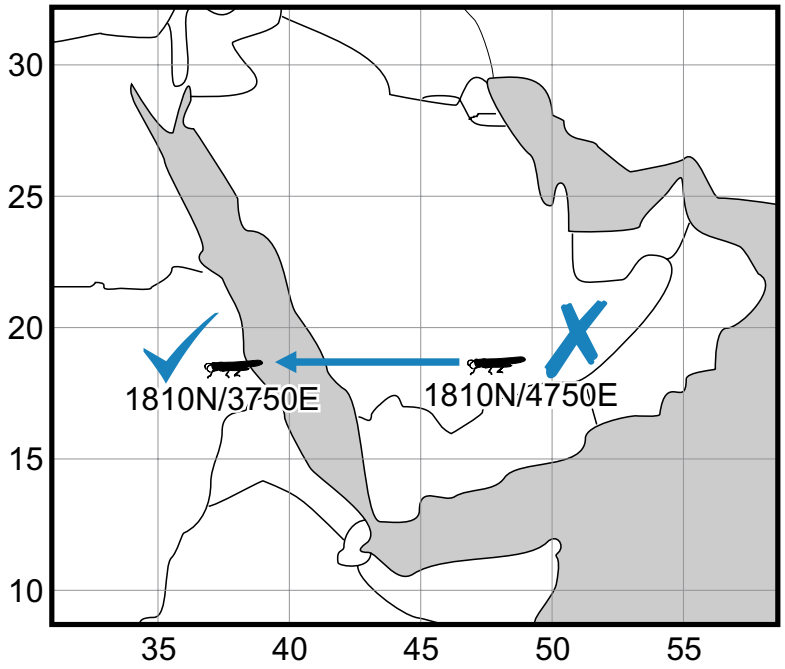
It may be convenient to keep the registration forms together in a single notebook or as a computer file for easy access. Field reports should be filed in their proper folders, one folder per country, region or district per year. These, in turn, should be kept in a safe and dry place such as a filing cabinet, organized by year.

Tip: if you use a system of registration, every report you receive should be given an unique identification code. It is also a good idea to register reports and information that you send out. This requires a very disciplined approach.

Summary of what to check:

- coordinates
- dates
- locust details

Figure 10. Processing reports: checking and correcting data.



Tip: if you think the coordinates may not be correct, try to imagine what mistakes you could make when reading maps or recording latitude and longitude in the field. Often, numbers are reversed or are wrong by 1, 10, 20 or 30.

How to check and correct data

Some reports that arrive from the field may contain data that are incorrect or missing. In these cases, it is up to the Locust Information Officer to correct the data or request clarification from the field.

Many of the errors or missing data involve the coordinates of the location of the survey or control operations. Often, the location name may be reported without coordinates. The Locust Information Officer should try to find the name of the reported location on any available maps or gazetteers and determine the correct coordinates. This means that a good stock of maps at different scales should be maintained in the Locust Information Office. The most useful map scales are those between 1:100 000 and 1:1 000 000. Maps of 1:100 000 will cover a smaller area but in much greater detail than those of 1:1 000 000. Gazetteers, or indexes of place names, may be available in your country or within an information management system such as RAMSES. Do not rely too heavily on place names alone as these can vary considerably from what is indicated on a map. There may often be several places with the same name in a country.

Another common mistake is that the coordinates were reported incorrectly. Again, the Locust Information Officer should try to correct these by finding the location name on a map and determining the right coordinates (see Fig. 10). If this is not possible, the Officer may have to make an estimate by guessing that the coordinates are off by one full degree or a fraction of a degree such as 10, 15 or 30 minutes north, south, east or west. Sometimes, longitude may be reported as E when it should be W, or vice versa. These are common mistakes that occur when determining coordinates from a map in the field.

Alternatively, the Locust Information Officer may wish to contact the Locust Field Officer for this information. This may also be necessary if data are missing about the ecological conditions or about the locusts which the Locust Information Officer cannot supply.

Tip: be sure to differentiate between the 0bserved date and the RADIOED date. The observed date is the date on which the observation was made. The radioed date is the date on which the information was sent. These often differ.

?

FAQ number 5 (see p. 44 for answers)

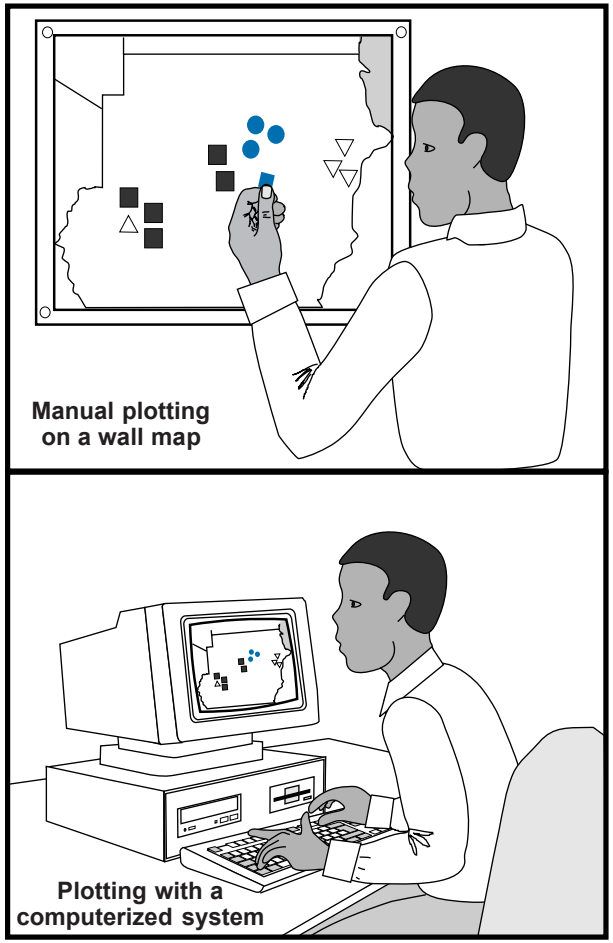
What are some of the common mistakes made when determining and recording coordinates?

Summary of what to plot:

- rainfall
- ecology
- locust details
- control operations

Include the date for each of these

Figure 11. Processing reports: plotting data.



Plotting: how to display data

After the report has been registered, each survey result should be plotted on a detailed map. This will help you to understand better where locust infestations are present, where surveys were conducted, where there is green vegetation and where there have been reports of rainfall. It will give you a visual picture of the locust situation in your country. From this, it will be easier to make a more accurate analysis and forecast.

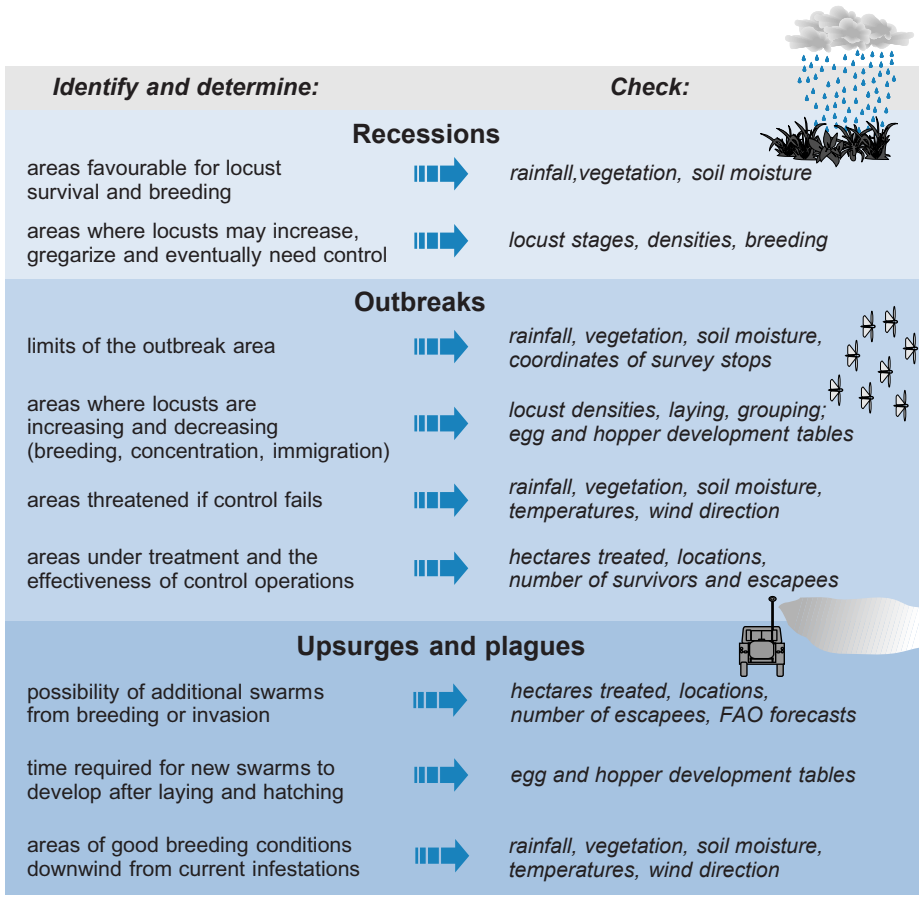
There are two ways to do this: either by hand or by using a computer program (see Fig. 11). If you are plotting by hand, then you must select a map of a suitable scale. If you only want to concentrate on a very small area, then a map of 1:250 000 scale may be adequate; if you will be plotting over a large area, then 1:500 000 or 1:1 000 000 or larger will be better. Most of these maps should be available from the National Survey Department in your country or they can be requested from FAO. You will also need some transparent film or paper, coloured pencils or stickers, a ruler and a large flat surface such as a table or a wall where you can work. The map may either hang on a wall or be placed on top of a table.

Each survey result should be plotted one by one on the map, either directly on the map (if it can be erased or cleaned off), or on transparent film, glass or paper on top of the map. Use coloured pencils or stickers to indicate different types of information such as locusts, rainfall and vegetation. You will also want to be able to show different types of locust maturity, density and areas infested. This can be done by using different colours or symbols. One set of symbols that can be used are those found in the monthly *FAO Desert Locust Bulletin*. Every report should be plotted if possible. You may need to create a new map every few weeks or after every month.

If you are using a computerized program, such as the RAMSES application, the software will automatically do the plotting, but first you must enter each survey result into the computer's database. In order to do this, each result must have coordinates. If not, the computer does not know where to place the symbol on the map. You will find that this method is much easier than plotting by hand. It is also a very powerful tool because the computer stores all the survey results that you have entered in its database. This allows you to query (or ask) the database for any type of data for any period of time in order to make a custom map. For example, your query could be for all the reports of mature adults that were seen laying any time between 1 January and 15 March 1999. The computer will then search its database and display symbols on a map showing the results of your query. Many different types of queries can be made as long as you have entered the data into the computer's database.

Tip: plot data carefully and slowly. It is easy to make a mistake when reading maps or when entering data into a computer database. Check your work often.

Figure 12. The analysis of locust survey and control results within a country will vary according to whether it is during a recession, outbreak, upsurge or plague.



Example: *A survey team reports breeding in two areas but control is not required.*

1. Analysis:
- *use development model or table to estimate laying, hatching and fledging dates*
- *use previous survey reports to see if other areas contain similar populations*
- *use rain and vegetation data to explain reported breeding and to suggest other areas*
- *use historical records of breeding to remind you of all potential breeding areas*

2. Are there areas that cannot be surveyed?
- *use remote-sensing imagery, or ask FAO for advice, on the potential in these areas*

3. Does this season's rainfall and vegetation suggest locust increase, gregarization or decline?
- *use this season's rain data and long-term means to identify unusually wet or dry areas*
- *use case studies and your (and the Locust Field Officer's) experience as analogues*

4. Write brief notes outlining your assessment.

Analysis: how to understand survey results

The results of each Desert Locust survey and control operation undertaken should be analysed or interpreted in order to try to understand what they mean. This can only be done once all available weather, ecological, locust and control data have been plotted, either by hand or using a computer programme (see Plotting on the previous page). Survey results should include the Locust Field Officer's interpretation or opinion of what the survey results mean in addition to the actual details (such as the completed *FAO Desert Locust Survey and Control Form*). This will help the Locust Information Officer during the analysis. Information obtained from other sources such as the National Meteorological Service or from FAO should be used. Remote-sensing imagery, if available, for estimating rainfall or green vegetation may also be helpful.

Based on the analysis, immediate action should be taken. How data are analysed and what follow-up action is required will vary according to whether it is a recession, outbreak, upsurge or plague situation (see Fig. 12). Longer-term action and planning should not only be based on analysis of survey results but should also consider the Information Officer's assessment and forecast of the situation (see Using assessments and forecasts for planning on p. 33).

Recession periods

During recession periods, it is important to determine which places are favourable for locust survival and breeding. If locusts are reported, identify the areas where there is a possibility of populations increasing to significant numbers that may eventually need to be controlled. Determine which areas require further survey.

Outbreaks

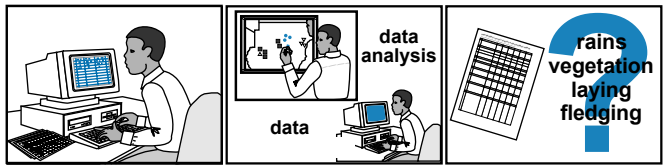
It is important to define the area that is affected by locusts based on the survey results. Within the outbreak area, locate those places where control operations are in progress and where locust numbers may be increasing or decreasing as a result of breeding, concentration or immigration. Use egg and hopper development tables or models to estimate development times (see Appendix 5.1). Examine the possibility of the outbreak extending to new areas by identifying other locations where conditions are favourable which are downwind from current infestations. Estimate the effectiveness of the control operations and determine where further control is required.

Upsurges and plagues

During upsurges and plagues, the analysis concentrates primarily on swarms and the potential for migration within a country as well as invasions from other countries and regions. The possibility of new swarms, either from invasion or local breeding, should be determined. Using ecological data, remote-sensing and daily winds, identify those areas where favourable breeding conditions exist which are downwind from current locust infestations and that could be invaded. Estimate the time required for the development of new swarms from laying to hatching and fledging using tables or models (see Appendix 5.1).

Figure 13. Analysis of the current locust situation within a country.

1 Are all reports entered in the database, plotted and analysed?



2 Using the above information and data:

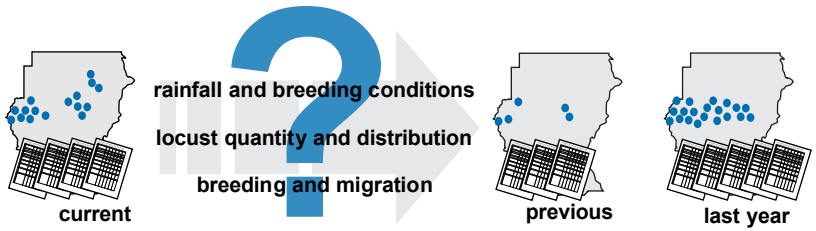
Examine the current situation
- locust maturity
- locust distribution
- locust behaviour and phase
- unsurveyed areas

Compare with
- previous report(s)
- previous years
- recession and plague frequencies

Assess the influence of
- rainfall
- vegetation
- temperature
- habitat suitability
- control

Determine from previous reports
- changes in the current infested area and locust phase
- changes in current locust development
- changes in current locust displacement
- undetected areas of locusts, rain, vegetation
- unusual rainfall
- recession, outbreak, upsurge, plague, decline

Examine
- similar (analogous) situations in the past
- any available case studies of analogous situations



HOW TO ASSESS THE CURRENT SITUATION

The current locust situation is best understood by combining the analyses of all the recent survey and control results with available meteorological and habitat information. Compare this with previous reports and historical data to understand how the current situation has developed and changed over time (see Fig. 13). During recessions, you should try to determine if there were any changes in (a) rainfall, especially any unusual rains; (b) the habitat including breeding conditions; (c) the infested areas; (d) the number of locusts present and their phase; (e) potential breeding in known as well as unsurveyed areas; and (f) possible adult movement. During outbreaks, upsurges and plagues, you should try to detect changes in (a) the number and sizes of infested areas where hopper bands and adult swarms are present; (b) the distribution of the infested areas due to local breeding, migration and invasion; and (c) the impact of control operations.

You should also compare the current situation with that of previous years for the same time period to see how it is similar or different. This will be of use when you are preparing a forecast (see the next section).

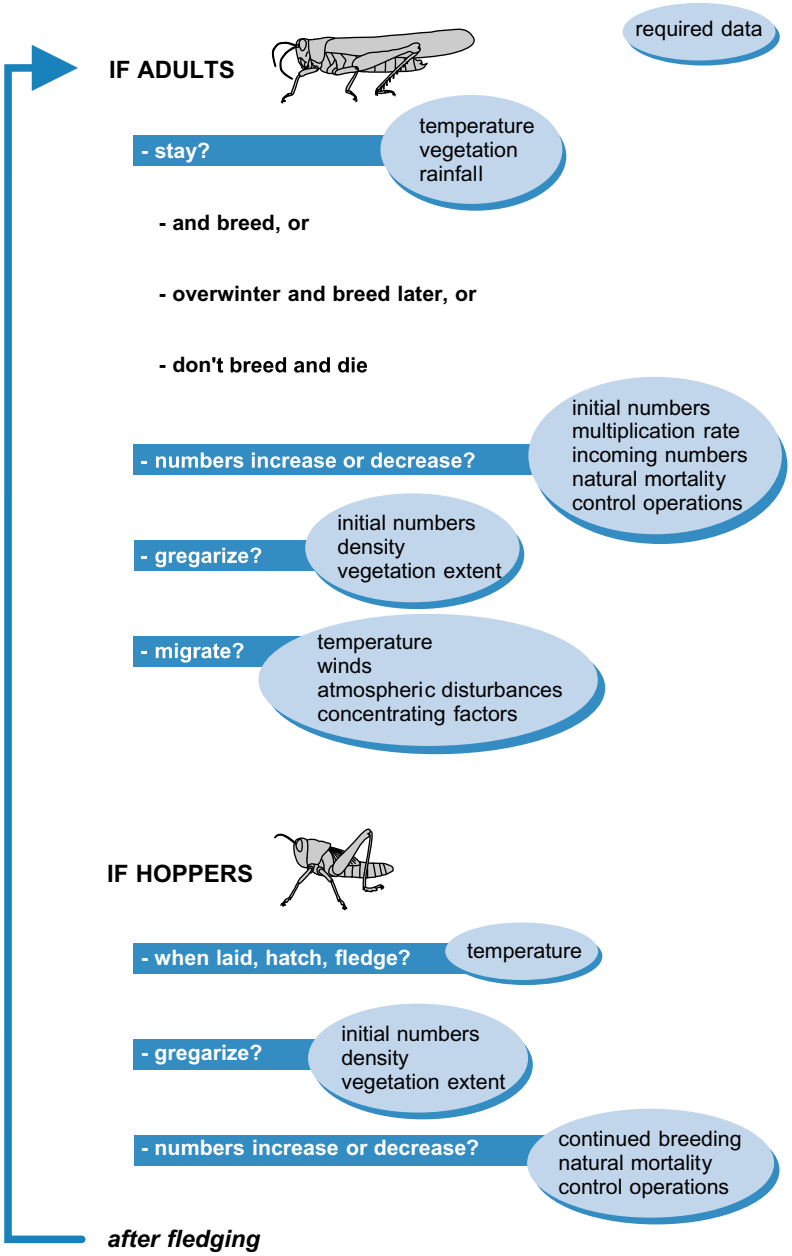
Tip: during recessions, try to identify:

- ***areas where locust numbers may increase***
- ***areas where gregarization may start to occur***

FAQ number 6 (see p. 44 for answers)

Is it possible to have several different assessments for the same situation? Which one is correct?

Figure 14. Preparing a national forecast: adults and hoppers.



HOW TO MAKE FORECASTS

A forecast is your best estimate of what may happen in the future. National forecasts should concentrate on estimating the timing and the scale of breeding and migration by adults and the development rates of hoppers in your country. You should indicate what you think will happen to the hoppers and the adults that may already be present or could be present in the future. Forecasts are important when planning what survey and control operations may be required and what, if any, donor assistance may be needed in your country. They can also help FAO to forecast the possibility of significant locust infestations developing and warn other countries of the likelihood of invasions.

As breeding and migration depend on the weather, specifically rainfall, temperature and winds, and because weather is difficult to forecast accurately in advance, Desert Locust forecasts may not be as precise as many people wish. Nevertheless, you should try to provide the best estimates you can. These should be based on your analysis of the information that has been received from the field and your assessment of the current situation. Your familiarity with the locust habitats, the seasonal changes in locust distribution and breeding and the corresponding climate and weather in your country as well as your own experience will be of great help. When forecasting, you may want to concentrate on events that are mostly likely to occur and avoid those that are likely to happen only in very rare circumstances. Remember that forecasting is often more of an art than a science!

Adult forecasts

If adults are reported, forecasts of what will happen to adults should indicate if they will stay or if they will migrate, if they will breed, if the population will increase or decrease, and if gregarization will occur (see Fig. 14). This should be based on your analysis of temperature, vegetation, rainfall, winds, initial and incoming locust numbers, breeding and the effect of control operations.

If adults are present, they will either stay in or near the area where they have been reported or they will migrate. This will depend on temperature, rainfall, vegetation, winds and their maturity. If conditions are favourable, they are likely to stay. If this is the case, they can breed quite soon (mature, green vegetation, moist soil, warm temperatures), they could wait and breed later (immature, good conditions but temperatures may be low), or they do not breed and simply die (poor conditions and too cold to migrate). If conditions are poor, they are likely to migrate. Based on winds, previous cases and your experience, estimate when they might migrate and to where.

Hopper forecasts

If hoppers or copulating adults are reported, forecasts of what will happen should indicate when laying, hatching and fledging are expected, if gregarization will occur, and if locust numbers will increase or decrease (see Fig. 14). This will depend on rainfall, vegetation, soil moisture, initial locust populations and control operations. Refer to the egg and hopper development tables in Appendix 5.1.

Figure 15. Preparing a forecast by comparison to similar (analogous) situations that occurred in the past.

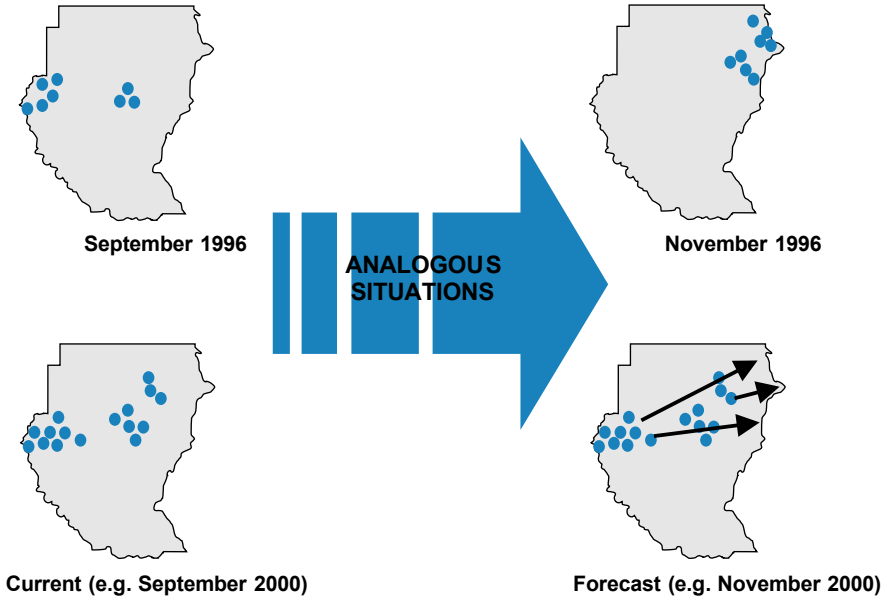
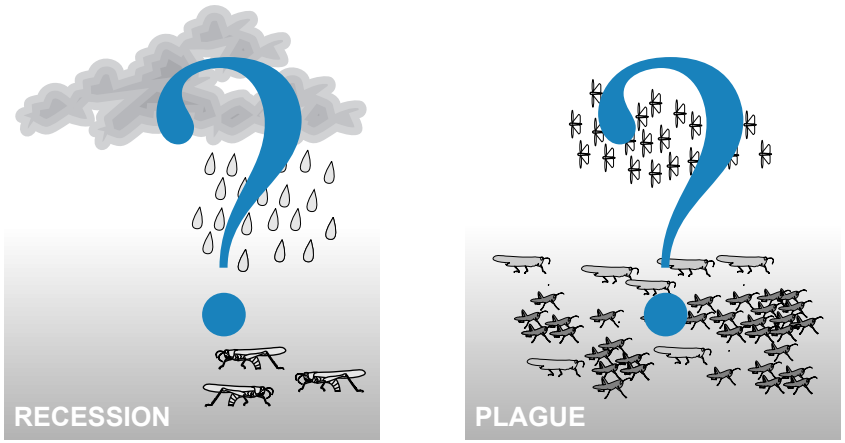


Figure 16. Forecasts during recessions should concentrate on predicting the location, timing and scale of breeding. Forecasts during plagues should focus on the timing, scale and possible destinations of swarm migration.



Forecasts based on similar situations in the past

A common method of forecasting is to try to find a situation that occurred in the past which is similar to the current situation (see Fig. 15). From this, you can study what happened during the situation in the past and consider the likelihood of this occurring again in the current situation. This is often referred to as forecasting based on analogous situations. This method depends on your own experience and the availability of case studies. A case study is a particular situation that has been examined in detail. The results of this examination are written up as a report, often with illustrations and maps. You may find that there are very few case studies available for the situation that you are interested in. This is why it is important to undertake such studies yourself that can be used in the future (see Case studies on p. 43).

Forecasting during recessions and plagues

During a recession, it is important to detect, as early as possible, where breeding may be occurring (see Fig. 16). Breeding requires the presence of both locusts and rain within a seasonal breeding area. It is unlikely that the distribution of the solitarious population will be sufficiently well known in your country. Furthermore, rainfall in desert areas is highly variable and may not always be reported. This means that any area where substantial rain has fallen at the right season must be regarded as a possible site for breeding. When rain occurs in the right quantity at the right time, some solitarious locusts usually appear to take advantage of the conditions. Therefore, the estimation of the occurrence of rain is the main concern during recessions. On the other hand, the seasonally infested areas during plagues normally receive enough rain for successful breeding. Therefore, the forecasting of swarm migration becomes the critical activity. This is essentially a task for DLIS since swarms can cross a continent within a few weeks and individual countries are not likely to have sufficient information to forecast such movements.

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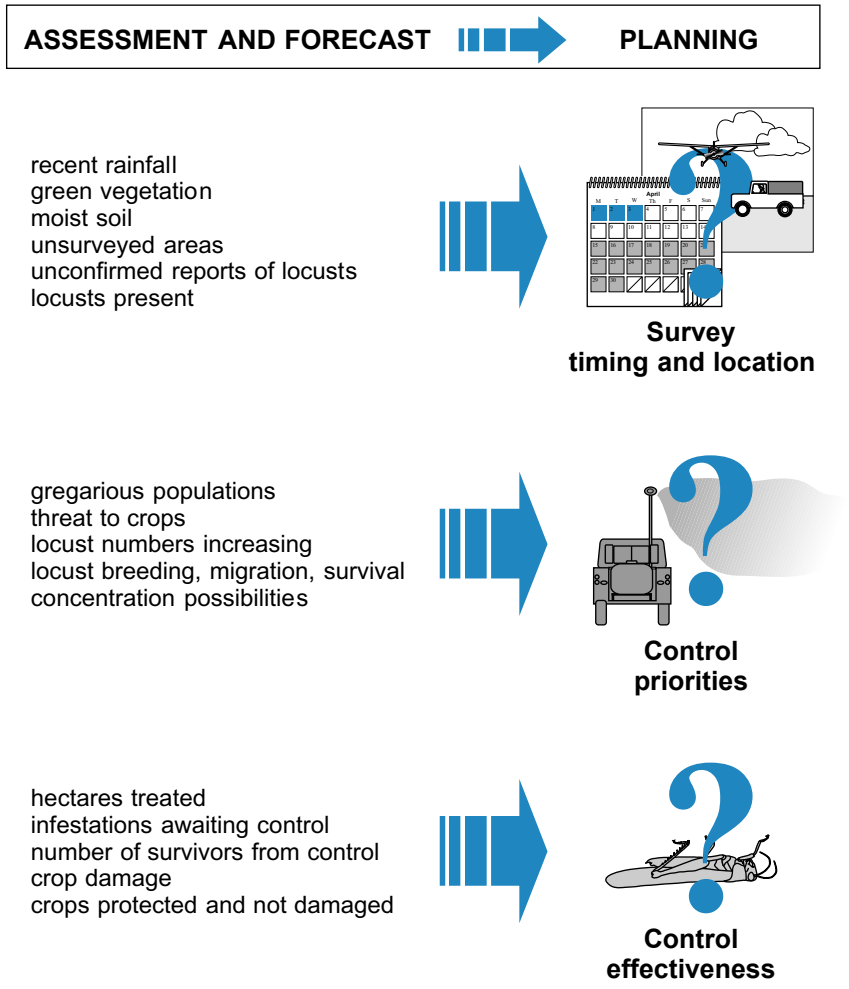
FAQ number 7 (see p. 44 for answers)

How accurate are locust forecasts?

Summary of using assessments and forecasts for planning:

- the timing and location of surveys
- the areas that require control
- the effectiveness of control operations

Figure 17. Using assessments and forecasts for planning.



USING ASSESSMENTS AND FORECASTS FOR PLANNING

In all cases, whether recession, outbreak, upsurge or plague periods, planning further surveys, determining control priorities and estimating the effectiveness of the current campaign should be based on the assessment of the current situation and the forecast of expected developments (see Fig. 17).

When and where is survey required?

From the survey results, identify those areas where rains have fallen recently, vegetation is green, soil is moist and locusts are present. Further surveys should be considered in these areas. Determine which areas have not been surveyed but may have received rain, where ecological conditions may be favourable, or where there have been unconfirmed reports of locusts. These areas need surveying. If breeding is in progress, estimate when fledging will occur. If adults are present, determine if they will move, when and to where to estimate the timing and location of surveys.

What are the control priorities?

Identify those populations that are gregarious or are becoming gregarious. These should be a high priority for control. If they threaten crops, they may require immediate control. Identify those populations that are dense or are increasing in density and could be future control targets. Take into consideration current ecological conditions and their effect on locust breeding, migration and survival. If the vegetation dries, there is a risk that locusts could move and concentrate in areas that are still green. If these locust gregarize, they should become a control priority.

How effective are the current control operations?

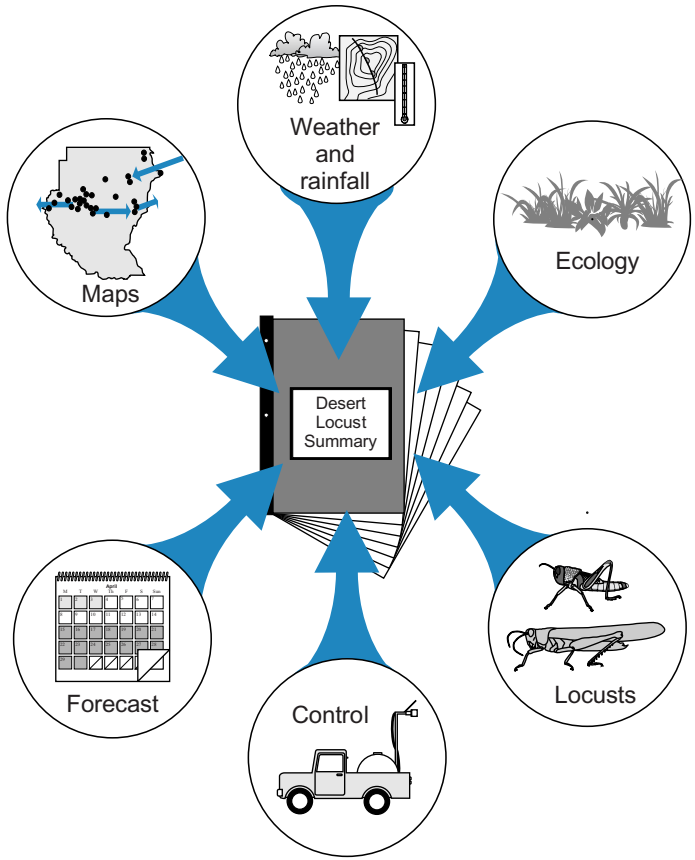
Calculate the number of hectares treated so far and the number and area of infestations awaiting control. Estimate the number of survivors that may require further control. Determine if there was crop damage and, if so, how much. Identify those areas near crops where control was undertaken that prevented damage.

It is nearly impossible to cover all areas during surveys, so there may be locusts present that were not detected or reported. Similarly, control may not always be effective and there may be some locusts that escape control operations.

Summary of information to be included in a national report:

- weather and rainfall
- ecology
- locusts
- control
- forecast

Figure 18. Preparing a summary of the situation and a forecast in a country.



Tip: for large countries, you may want to organize the information according to administrative regions or seasonal locust breeding areas.

HOW TO REPORT

National reporting

Requirements for national reporting will vary from country to country. The Locust Information Officer may be required to present information to the Locust Unit Head and the Donor Steering Committee and to prepare situation summary reports (see Fig. 18).

Presenting information

The following information should be included when making presentations to the Locust Unit Head and to the Donor Steering Committee:

- how ecological conditions affect locust breeding, migration, and survival?
- what is the distribution of the populations – in which areas of the country?
- if control operations were carried out – how, on which infestations and how many hectares were treated in total?
- which areas still need to be surveyed and controlled (and when)?
- what is the likelihood of crop damage?
- what is expected to occur in the coming weeks?

Preparing summaries

The summary should be based on the assessment and forecast of the current situation. It should be written in a clear and concise manner, and divided into several sections:

Weather and rainfall. Summarize in what direction the prevailing wind was blowing if known, the range (minimum and maximum) of temperatures during the day and night, and the locations, dates and quantities of rainfall that were reported. Try to indicate if these were normal or above or below normal.

Ecology. Indicate where vegetation is becoming green, is already green, becoming dry and is already dry, including the stage of any nearby crops. A map showing areas of green vegetation, recent rainfall and prevailing winds could be useful.

Locusts. It may be necessary to summarize a large quantity of data from surveys into just a few sentences or paragraphs. These can be presented in chronological order or by region or district. Provide just enough detail to explain the current situation and link it to the weather, rainfall and ecology.

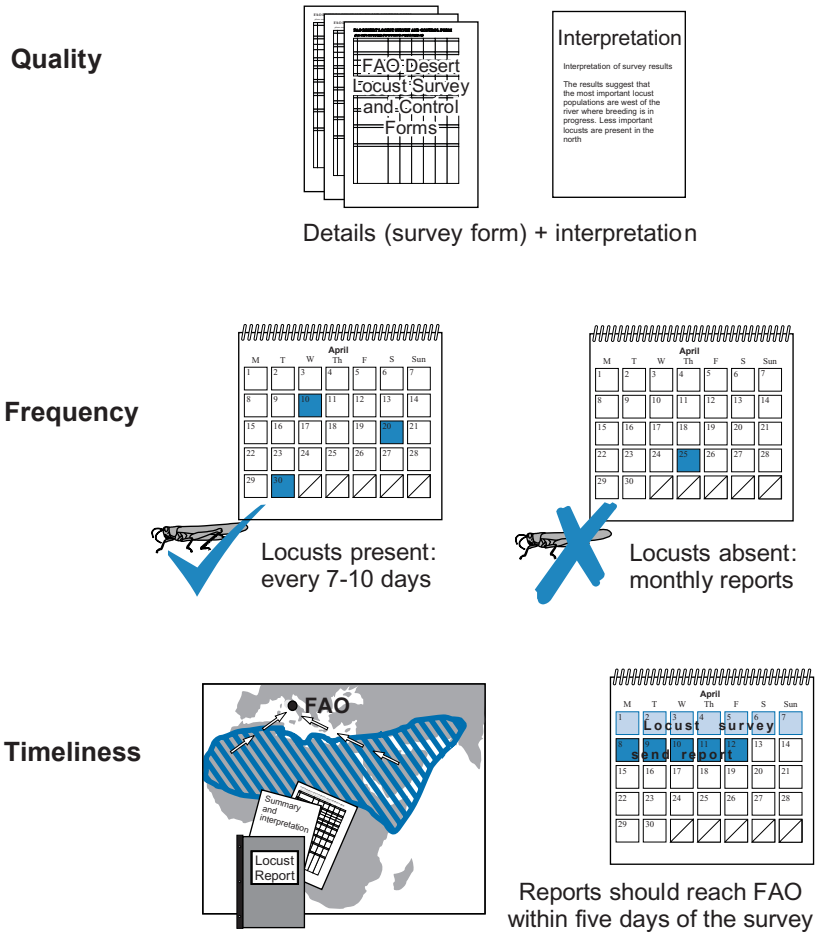
Control. Indicate when, where and how control operations were carried out, how much pesticide was used, how many hectares were treated and against what types of locust infestations, such as swarms or hopper bands. A map showing locations of current infestations that were controlled and those that require control could be useful.

Forecast. Estimate the timing and the scale of breeding and migration. Try to include a map showing areas and timing of expected breeding and migration.

Summary of reporting to FAO DLIS:

what:	● details of survey results (FAO form) ● simple and brief interpretation of results
when:	● within 5 days from end of survey ● at least by the 25th day of every month
how often:	● 7-10 days (when locusts are present) ● monthly (when locusts are absent)

Figure 19. Good reporting to FAO.



Reporting to FAO

As Desert Locusts can move rapidly between countries and regions, it is important to have a global view of the situation. This allows analysis and forecasts to be made so that affected countries can be warned in advance of potential invasions and threats of locust buildup. This work is done by DLIS in Rome as part of FAO's mandate. In order to carry out these activities effectively, DLIS relies on data and assessments received from affected countries.

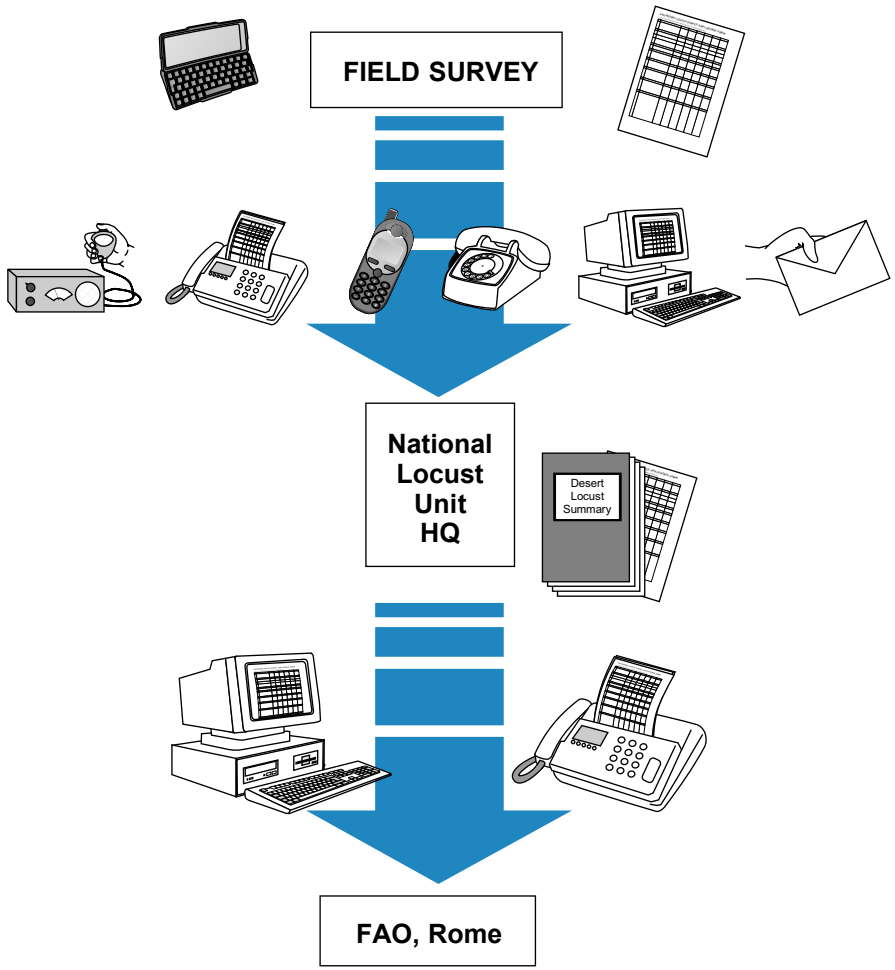
It is critical that complete locust information arrives at FAO as quickly as possible so that timely warnings and forecasts can be sent to threatened countries (see Fig. 19). Affected countries are encouraged to adopt the following procedures:

- results from survey and control operations should be sent to FAO as soon as these activities are completed, or no later than five days after the last day of the survey or control
- during periods when locusts are present, FAO should be informed on a weekly basis with full details
- during periods when locusts are not present, FAO should be informed on a monthly basis even if only to say that there are no locusts or that there were no surveys conducted. These reports should be sent by the 25th day of the month so they can be included in the monthly *FAO Desert Locust Bulletin*
- details from survey and control operations with a brief interpretation of these results should be sent directly to FAO DLIS by fax or e-mail. If the *FAO Desert Locust Survey and Control Form* is used, this should be faxed or sent as an e-mail attachment. If RAMSES is being used, the appropriate data should be exported as a file that can be sent by e-mail

FAQ number 8 (see p. 44 for answers)

What happens when a poor report is received by FAO from a locust-affected country?

Figure 20. The transmission of data and reports.



FAO DLIS (Rome)

Tel.: +39 (06) 570 52420 Fax: +39 (06) 570 5527

E-mail: eclo@fao.org

HOW TO SEND INFORMATION

Results from survey and control operations must be transmitted from the field where they were undertaken to the National Locust Unit headquarters (see Fig. 20). From there, information must be transmitted to FAO DLIS in Rome. Therefore, it is likely that the ways of transmitting data within a country and internationally may be different.

From the field: radio, fax, telephone, e-mail, hand-carry

HF radios, faxes, telephone, e-mail and hand-carrying are the main ways to transmit survey and control results from the field to the National Locust Unit headquarters. In remote areas, radios and perhaps relatively new equipment such as handheld computers that can send data via HF radio modems are probably the most suitable for transmission of survey and control results. If surveys are carried out near villages or agricultural offices that have e-mail or fax machines, the transmission of completed forms and brief interpretations may be possible using these means. As mobile (or cellular) phone services become available in affected countries, this may be an additional means of transmitting information.

If radios or telephones are used, then every detail from the completed survey form should be clearly transmitted. At the recipient end, a duplicate form may have to be completed. This type of transmission may be problematic because of the difficulty of hearing the Locust Field Officer clearly, the possibility of making mistakes, and the need to complete a new form. Data entered at the survey location into a handheld computer can be downloaded directly into a computerized database, such as RAMSES, without having to re-enter the data into the computer at the National Locust Unit headquarters.

The original report and forms should always be given to the National Locust Unit headquarters in case the report was poorly received by radio which leads to errors or when only summaries are sent by radio.

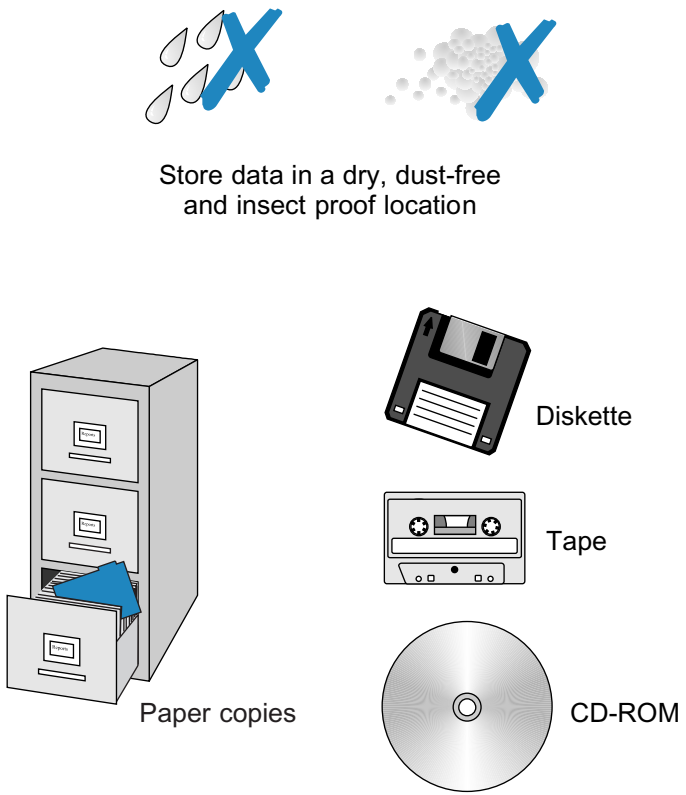
To FAO: e-mail, fax, internet

The transmission of the completed *FAO Desert Locust Survey and Control Form* with its interpretation to FAO DLIS is best done by e-mail or fax. E-mail is generally preferred because it is cheaper, clearer and the data can go directly into a database that is part of a large computerized geographic information system at DLIS, called SWARMS. This is used for data management and analysis. If RAMSES is being used by the country, an output file can be created and sent by e-mail with a brief interpretation of the data. Eventually as Internet access becomes more widespread and faster, this may be an additional method of transmission.

Summary of data storage media:

- paper copies (in filing cabinets)
- computer hard disk
- CD-ROM
- tape
- magneto-optical diskette

Figure 21. Storing and archiving data.



HOW TO STORE DATA

It is very important to store the results from surveys and control operations as well as all locust reports, summaries and bulletins (see Fig. 21). You should try to find a safe place to store this information at the National Locust Unit headquarters, somewhere that is dry, free of dust and insect proof. Sturdy filing cabinets may be a good way to store the information. As mentioned earlier, you may want to organize this information by year. You may want to store recent years in a filing cabinet that is easy to access while those from a long time ago may be in several filing cabinets that may be less accessible. It is important to organize this storage in such a way that you know where everything is and it is easy to find whatever information you may be looking for in the future.

Electronic copies of field reports could be archived by scanning these into a computer, using a sheet-feed scanner, and burning them onto a CD-ROM. Several backup copies of each CD-ROM should be made. Archived reports on a CD-ROM can be viewed on a computer or printed as a hard copy. Contact FAO DLIS for more information.

Data that have been entered into a computerized database or custom application such as RAMSES will be automatically stored in the computer. Nevertheless, it is an essential practice to make regular backups of these data on to another hard drive, CD-ROM, or other type of storage media. Ideally, backups should be stored in a separate building. This will also become critical as more and more data are entered into the computer.

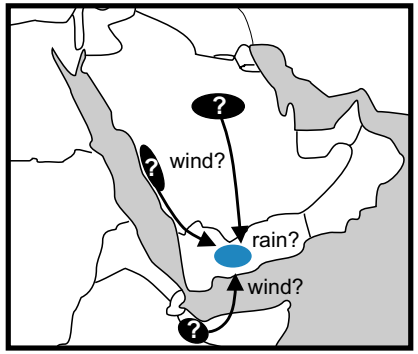
Tip: it is essential to back up data on a regular basis. These backup copies should ideally be stored in a separate building to avoid fire.

?

FAQ number 9 (see p. 44 for answers)

What is the best method for storing locust and habitat data?

Figure 22. Some common steps taken when making a case study.

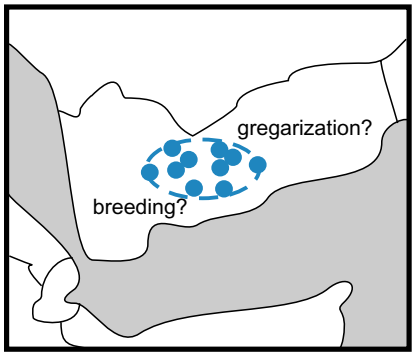


1. Origins

Determine the sources of the initial populations and their migration routes and timing.

Examine all available data to determine when it rained and when conditions became favourable.

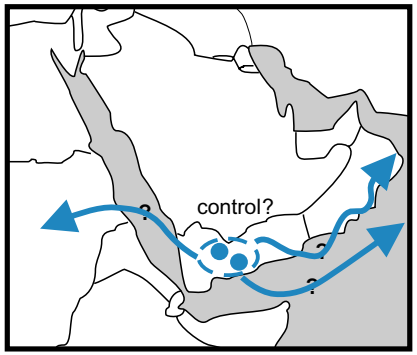
Estimate the dates of first arrivals and first laying.



2. Development

Study the distribution of populations and breeding over time and the change in locust numbers in response to the habitat.

Estimate the dates of laying, hatching and fledging as well as the scale of breeding and first formation of groups, bands and swarms.



3. Decline

Determine the effects of control operations and drying conditions on locust numbers.

Examine the timing and scale of migration out of the infested areas and possible destinations.

Compare this situation with other similar instances in the past.

HOW TO MAKE A CASE STUDY

In order to improve our understanding of locust behaviour and population dynamics, it is important to make an in-depth and detailed study of a particular locust situation (see Fig. 22). Such studies can be very useful for forecasting because the Locust Information Officer will often try to find a past situation that is similar to the present locust situation. If by chance a case study has been undertaken for that particular situation, it could give the officer valuable insight as to what could be expected to occur in the near future.

When preparing case studies, you should try to determine or establish:

- the origin of the locust infestations
- the timing and extent of rainfall and green vegetation
- the number of locusts present and how this has changed over time
- the area infested and how this has changed over time
- the timing and areas of breeding
- the phase change of the locusts
- the timing and routes of immigration and emigration
- the impact of chemical and natural control
- the frequency of historical infestations in the area of study
- analogous events

Those interested in undertaking case studies and who would like to have additional guidance should contact FAO DLIS.

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FAQ number 10 (see p. 44 for answers)

Where can I find other case studies that have been undertaken?

FREQUENTLY ASKED QUESTIONS (FAQS)

1. What information does FAO DLIS provide to affected countries and donors, and how can I receive it?

Answer: The Desert Locust Information Service (DLIS) at FAO headquarters in Rome operates a centralized information and forecasting system to keep affected countries and donors informed on a regular and timely basis of the current locust situation. It provides forecasts of up to six weeks or longer of potential breeding, migration and other significant developments that could occur. Survey data and field reports received from affected countries are analysed together with data on the ecological conditions, rainfall reports and weather data. These are compared to historical data and analogous situations in order to provide a meaningful forecast. DLIS issues a monthly bulletin throughout the year which is transmitted by e-mail, fax, post and FAO pouch during the first week of the following month. During periods of increased locust activity, updates are issued in between the bulletins. Countries are immediately alerted or warned when any significant event occurs. The bulletins and other information on plagues, publications, FAQs, training, and locust-related links can also be found on their Internet site (www.fao.org/news/global/locusts/locuhome.htm). On the site, an interactive mapper program allows users to plot the current or recent locust situation on a map, download it and print or save it. This is the best way to keep up-to-date on the locust situation. Contact FAO DLIS for more information or if you want to receive the bulletins.

2. How many Locust Information Officers should a country have?

Answer. This depends on the size of the country as well as the size of the national locust programme. Large countries such as the Sudan, Saudi Arabia and India may need several officers in order to manage properly the large amount of data that is received from the field. One person may be the designated Locust Information Officer, supplemented by several assistants. On the other hand, one Locust Information Officer is probably adequate in smaller countries or in those countries where locusts are active only a few months in a single year.

3. Does every locust-affected country collect the same data?

Answer: Those countries with an active monitoring programme in which surveys are carried out by Locust Field Officers generally collect the same basic data as presented in this guideline. Some countries may collect additional data pertaining to the habitat. It is important to remember that there is a trade-off between the quantity of data collected at a survey stop and the time required to collect these data. It should be clear before collecting the data how they are to be used.

4. What do I need to know about meteorology in order to understand and use meteorological data?

Answer: A basic understanding of meteorology is useful when trying to understand meteorological data and incorporate them into an analysis of a particular locust situation. Some areas on which to concentrate are: seasonal wind and rainfall patterns, atmospheric disturbances, sources of rainfall and winds, temperature and wind relationships, convergence zones, monsoons, cloud types, low-level inversion and convective buildup, and how data are collected and reported at the national and international levels.

5. What are some of the common mistakes made when determining and recording coordinates?

Answer: When determining coordinates from a map, it is easy to misread the latitude or longitude by a factor of one degree, 10, 15 or 30 minutes, or to reverse the numbers (e.g. 1531 instead of 1513). Coordinates may also become changed when transcribing from Arabic to Roman numerals. Latitude and longitude coordinates can be inverted as well; for example, 3513N/2911E should be 2911N/3513E. This is more problematic in countries where the latitude and longitude are similar (e.g. Chad, Egypt, Libyan Arab Jamahiriya, Senegal). Other errors occur if some field officers using GPS are recording their location in decimal degrees while others are using degrees, minutes and seconds. All GPS units should be standardized on the latter setting.

6. Is it possible to have several different assessments for the same situation? Which one is correct?

Answer: Yes. This will vary according to the quality of the data, their interpretation, and the experience and insight of those who are analysing the data. In most situations, there is no single correct assessment but some may be closer to the truth than others.

7. How accurate are locust forecasts?

Answer: The accuracy of locust forecasts varies greatly. Forecasts that are more general in time and space are usually more accurate than those that are more detailed and specific. But general forecasts may be less useful. Forecasting unusual events that occur irregularly is less accurate than forecasting seasonal events. It is difficult to test the accuracy of locust forecasts because they are based on probabilities. These probabilities would need to be categorized from the outset and only over time could one tell if they are correct.

8. What happens when a poor report is received by FAO from a locust-affected country?

Answer: If a report is extremely vague without any details, it is difficult for FAO DLIS to analyse it and use it for assessment and forecasting purposes. Therefore, the Locust Information and Forecasting Officers at DLIS in FAO headquarters

make every effort to contact the national Locust Information Officer in the affected country and ask for clarification or more details. This is done directly by telephone, e-mail or fax.

9. What is the best method and medium for storing locust and habitat data?

Answer: The field of electronic storage is rapidly changing with new equipment and media being introduced nearly every year. At present, the most durable and long-lasting media are magneto-optical disks but these can be expensive. Tape media are often the best for large storage requirements but they may not last very long and can be difficult to manage. Overall, CD-ROMs may be the most practical for locust units because they are inexpensive, convenient, durable and easy to exchange.

10. Where can I find other case studies that have been undertaken?

Answer: Case studies that have been undertaken for various locust situations can be found in the published literature as well as obtained from locust organizations or institutes such as the Natural Resources Institute or FAO. RAMSES includes case studies for the particular country in which the program is installed. See Appendix 5.9 for more details.